EMPLOYEES' INSURARANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

a. PENSION SYSTEMS (Continued)

DISABILITY PENSION (Cont'd.)

1) Fixed sum of $90.00 subject to all deductions of the "one per cent formula" except that the full amount of the Social Security disability benefit is deductible. Rarely yields the greatest pension figure. This is a change from the previous figure of $75.00.

2) The "minimum pension formula" as described for an age pension.

3) The "one per cent formula" as described for an age pension. Deduction for Social Security disability benefit is limited to $85.00. Generally, the other deductions apply as they do in an age pension.

EARLY RETIREMENT - An eligible employee may elect to retire early on an age pension. He may make this election any time between his 60th and 65th birthdays. He may choose either (1) a normal age pension deferred to age 65 as computed under this Agreement, but based on continuous service only to the date of early retirement, or (2) an immediate age pension based on continuous service to the date of early retirement but reduced to its equivalent actuarial value at the time of retirement.

DEFERRED VESTED PENSIONS - An employee whose service terminated in a layoff with no recall within two years or by the permanent shutdown of an operation may receive an age pension at age 65 as computed under this Agreement if (1) he was age 40 or older at the expiration of the two years following layoff or at the time of termination, (2) has a minimum of 15 years of continuous service, and (3) makes application for the pension no earlier than 90 days prior to his 65 th birthday and no later than age 70.

BENEFITS EXTENDED TO PRESENT PENSIONERS - By side letters of agreement which are not a part of the Pension Agreement and do not set a precedent, the minimum monthly pension is increased for pensioners (age and disability) who retired under the 1954 and 1949 Pension Agreements. Those who retired from 11/1/1954 to 11/1/1957 will be paid a monthly minimum of $2.25 for each year of continuous service and those who retired between 3/1/1948 and 11/1/1954 will receive a monthly minimum of $2.00 for each year of continuous service with a maximum of 30 years applying in both instances. No deduction for Social Security. Where pensions greater than the new minimums are being received, there will be no change. Recomputation for these pensioners is automatic, and no further application on their part is necessary.

SURVIVORSHIP OPTION - An eligible employee may elect an actuarially-reduced pension at retirement and upon death have a like amount or an amount half as great continued during the lifetime of a "co-pensioner" previously named by the employee. This election and the naming of the co-pensioner must be made by the employee five or more years prior to age 65 or retirement, whichever is earlier, on a form furnished by the Company.

2.

a. PENSION SYSTEM (Continued)

SURVIVORSHIP OPTION Cont'd.)

An election of this kind at a later date is possible, but it is then subject to the approval of the Pension Committee and will require satisfactory evidence of the good health of the employee. The contract language includes rules to govern the revocation or change of the election as well as the status of the election in the event of the death of the employee prior to retirement or age 65, the death of the co-pensioner before or after the retirement of the employee, and so forth. Present eligible employees between ages 60 and 65 must make an election before January 1, 1958 and will be contacted in the very near future. In the future all eligible employees will have to accept or refuse this option prior to attaining age 60.

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

a. PENSION SYSTEMS (Continued)

Funded Pension Plan (Cont'd.)

During the year the following age pensions were granted:

Name	Mine	Eff.Date	Gross Pension	Net Pension
Carl V. Sholund	Canisteo	2-1-57	130.00	45.00
Ray Borlace	Maas	1-1-57	176.62	92.00
Lenwood R. Williams	General Shops	1-1-57	176.29	91.00
Martin Flaa	General Shops	1-1-57	184.58	100.00
John V. Neva	Sargent	2-1-57	122.17	37.00
John E. Ketola	Bunker-Hill	2-1-57	118.33	33.00
Andrew A. Hemmila	Maas	2-1-57	126.33	41.00
Charles E. Pellonpaa	Cliffs-Shaft	2-1-57	140.00	55.00
Francesco A. Cetola	Hawkins	2-1-57	134.17	49.00
Earl Rule	Negaunee Shaft	4-1-57	101.10	16.00
Jacob Saari	Bunker-Hill	3-1-57	132.17	47.00
Frank J. LaCombe	Maas	3-1-57	140.00	55.00
Gust L. Nelson	General Shops	4-1-57	156.73	72.00
Victor Siltala	Cambria-Jackson	4-1-57	140.42	55.00
Ettore Vecellio	Maas	4-1-57	146.42	61.00
Adolph Anderson	Maas	4-1-57	139.50	55.00
Richard Oien	Maas	4-1-57	143.20	58.00
Arturo C. Paulon	Bunker-Hill	5-1-57	121.67	37.00
Julius Koski	Maas	6-1-57	140.00	55.00
Thomas A. Sparnoll	Maas	6-1-57	146.00	61.00
Sam Siltanen	Cliffs-Shaft	6-1-57	140.00	55.00
Emil Nicolle	Spies	7-1-57	140.00	55.00
Fred Bath, Sr.	Maas	10-1-57	140.00	55.00
Silas J. Moquin	Cliffs-Shaft	8-1-57	110.17	25.00
John C. Paavola	Cambria-Jackson	8-1-57	140.00	55.00
Howard Rochon	Maas	8-1-57	110.50	26.00
Onnie Jaurakainen	Maas	8-1-57	140.00	55.00
John S. Carlson	General Storehouse	9-1-57	110.33	25.00
Isaac J. Wahto	Sargent	9-1-57	127.17	42.00
Clifton Huddy	Maas	10-1-57	140.00	55.00
Andrew L. Ruhkala	Bunker-Hill	11-1-57		53.00
Alex Hulti	Sargent	11-1-57		66.80
John Bann	Hawkins	11-1-57		39.80
Frank Dushane	Cambria-Jackson	12-1-57	66.75	66.80
John Alvari	Maas	12-1-57	72.01	72.00
William T. Pascoe	Cliffs-Shaft	12-1-57	52.11	52.10
John Oljymaki	Mather Mine "A"	1-1-57	125.33	40.00
Alfred E. Beadle	Mather Mine "A"	4-1-57	121.83	37.00
John A. Maki	Mather Mine "A"	4-1-57	133.00	48.00
Hugo Johnson	Mather Mine "B"	8-1-57	140.00	55.00
John O. Anderson	Mather Mine "A"	8-1-57	181.29	96.00
John J. Argall	Mather Mine "B"	9-1-57	140.00	55.00
Emil M. Warlin	Mather Mine "B"	11-1-57		51.80
Arthur Fogelberg	Holman-Cliffs	2-1-57	133.67	49.00

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

a. PENSION SYSTEMS (Continued)

Funded Pension Plan (Cont'd.)

There were 44 age pensions granted during the year.

A standard Social Security deduction of $85.00 is provided by the pension contract on all age pensions effective on or after November 1, 1954. For that reason the amount of Social Security is not shown in the above list.

During the year the following disability pensions were approved.

Name	Mine	Eff.Date	Gross Pension	Net Pension
John F. Lucas	Sargent	5-1-57	86.92	87.00
Joseph E. Scanlon	Maas	8-1-57	75.00	34.50
Leo J. Savageau	Bunker-Hill	12-1-57	39.41	39.40
Emil Holmi	Mather Mine "B"	3-1-57	75.00	75.00
Eug[illegible] C. Carlson	Mather Mine "A"	6-1-57	82.91	83.00
August L. Hintsala	Mather Mine "A"	11-1-57		72.00

Revisions to the Social Security Act provided for a disability insurance benefit effective July 1, 1957. This benefit was payable to covered workers over fifty years of age who are totally disabled and completely incapacitated, as far as earning wages is concerned. The maximum benefit is $108.50 per month. Under the provisions of our pension plan this disability insurance benefit was deductible in its entirety from the pensions of our disability pensioners. This was true only for the period from July 1 through October 31, 1957. Pension revisions effective November 1, 1957 provided for a computation without regard to Social Security. For the purpose of record it is noted that disability pensions were continued from July through October 1957 at the same rate as prior to 1957 in those cases where the actual disability insurance benefit was not being paid. There was considerable delay in the processing of the Social Security benefit and if it was later learned that a disability pensioner was qualified for the Social Security award a retroactive adjustment was made.

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

a. PENSION SYSTEMS (Continued)

Funded Pension Plan (Cont'd.)

The following pensions, twenty-seven in number, were discontinued during the year for the reasons shown.

Name	Mine	Pension No.	
Peter Drca	Hawkins	CC-148	Died 6/1/56
Carmelo Russo	Cambria-Jackson	CC-26	Died 11/1/57
Gust A. Johnson	General Storehouse	CC-60	Died 11/1/57
William K. Carlson	General Storehouse	CC-87	Died 11/22/57
Erick Jacobson	General Storehouse	CC-105	Died 11/24/57
James Ryan	Cliffs-Shaft	CC-122	Died 10/18/57
Chester A. Nelson	General Storehouse	CC-128	Died 10/26/57
John S. Carlson	General Storehouse	CC-140D	To age pension 9/1/57
Otto Hanninen	Maas	CC-146	Died 2/19/57
Joseph L. Riberdy	Lloyd	CC-149D	Died 1/11/57
Earl Rule	Negaunee Shaft	CC-156D	To age pension 4/1/57
Spaso Glusica	Agnew	CC-117	Died 8/10/57
Harry Johns	Maas	CC-197	Died 10/13/57
Richard Johns	Cambria-Jackson	CC-217	Died 11/12/57
Frank Dushane	Cambria-Jackson	CC-260D	To age pension 12/1/57
Carl V. Sholund	Canisteo	CC-261D	To age pension 2/1/57
Sam Trevarton	Spies	CC-282	Died 8/18/57
John Steve	Cliffs-Shaft	CC-291	Died 1/22/57
Arthur Truscott	Maas	CC-292	Died 2/19/57
Russell F. Pascoe	Maas	CC-297	Died 7/4/57
Martin Cimermancic	Sargent	CC-306	Died 7/18/57
Erland K. Maki	Maas	CC-308	Died 11/18/57
Jacob N. Hakala	Mather Mine "A" Shaft	NM-33	Died 8/1/57
Battista Cavallo	Athens	AM-9	Died 9/20/57
Daniel Fitzhenry	Holman-Cliffs	MC-10	Died 10/31/57
Tom Knudson	Holman-Cliffs	MC-16	Died 11/6/57
Grant Hess	Holman-Cliffs	MC-20	Died 2/4/57

At the close of 1957 there were 343 age pensioners and 13 disability pensioners under this plan in the Michigan and Minnesota Mining Departments.

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

a. PENSION SYSTEMS (Continued)

Pension Plan for Salaried Employees

The pension plan for salaried employees was effective January 1, 1951 and was revised November 1, 1956 and November 1, 1957. It has always been essentially a counterpart of the plan for the hourly-rate bargaining employees and reference may be made to the Funded Pension Plan - Hourly-rate Bargaining Employees for general details.

This Department handles the initial processing of all pension applications under this Plan and submits them to the Pension Committee in Cleveland for final disposition.

During the year the following pensions were granted under the Plan.

Name	Former Occupation	Eff. Date	Gross	Deductions		Net
Leonard Halmi	Janitor Hibbing Office	1-1-57	140.00	85.00	SS	55.00
Howard D. Maloney (Disability Pension)	Mech. Foreman Maas	1-1-57	219.16	62.81	CR	156.00
John S. McNabb	Chief Clerk Ishpeming Office	3-1-57	419.53	85.00 117.38	SS CR	217.00
Gunnard L. Wallenstein	Hydroplant Operator	4-1-57	146.18	85.00 55.64	SS CR	6.00
Swante Merrila	Diamond Drill Foreman	7-1-57	157.50	85.00 45.44	SS CR	27.00
Theodore E. Haglund	Warehouseman General Storehouse	7-1-57	151.81	85.00 48.65	SS CR	18.00
C.Leander Johnson	Mech. Foreman Mather "A" Mine	10-1-57	226.47	85.00 75.80	SS CR	66.00

Code letters for deductions: SS-Social Security
CR-Contributory Retirement-Company proportion.

A list of pensioners whose pensions were discontinued during the year follows.

George Quick	Agnew Mine	Died 1/2/57
Henry J. Mayrand	Electric Power Department	Died 3/15/57
Charles W. Urquhart	General Storehouse	Died 10/7/57

At the end of the year there were 47 age pensioners and 1 disability pensioner from Michigan and Minnesota Mining Departments under this plan.

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

a. PENSION SYSTEM (Continued)

Retirement Payrolls

The original purpose of the Retirement Payrolls was to supplement Social Security benefits being paid to our retired employees. The payrolls were initiated on March 16, 1939 and were the major retirement plan of the Company through February 1950 when the Pension Plan of March 1, 1950 became effective. This latter Pension Plan has all but eliminated additions to the Retirement Payrolls, and any additions now are in the nature of special cases.

A retired employee's Social Security benefit was originally supplemented by $10.00 per month over The Retirement Payrolls. Beginning with July 1948 this amount was increased by $10.00 per month in all cases so that the usual allowance over the payroll was $20.00 per month. The monthly allowances of each retiree was increased by $7.50 effective November 1, 1957 by direction of the Cleveland Office. Our retired employees carry fifty per cent of the life insurance in force on their lives at the time of their retirement. Since March 1, 1950 this is done without cost to the employee.

There were no additions to the Mining Department Retirement Payroll during 1957. The following retirees, ten in number, were dropped from the Mining Department Retirement Payroll during the year:

Name	Ret. No.	Amount	Reason
Frank Helgren	215	$ 20.00	Died 1/17/57
Erick Soyrinki	41	23.81	Died 5/4/57
Jacob Kivisto	258	35.00	Died 5/25/57
William Tobin	182	20.00	Died 8/18/57
Jules Verstraete	207	20.00	Died 9/24/57
Richard Williams	224	20.00	Died 8/5/57
Gust Wernholm	340	20.00	Died 10/2/57
Henry Heiser	102	20.00	Died 11/20/57
William Stanaway	344	20.00	Died 11/11/57
George R. Thompson	205	27.50	Died 12/22/57

Two Retirement Payrolls are prepared in this office to handle payments to Minnesota retired employees, one for the Canisteo Mine and the other for the Mesaba-Cliffs Mining Company - Mining Department.

There were no additions on the Canisteo Mine Retirement Payroll during the year. The following retiree was dropped during 1957:

Ole Sherman	Ret. No. 5	$20.00	Died 2/8/57

There were no additions on the Retirement Payroll of The Mesaba-Cliffs Mining Company - Mining Department during 1957. There were three deaths, as follows:

Andre Sasah	Ret. No. 6	20.00	Died 2/24/57
Matt Arminen	16	20.00	Died 2/3/57
M. E. Gaffney	23	20.00	Died 6/16/57

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

a. PENSION SYSTEM (Continued)

Retirement Payrolls (Cont'd.)

A resume of the 1957 Retirement Payrolls follows:

Number of Mining Department Retired Employees 12/31/1956	114
Number of Mining Department Retired Employees 12/31/1957	104
Total Expenditure to above employees for year 1957	$30,055.96
Number of Canisteo Mine Retired Employees 12/31/1956	3
Number of Canisteo Mine Retired Employees 12/31/1957	2
Total Expenditure to above employees for year 1957	$550.00
Number of Mesaba-Cliffs Mng. Co. Retired Employees 12/31/1956	16
Number of Mesaba-Cliffs Mng. Co. Retired Employees 12/31/1957	13
Total Expenditure to above employees for year 1957	$3,455.00
Total Number of Retired Employees 12/31/1956	133
Total Number of Retired Employees 12/31/1957	119
Total Expenditure to retired employees for year 1957	$34,060.96

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

a. PENSION SYSTEM (Continued)

The table below shows the pension payments for the Mining Department and Holmes Mine Department combined for the years 1908 through 1957. The Holmes Mine Department payroll became inactive with the death of its last pensioner on April 23, 1949.

Year	Old Age	Widows and Orphans	Total
1908 thru 1946	790,710.31	22,547.00	$13,257.31
1947	4,156.68	-	4,156.68
1948	3,840.68	-	3,840.68
1949	3,260.68	-	3,260.68
1950	2,400.68	-	2,400.68
1951	1,438.78	-	1,438.78
1952	1,076.00	-	1,076.00
1953	796.00	-	796.00
1954	936.00	-	936.00
1955	936.00	-	936.00
1956	936.00	-	936.00
1957	781.00	-	781.00
	$11,268.81	22,547.00	$33,815.81

Includes payment of $2,500.00 made by the Cleveland Office in 1930.

Republic Mine Department

This payroll is inactive. During its active years - 1920 through June 1953 - a total of $149,689.04 was expended over the Republic Mine Department Pension Payroll.

Land Department

This payroll is inactive. During its active years - 1927 through June 1953 - a total of $6,836.88 was expended over the Land Department Pension Payroll.

Furnace Department

This payroll became inactive in 1948. During the years when it was active - 1910 through 1948 - a total of $66,155.22 was expended over the Furnace Department Pension Payroll.

EMPLOYEES' INSURANCE, COMPENSATION AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

b. INCAPACITATED EMPLOYEES (DONATION PAYROLL)

During the year payments were continued to certain men who did not have sufficient service to bring them within the provisions of the Pension Plan of 1/1/1909 but whose cases had merit and to other men who retired under Social Security but had so little employment under that system that their benefits were inadequate. These payments were made over the Donation Payroll. Some of these men were totally disabled through mine accidents while others became incapacitated from illness or disease and required assistance because of large families. There have been no additions to the payroll since 1952. It is the policy to avoid additions to this payroll and it is employed only in unusual circumstances.

On February 1, 1947 direct relief in the form of grocery, clothing, and fuel orders was discontinued as a regular practice, and allowances over the Donation Payroll were granted in their place. At the close of 1957 only one such recipient - Mrs. Johanna Forstrom - remained on the payroll.

The Holmes Mine Department Donation Payroll became inactive on June 30, 1953. During its active years - January 1932 through June 1953 - a total of $18,920.92 was expended over the Holmes Mine Department Donation Payroll.

After being granted the Furnace Department donations were paid originally by the Furnace Department itself, and later by the Cliffs-Dow Chemical Company. By direction from Cleveland on September 1, 1937 the donations were paid by this office over the Furnace Department Donation Payroll. The payroll became inactive in August 1950 with the death of its last payee, and it will remain inactive. During its active years - September 1937 through August 1950 - a total expenditure of $11,910.00 was made over the Furnace Department Donation Payroll.

The Mesaba-Cliffs Mining Company Donation Payroll remained inactive during the year. The last payment over this payroll was made in March 1948. From the date of origin, January 1, 1946, through March 1948 a total expenditure of $795.00 was made over the Mesaba-Cliffs Mining Company Donation Payroll.

There are four widows receiving Donation payments, all on the Mining Department Payroll. Two of these widows, Mrs. J. H. Tregoning and Mrs. Fiina Kampinen, were granted regular donations; one, Mrs. Johanna Forstrom appears on the payroll because of the conversion of direct aid orders to monetary allowances; and one, Mrs. Lyda M. G. Turgeon, is being paid over this payroll rather than under the Pension Plan of 3/1/1950.

The total expenditure over the Donation Payroll for 1957 was $4,187.80. The payroll carries twelve names as the year closes. As with the Pension and Retirement Payrolls the monthly allowance of each payee on this roll was increased by $7.50 with the exception of Lyda M. G. Turgeon. Her allowance was increased in accordance with the revisions of the Funded Pension Plan, from $43.00 to $60.00. This is a special case and it was cleared by letter with the Cleveland Office. This increase was a result of the increases granted to pensioners under the Funded Pension Plan.

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

c. SAFETY WORK

The Central Safety Committee meets regularly to review accidents and to classify them. The committee tries to interpret the cause of every accident and, as far as possible, establishes rules and regulations for the purpose of trying to prevent further accidents.

Central Safety Meetings were held on the following dates in 1957:

January 31	July 31
February 28	August 30
March 29	September 30
April 26	October 31
May 29	November 27
June 27	December 30

The roster of the Central Safety Committee as of December 31, 1957 was as follows:

J. S. Westwater	H. W. Sundberg
H. C. Swanson	E. D. Cory
T. A. Kauppila	O. J. Anderson
Onnie Marjama	H. W. Rembold
Gilbert A. Dawe	R. M. DeGabriele
R. L. Tobie	Ogden E. Johnson
Kenneth Olson	Arne Andelin
John M. Haivala	E. W. Lindroos
Dr. Bert E. Moore	A. J. Stromquist

d. MEDICAL SERVICE

For years the Company has provided proper medical service for the care of all occupational accidents and injuries. The Company has contracted with Doctors R. G. Williams of Ishpeming and R. L. Paine of Negaunee. The Doctors are on call in case of accidents and this program assures medical service in all cases of accidents and injuries associated with the work of our employees. During 1957 for this service the Company paid the Doctors 70¢ per man per month.

e. IRON RIVER HOSPITAL

The Superintendent of the Employees' Insurance, Compensation & Pension Department served on the Board of Trustees of the Iron River General Hospital at Stambaugh. He attended the annual meeting of the hospital trustees and participated in their deliberations. We have discontinued work at the Spies Mine and we are no longer participating directly in maintaining the employee medical plan in the Iron River district. Our Company retains its stock in the General Hospital of the Iron River District.

EMPLOYEES' INSURANCE, COMPENSATION, AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

f. PHYSICAL EXAMINATION OF EMPLOYEES

Dr. Bert E. Moore serves in the capacity of Director of our Industrial Hygiene Department which is now housed at the clinic of Dr. R. G. Williams in the 8th Addition in Ishpeming. Dr. Moore became Director upon the retirement of Dr. George McL. Waldie. We are pleased to report that Dr. Moore carries on a good program and we often hear of his courtesy to our people.

The total of examinations made through December, 1957, is as follows:

	Cleveland-Cliffs	Inland Steel
January	333	35
February	282	37
March	138	31
April	103	29
May	176	29
June	137	25
July	191	-
August	142	24
September	112	24
October	185	33
November	90	12
December	262	-
	2151	279

g. COMMUNITY HEALTH

During 1957 the health conditions in the area were near normal. Morgan Heights Sanatorium, which is under the direction of Dr. James A. Acocks, continues its excellent service to the community and is considered one of the best County Tuberculosis Sanatoriums in the state. He has done an outstanding job in the field of tuberculosis care.

Each city in Marquette County has a health officer and a full time school nurse. The County of Marquette also retains a full time nurse service and these services are made available to the township districts mostly through the schools.

The city health officers in Marquette County are:

W. A. Corcoran, M. D. - Ishpeming
R. L. Paine, M. D. - Negaunee
A. L. Swinton, M. D. - Marquette

The Superintendent of the Employees' Insurance, Compensation and Pension Department has now served 23 years as Chairman of the Board of Directors of Bay Cliff Health Camp in Marquette County. Bay Cliff Health Camp serves children from the fifteen counties of the Northern Peninsula of Michigan on a non-cost basis. These are afflicted or underprivileged children who are

EMPLOYEES' INSURANCE, COMPENSATION, & PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

g. COMMUNITY HEALTH (Continued)

certified to the camp by local health departments or local doctors. Most of the children require special care because of their physical condition. The following types of cases are served: children with rheumatic hearts, convalescent poliomyelitis cases, diabetics, children with various cardiac conditions, those having speech and hearing defects, those having special personality problems resulting from illness, and some who are undernourished.

h. RELIEF WORK

Direct relief is extended only in emergency cases. There are no regular recipients of direct relief. During the year we had two relief expenditures, one during the month of May in the amount of $48.41; and one during September in the amount of $60.36 - total for the year $108.77. This statement does not include cash assistance.

i. EMPLOYMENT

This Department cooperates in every way possible with the Employment Office, which is under the supervision of Mr. H. W. Sundberg. Applications for employment which come to the department are discussed with Mr. Sundberg and the best interest of the Company is kept in mind.

j. IMPROVEMENT WORK

The Company continues its improvement work by way of gardening and improvement of grounds and the Landscape Department is still in charge of Mr. Peter DeRoche. We receive many compliments from visitors and tourists upon the fine appearance of our mines and other Company properties.

k. COMMUNITY SERVICE WORK

Each year we call attention to our report to the American Legion Building in Negaunee, which is leased by our Company to the Legion. In recent years it has been the responsibility of the Legion to take proper care of the building and recently it has been suggested that the furniture and other equipment be turned over to the John H. Mitchell Post #66 - American Legion of Negaunee.

Many activities take place in the Negaunee Legion Clubhouse. The same is true of the American Legion Club building in Ishpeming, but this building is no longer owned by our Company.

l. OUTDOOR ACTIVITIES

Every year shows added interest in the outdoor activities in the Ishpeming-Negaunee area. The ski tow and the Winter Sports Club is very popular and the ski tournaments which are held each year attract several tourists. The 70th Annual Ski Tournament was held in Ishpeming under the supervision of the Ishpeming Ski Club during February. The National Ski Museum and Hall of Fame attract a great many people to Ishpeming and will eventually become a very important attraction in the sports world. A new and popular ski area, known as Cliffs Ridge, began operating during 1957 in the vicinity of Marquette.

EMPLOYEES' INSURANCE, COMPENSATION AND PENSION DEPARTMENT

ANNUAL REPORT YEAR 1957

2.

m. THE MATHER INN

The Mather Inn seems to be the most popular hotel in the Northern Peninsula. Mr. Juel Casperson, who took over the management late in 1955, seems to have not only improved the services, but has increased the patronage. The Mather Inn is used more and more each year for various types of meetings of groups of people, particularly those from the Upper Peninsula.

n. VARIOUS DEPARTMENTS AND ACTIVITIES

The Superintendent of the Department was taken ill in August, 1957. Subsequently an amputation of his right leg above the knee resulted. He was unable to be in his office for the remainder of the year and was, therefore, not available for a detailed reporting under this section.

o. POLICE DEPARTMENT

Reference to the Police Department, under the direction of Chief of Police Emil Hoff, has been made previously in this report. Mr. Hoff contacts the regular officers of the Police Department with considerable regularity and checks on their reports.

p. APPRECIATION

Appreciation is expressed for the splendid assistance, fine cooperation and the many courtesies extended to this Department by Mr. Grover J. Holt, Assistant to the President and former General Manager; Mr. James S. Westwater, Manager of Michigan Mines; Mr. C. W. Allen, Vice President; Mr. Harry C. Swanson, District Superintendent; and Mr. Ogden E. Johnson, Director of Industrial Relations. The excellent cooperation of the Safety Department and its director, Mr. A. J. Stromquist, is appreciated. We shall continue to exert every effort to maintain cooperation and efficiency within this Department and we will cooperate in every possible manner with those departments associated with the Employees' Insurance, Compensation, and Pension Department.

Appreciation is also expressed for the splendid cooperation of the folks who make up the Employees' Insurance, Compensation, and Pension Department, with its bureau of Industrial Hygiene.

REPORT OF GEOLOGICAL DEPARTMENT FOR YEAR ENDING DECEMBER 31, 1957

CONTENTS

SUMMARY OF DEPARTMENTAL ACTIVITIES

The following is a brief summary of the outstanding 1957 activities of the Department in the Company's exploration program:

1. Cascade Direct Shipping Ore

The Department is particularly proud of its discovery of a merchantable orebody of direct shipping ore in the Cascade District. Our continuing work indicates a reserve of 43,452,000 tons with an estimated analysis of 62.48 Fe., .082 Phos., 5.00 Silica, and .153 sulfur.

2. Marquette Range Low Grade Ore Appraisal

Late in the year of 1957 we were able to submit an appraisal of a potential reserve of the Marquette Range beneficiating ores. This is the first time in over five years of intensive effort, that we have been able to discuss with some certainty this potential. Ore Reserve Report No. 10 by Donald R. Lukkari and the Special Ore Reserve Report No. 9 provides this summary.

3. Western U. S. Field Office

For a number of years we have recommended a Western United States field office to provide more efficient and effective acquisition of valuable iron ore lands in the United States. This office was opened during the summer but unfortunately was closed in the late fall with the reduction of the Company's activities.

4. Operation Overthrust

Work was started on Operation Overthrust with the full time activities of Mr. Robert W. Riedel. This is a major primary exploration tool and will be of great benefit to our Canadian Exploration program.

5. Wisconsin Anomalies

During the year an airborne magnetic survey was made in Wisconsin revealing a number of significant magnetic anomalies. This has been followed with field work and preliminary work on options and leases.

6. Albanel Minerals Reserves

The metallurgical test work on the 1956 and 1957 drilling was reappraised in a series of ore estimates by Messrs. Boyum and Sutton, and indicates mineable reserves in excess of 150 million tons of concentration by magnetic separation. Weight recoveries range from 30% to 33%.

7. Exploration Accounting System

During the year a long term goal was achieved in establishing a satisfactory exploration accounting system. This has been initiated in our Canadian activities and we plan to extend it to the other areas. It is of great value in appraising costs and making up Expenditure Financial Forecasts and for assessment work.

8. Research and Exploration

During the year continuing research was done in exploration methods. A new induction polarization technique was experimented with and was successful on the Marquette Range. Experiments were also conducted in mine refraction seismics and new coring equipment.

9. Reduction in Department

The current business recession and the reduced activities of the Company brought about a reduction in the Company's staff back to the level of 1948.

I. STAFF

A. Distribution

Ishpeming, Michigan continued to be the general headquarters for the supervision of the Company's exploration activities including all geophysical areas. District offices were maintained at Hibbing for the Minnesota Area and at Port Arthur, Ontario and Ottawa, Ontario for the Canadian activities. A new office was established in Salt Lake City for the Western activities. With the curtailment of the Company's exploration program, the office was closed again in December.

The general magnitude of the exploration program in 1957 was $200,000 less than 1956. Emphasis shifted from drilling to field work. This brought about reduced exploration costs even though the total number of temporary summer workers was increased. The details of the staff are contained in Table I. In November, drastic reductions were made in the permanent staff amounting to 43%. This brings the Department to a size comparable to the year 1948.

Mr. Burton H. Boyum continued as Chief Geologist supervising all of the Company's exploration activities. Continued emphasis was placed on the maintenance of standard proceedure techniques and equipment as well as evaluating program emphasis on the geographical areas and the proportion of metallurgical and direct shipping ore exploration. Numerous trips were made to visit the field offices and field projects. Eleven trips were made to Canada visiting all but the far western provinces. Mr. Boyum and Mr. Rex collaborated on the Western United States program and one visit was made to South America.

Mr. Gerald J. Anderson continued as Michigan District Geologist, supervising the Michigan staff of mine and field geological and geophysical activities as well as the Michigan Drilling Division. During the greater part of the year he was assisted in the supervision of the Drilling Division by Mr. Roy Hillmer, Drilling Engineer. At the end of the year Mr. Hillmer was separated from the Department. Mr. Swante Merrila retired as lead foreman and was succeeded by Mr. Carl Ostlund. Messrs. Alvin Nelson and Marvin Toivonen were reduced in status having been salaried Drill Foremen. Mr. Charles Nault replaced Mr. Jack Nease and he also was separated from the Department in December.

The Michigan geologists may be considered in two groups, the men assigned to the operating properties and those on exploration projects. At the beginning of the year four geologists were assigned to the underground mines and one to the open pit properties. Mr. James P. Meyers assigned to the Cliffs-Shaft Mine has been devoting an increasing amount of his time to engineering matters and at the end of the year was transferred to the Engineering Department. Messrs. Ted Engel, Paul R. Bluekamp, and Lee Erickson continued at the Bunker Hill, Mather Mine "B" Shaft and Mather Mine "A" Shaft respectively. Mr. James W. Villar continued his work at the open pit mines.

Mr. Robert W. Riedel was transferred to the Port Arthur office in late summer. Mr. Tsu-Ming Han continued his work as Microscopist. In December Mr. Donald R. Lukkari had a change of status in that he too, like Mr. Han, is now shared with the Metallurgical Department. Mr. James E. Tusa had

been employed the past two summers as a temporary field geologist and joined the permanent staff when Mr. Riedel moved to Canada. Mr. Tusa was laid off in December as part of the reduction of the permanent staff. Mr. Robert W. Ryan and Mr. Ronald C. Foisie were separated from the Department in the latter part of the year.

Mr. E. Richard Randolph continued his activities in Minnesota and also assisted on the Wisconsin program as part of the U. S. General activities.

Mr. Eric J. Rex spent the first portion of the year completing the reports and records on the Albanel Minerals project and then moved to Salt Lake City to supervise the Company's Western field work. He moved back to Michigan in December and transferred to the Metallurgical Department.

The Canadian activities in 1957 were handled by two separate organizations. Canadian Cliffs Ltd. was taken over by a new Canadian corporation called Albanel Minerals Ltd. This latter company is owned 55% by The Cleveland-Cliffs Iron Company and 45% by the M. J. O'Brien Company of Ottawa. Exploration supervision is provided by Messrs. M. W. Bartley and B. H. Boyum with Mr. W. R. Sutton as Project Supervisor. The Canadian exploration, other than Albanel Minerals, was assumed by a new company called Cliffs of Canada, 100% owned by The Cleveland-Cliffs Iron Company. Here, also, the exploration supervision was provided by Messrs. Bartley and Boyum. In addition, the staff of Bartley, Greer and Associates was utilized on a part time or a full time basis. Dr. J. M. Neilson continued as Consultant throughout the year and as a Field Supervisor during the summer season.

TABLE I

GEOLOGICAL DEPARTMENT

Burton H. Boyum, Chief Geologist

MICHIGAN

Gerald J. Anderson, Michigan District Geologist

EXPLORATION DRILLING DIVISION

Gerald J. Anderson, Supervisor
Roy W. Hillmer, Drilling Engineer (A)
Swante Merrila, Foreman (B)
Carl Ostlund, Foreman
Alvin Nelson, Foreman (C)
Marvin Toivonen, Foreman (D)
Eino O. Kujala, Diamond Drill Clerk
Jack Nease, Ass't. Diamond Drill Clerk (E)
Charles Nault, Ass't. Diamond Drill Clerk (F)

TEMPORARY PERSONNEL

Earl W. Behrens, Geologist
Jen-Ho Fang, Geologist
Roy A. Koski, Geologist
Paul Ribbe, Geologist
Keith C. Roberts, Geologist
John E. Anderson, Field Assistant
Stanley J. Chapman, Field Assistant
George DeRoche, Field Assistant
James Hodge, Field Assistant
John C. Palmquist, Field Assistant

MICROSCOPY

Tsu-Ming Han

GEOLOGISTS

Paul R. Bluekamp
Ted Engel, Jr.
Lee Erickson
Donald R. Lukkari (G)
James P. Meyers (H)
Robert W. Riedel (I)
James E. Tusa (J)
James W. Villar

TECHNICIANS

Robert W. Ryan (K)
Ronald C. Foisie (L)

DRAFTSMEN

Gideon S. Johnson
John V. Larson
Donald R. Nankervis

SECRETARIAL

Mrs. Belle Bloch, Office Secretary
Miss. Klara Marie Hult

(A) Transferred to Metallurgical Department December 31, 1957
(B) Retired June 30, 1957
(C) Demoted to Hourly Foreman December 1, 1957
(D) On Salary July 1, 1957. Demoted to Diamond Driller December 1, 1957
(E) Transferred to Cambria-Jackson May 1, 1957
(F) Started May 1, 1957, transferred to Mather Mine "B" Shaft December 15, 1957
(G) Time divided one-half Geology one-half Metallurgical Department beginning December 15, 1957
(H) Transferred to Engineering Department December 31, 1957
(I) Transferred to Operation Overthrust August 15, 1957
(J) Started October 1, 1957, laid off December 1, 1957
(K) Transferred to Metallurgical Department December 15, 1957
(L) Transferred to Metallurgical Department December 15, 1957

MINNESOTA

E. Richard Randolph, Minnesota Geologist

Temporary Field Staff

Richard H. Beck, Geologist
John H. Burr, Jr., Geologist
Morris Comstock, Draftsman and Field Assistant
Ray Costellano, Draftsman and Field Assistant
Donald L. Sterling, Field Assistant

U. S. GENERAL

E. J. Rex, Project Supervisor (Transferred to Metallurgical Department December 15, 1957)

Temporary Field Staff

Kiril Spiroff, Senior Geologist
James E. Tusa, Geologist
John C. Paulsen, Geologist
Bruce M. Bertram, Field Assistant
Paul H. Ekberg, Field Assistant
Lynn Harmsen, Field Assistant

Dr. John S. Sumner, Consultant

CANADA

Cliffs of Canada, Ltd.

Dr. M. W. Bartley, Resident Manager
Dr. James M. Neilson, Consultant
Dr. W. L. C. Greer (Bartley, Greer & Associates)
Neil Black " " " "
Stanley K. Leaming " " " "

Temporary Field Staff

G. L. Colborne, Geologist
Roger R. Hall, Geologist
Lewis A. Gustafson, Geologist
Donald P. Bertsch, Geologist
William F. Bradford, Geologist & Geophysicist

Albanel Minerals, Ltd.

Dr. M. W. Bartley, Resident Manager
Walter R. Sutton, Project Supervisor
Dr. L. C. Coleman, Party Chief (Summer)
W. A. Meakin, Drill Supervisor & Party Chief (Spring)

Temporary Field Staff

T. T. Quirke, Jr. Geologist
Curtis A. Bury, Geologist
David R. Hoeft, Geologist
Gerald Hussin, Geology & Drills
David R. Moody, Geology & Drills
James T. Neal, Geology & Drills
Thomas Skimming, Geologist
C. B. Parker, Field Assistant
R. A. Prusok, Field Assistant
W. P. Russell, " "
R. E. Sebolt, " "
Douglas Trask, " "
C. G. Von Ness, " "
J. J. Dennis, Surveyor
John E. Nye, "
John R. Wojcik, Surveyor Helper

B. Man-Hour Summary

The following Table II is the hourly rate personnel carried on the General Storehouse payroll as members of the Exploration Drilling Department:

TABLE II

DISPOSITION OF HOURLY RATE PERSONNEL
GENERAL STOREHOUSE PAYROLL

Total Days Worked	-	224
Saturdays & Sundays	-	105
Holidays	-	7
Days lost (4 day work week)	-	9
Total		365

Description	Ave. No. of Men	New Hire	Separations	Total Hours Worked	Statistical Men	Labor Costs
Runners	24	2*	-	47,296	26 5/8	$ 127,183.21
Helpers	28	4	33	54,163	30 3/4	123,484.22
Total	52	6	33	101,459	57 3/8	$ 250,667.43**

* Promotions and change of status.

** $70,308.38 of this total represents the wages of Diamond Drill personnel that were working on various underground rigs.

Labor costs per foot of surface drilling $7.95 per foot.

Table III shown below is a recapitulation of the various components of the Exploration Staff:

TABLE III

MAN-HOUR SUMMARY

A. MICHIGAN

		Men	Hours	Dollars
1.	Geological (Account 426)			
	Permanent	16½	31,071	$ 95,215.41
	Temporary	10	4,820	11,875.60
	Sub-Total	26½	35,891	$ 107,091.01
2.	Drilling Division (Account 435) (Does not include contract labor)			
	Labor	52	101,459	$ 250,667.43
	Supervisors and Clerks	7¼	14,701	41,789.49
	Sub-Total	59¼	116,160	$ 292,456.92
	Total for Michigan	85¾	152,051	$ 399,547.93

		Men	Hours	Dollars
B.	MINNESOTA (Account 326)			
	Permanent	3	5,320	$ 16,404.00
	Temporary	4	2,040	4,812.00
	Foremen	6	1,480	-
	Total	13	8,840	$ 21,216.00
C.	U.S. GENERAL & FOREIGN (Account 436)			
	Western States			
	Permanent	1	1,504	$ 6,518.00
	Temporary	6	3,024	7,895.02
	Total	7	4,528	$ 14,413.02
D.	CANADA			
	1. U. S. Charges (Account 439)			
	Permanent	2	1,168	$ 5,036.00
	Temporary	1	198	363.33
	Sub-Total	3	1,366	$ 5,399.33
	2. Cliffs of Canada Ltd.			
	a. Outside Explorations			
	Administrative	3	800*	$ 5,137.00
	Professional & Technical	9	19,472	36,927.00
	Sub-Total	12	20,272	$ 42,064.00
	b. Land Offers			
	Administrative	3	1,600*	$ 10,264.00
	Professional & Technical	4	7,534	15,429.00
	Sub-Total	7	9,174	$ 25,697.00
	3. Albanel Minerals, Ltd.			
	Administrative	3	3,200*	$ 19,790.00
	Technical (Average)	15	27,534	53,026.00
	Sub-Total	18	30,734	$ 72,816.00
	Total in Canada	29	60,180	$ 140,577.00
	Total Canada (including U. S. Charges)	32	61,546	$ 145,976.33
	GRAND TOTAL (All Areas)	134 3/4	225,599	$ 575,753.95

* Estimated and includes prorated time for Bartley, Greer, Neilson and Black.

The following tabulation, Table IV shows the distribution of the professional members of the Geological Department by projects, during part or all of 1957:

TABLE IV

DISTRIBUTION OF PROFESSIONAL EXPLORATION STAFF
DURING PART OR ALL OF 1957

MICHIGAN

Operating Mines

Bunker Hill Group	Ted Engel, Jr.
Cambria-Jackson	Paul R. Bluekamp
Cliffs-Shaft	James P. Meyers
Mather Mine "A" Shaft	Lee Erickson
Mather Mine "B" Shaft	Paul R. Bluekamp
Humboldt	James W. Villar
Ohio	James W. Villar
Republic	James W. Villar
Tilden	James W. Villar

Exploration Projects

Cascade East-End	Donald R. Lukkari
New Richmond	Donald R. Lukkari
Section 4, 47-27	James P. Meyers
Section 10, 47-27	James P. Meyers
Tilden Fire Tower	Donald R. Lukkari
Tilden-West	Donald R. Lukkari
Empire Phase II	Donald R. Lukkari
Ogden Schoolhouse	Donald R. Lukkari
Isabella	Donald R. Lukkari
South Sturgeon-Indian Lake	Robert W. Riedel
Ford River-Escanaba	Robert W. Riedel
Rapid River	Robert W. Riedel
Cameo	Robert W. Riedel
Humboldt Mine Area	James W. Villar
Gwinn District	Gerald J. Anderson
Land Offer 3697 - Florence, Wisconsin	Gerald J. Anderson
Land Offer 3643 - Norway-Vulcan Area	Gerald J. Anderson

II. GEOLOGICAL AND GEOPHYSICAL FIELD WORK AND SURFACE EXPLORATION

A. Michigan

1. Empire Mine Development - Donald R. Lukkari, Geologist

During the period from June 19 to August 13, 1957, a field party consisting of Keith C. Roberts, Geologist, and Messrs. James R. Hodge and John C. Anderson, Field Assistants, conducted geological mapping and surface outcrop sampling in the Empire Area. This area had previously been sampled by Metallurgical Department personnel, but no structural data had been recorded. It was hoped the geological mapping would help delimit the iron-formation and assist in the selection of a possible plant site. The sampling served to check the validity of previous work and to test new exposures which were found. Several of the previous samples were found to have been taken from float material. A breakdown of the cost of the field work is as follows:

Geology.....$1,678.02
Engineering.....$ 195.72

A Phase II Development Drilling program was initiated during 1957. By the end of the year 16 holes had been completed and the 17th hole was being drilled. Most of these holes were drilled to outline the Class II and Class III material in order to facilitate pit planning and help select a plant site. Five holes were put through the overburden South of the footwall contact in order to substantiate the ledge material and test the thickness and character of the overburden.

Hole No. 23 encountered an extension of Class I material to the Southeast of the Main orebody. This extension was substantiated by Hole No. 30 which also showed favorable results in the area between Hole No. 23 and the Main orebody.

At the end of the year Hole No. 36 was being drilled at a -40° across the North end of the orebody. This will conclude the Phase II development drilling program.

The holes that were drilled in the Empire Area during 1957 are indicated on Figure 1.

2. Cascade District - Donald R. Lukkari, Geologist

a. Cascade East-End Development

No field work was conducted on the Cascade East-End during the year. Geological work consisted of interpretations of the drill hole results. Estimates were made of both the metallurgical and direct shipping ores.

Four holes were completed in the direct shipping program. They encountered a total of 543 feet of first class ore which expands the orebody to an estimated 44,868,000 tons.

In addition, the first 660 feet of Hole No. 59 was tested for M.O.C. results. Some Class A material was revealed by the testing. This represents an estimated 1,755,000 tons of crude which may be an extension of

the New Richmond Class A material. The drilling conducted during 1957 in the Cascade East-End is indicated on Figure 2.

Twenty-three short holes through the overburden were also drilled during the year. They were designed to test the ledge contours in the prospective shaft site area. They again demonstrated the utility of the Joy 225-A truck-mounted rig for this type of work.

b. New Richmond

No field work was conducted on the New Richmond Property during the year. Evaluation of the data obtained from the diamond drilling comprised the bulk of the geological work on this area.

Four holes were finished during the year completing the metallurgical drilling in the area. Two holes were carried to footwall and two other holes were re-entered and deepened. This made a total of four holes that were drilled to test for direct shipping ore on the footwall. No ore was encountered in these holes. They revealed the footwall to be at a higher elevation than was expected. It is believed that a major fault cuts Northwest and Southeast across the basin near the East end of the New Richmond Property. The West side is upthrown and according to present drilling has been barren of ore concentration.

The test results on the drilling revealed an estimated 27,875,250 tons of Class A crude available with a minimum amount of stripping. Economic studies of enlarging this tonnage by taking more Class B material are underway by other departments. The holes in which drilling was conducted during 1957 are indicated on Figure 2.

c. Isabella Area

Preliminary field work had been performed on the Isabella Area several years ago. This work was reviewed in 1957 and a drilling program was laid out. By the end of the year four holes were completed and a fifth hole was being drilled.

The M.O.C. test results on the first four holes look encouraging and a preliminary estimate of the combined Class A and B material, based on these first four holes, shows an estimated 45,756,000 tons of crude material. By stripping 2,106,000 cubic yards of quartzite, an additional 20,000,000 tons of crude material would be available. This area will be tested by Holes No. 5 and No. 6 to see if this material also responds favorably. The location of the drill holes are indicated on Figure 2.

3. Ishpeming District - James P. Meyers, Geologist

a. Section 4, 47-27 - Deep Drilling

In August, 1956, a diamond drill hole was commenced in Section 4, 47-27, between two previously drilled holes in which soft ore had been encountered. This hole was drilled in an effort to prove or disprove a continuous ore structure between these Holes No. 37 and No. 44. The hole was stopped upon entering the footwall slate. Since the hole did not encounter any ore, the continuity of the ore structure was disproved and exploration was suspended. In the future some exploration must be

done in Section 9, 47-27, so as to delimit the orebody found with the series of 37 holes.

Hole No. 53 is located approximately midway between Holes No. 37 and No. 44 in Section 4, 47-27. The hole was commenced in August, 1956, and completed in June, 1957. The total depth of the parent hole was 3340' and of a short branch hole was 2790'. Six feet comprised the thickness of mineable ore encountered in the hole. The short branch hole was drilled to the north of the parent hole to establish more information of the structure on this section. The information thus obtained resulted in the termination of exploration for deep soft ores in Section 4, 47-27.

b. Section 10, 47-27 - Deep Drilling

Diamond drilling for deep soft ore in Section 10, 47-27, was commenced in 1955, continued throughout 1956, and terminated in March, 1957. Drilling in this area was confined to one Hole No. 29. The hole was located on the basis of the geology predicted in the Deep Soft Ore Study. Upon completion of Hole No. 29, further exploration in this area was terminated.

Hole No. 29 is located on the old Lake Mine surface on the North shore of Lake Angeline in the NW¼ of the SE¼ of Section 10, 47-27. The hole, which had been drilled to a depth of 4950' by the end of 1956, was continued to a depth of 5345' in 1957 at which point it was stopped. In 1957, this hole was drilled through intrusive, lean ore, oxidized iron-formation, unoxidized iron-formation, and argillaceous oxidized iron-formation. The hole was stopped because of badly caving ground in the bottom of the hole, the apparent proximity of the footwall contact, and generally adverse drilling conditions. Drilling proved much greater depths to the footwall Siamo slate than had been anticipated so additional drilling plans were dropped.

4. Tilden Area - Donald R. Lukkari, Geologist

a. Ogden-Schoolhouse Area

Three field parties worked in the Ogden-Schoolhouse Lake Area during the period from June 19 through August 23, 1957. Messrs. Jen-Ho Fang, Geologist, and George M. DeRoche, Field Assistant; and Roy A. Koski, Geologist, and John E. Anderson, Field Assistant, began the work on June 19th. On July 15th, the field parties were re-assigned and Messrs. John C. Palmquist, Geologist and George M. DeRoche, Field Assistant, completed the project. A total of 14 miles of line were traversed and 46 metallurgical samples collected. A breakdown of the cost is as follows:

Geology.....	$2,407.24
Engineering.....	$ 95.73

On the basis of the above field work a modest drilling program was outlined for the area. Three holes have been completed for a total of 1131 feet during the year. Test results which have been received show poor to fair concentrating results by straight magnetic separation. The location of the drill holes are indicated on Figure 1.

b. Tilden Fire Tower

The Tilden Fire Tower drilling program was completed early in the year. Three holes were finished for a total of 652 feet.

No field work was conducted on the area, and again the bulk of the geological work was interpreting the results of the drilling program. An estimated 29,616,750 tons of Class A metallurgical ore is available with a minimum of stripping . Studies are being conducted by other departments of the feasibility of expanding this tonnage by taking more of the Class B material. The holes completed during the year are indicated on Figure 1.

c. Tilden West

A drilling program was initiated on the areas in Sections 22 and 27, 47-27 which were covered by field parties in 1956. Seven holes were drilled for a total of 3536 feet. The M.O.C. test results were rather poor. An estimated 7,164,000 tons of Class A crude material is available with a minimum of stripping.

The drilling in Section 27 revealed a significant change in the footwall contact. It was moved approximately 1000 feet North of the original interpretation. The location of the drill holes are indicated on Figure 1.

5. Humboldt District - James W. Villar, Geologist

One field crew, consisting of a geologist and field assistant was maintained throughout the Humboldt Area for approximately three months in order to pursue two major projects.

A detailed magnetic (super-dip) survey of the Northeast and a portion of the East Hill Areas was undertaken. The exploration included the area bounded by the 4000 S.- 5800 S. and 9200 W. - 5300 W. coordinates. Several vicinities exhibit anomalous magnetic readings, but they are for the most part localized and probably reflect sporadic occurrences of magnetite. The survey data is presently being correlated with diamond drill hole and outcrop information which should provide the framework for outlining areas worthy of additional pursuit.

Outcrop mapping and sampling of the area immediately east of the present mining footwall was completed. This project revealed no extensive zones of oxidized iron-formation. One finger-like protuberance was recorded in the southern vicinity, but the oxidation appears to be in a narrow and restricted form which would seriously impede any feasible scheme of development. The structural and lithological features compiled will prove very valuable in determining ultimate mining limits and development plans.

Personnel Breakdown

	Engineering	Geophysics	Geology	Total
Keith Roberts (Geologist)	52 Hrs.	8 Hrs.	152 Hrs.	212 Hrs.
Paul Ribbe (Geologist)	128 "	152 "	48 "	328 "
George DeRoche (Geologist)	16 "	-	-	16 "
Stanley Chapman (Ass't.)	174 "	156 "	68 "	398 "
John Anderson (Ass't.)	-	24 "	-	24 "
Total	370 "	340 "	268 "	978 "

6. Gwinn District - O.E. 1208 - Robert W. Riedel, Geologist
Donald R. Lukkari, Geologist

One field party worked in the Gwinn Area from June 13 through September 13, 1957. The party consisted of John C. Behrens, Geologist, assisted at various times by John C. Palmquist, James R. Hodge, John E. Anderson, and Stanley J. Chapman. A total of approximately 14 miles of line were surveyed by sundial compass. Approximately 2 miles of magnetometer traverse and 3½ miles of gravimeter traverse were covered. In addition 19 samples were taken from mine dumps and outcrops.

The magnetometer survey did not reveal any significant anomalies. The gravimeter traverse did show a two milligal high in one area. This could indicate enrichment of the iron-formation. The cost of the exploration was $6,118.12. The field work is outlined on Figure 3.

7. Florence, Wisconsin - L.O. 3697 - Donald R. Lukkari, Geologist

One field party consisting of Paul Ribbe, Geologist, and Stanley Chapman, Field Assistant, spent four days running a magnetometer survey on this area. They occupied 262 stations and ran about 4½ miles of traverse at a cost of $544.24. An anomaly of approximately 300 gammas was observed. Another one-half mile of traverse was covered in 23 stations by Donald Lukkari, Geologist and Ronald Foisie, Field Assistant, to substantiate the anomaly. The anomaly was crossed about 400 feet East of the original line and showed the same amplitude. Further exploration is discouraged by the apparent thickness of overburden in the area.

8. Norway-Vulcan - L.O. 3643 - Donald R. Lukkari, Geologist

One field party consisting of John C. Palmquist, Geologist, and George M. DeRoche, Field Assistant, performed detailed outcrop mapping and sampling in Section 9, 39-29. The work was performed between August 27 and September 11, 1957. The 1956 field work on this area indicated that the best results appeared in Section 9. Since only a few weeks were available, the detailed work was focused on this section.

A total of 41 fifty pound metallurgical samples were taken. Of these, six were eliminated because they analyzed less than 20.00% crude iron. The remaining 35 samples were composited into 11 samples and subjected to standard M.O.C. tests. An arithmetical average of the concentrate shows the following:

% Wt.	% Fe.	% SiO_2	% Fe. Rec.
45.03	64.28	9.46	92.80

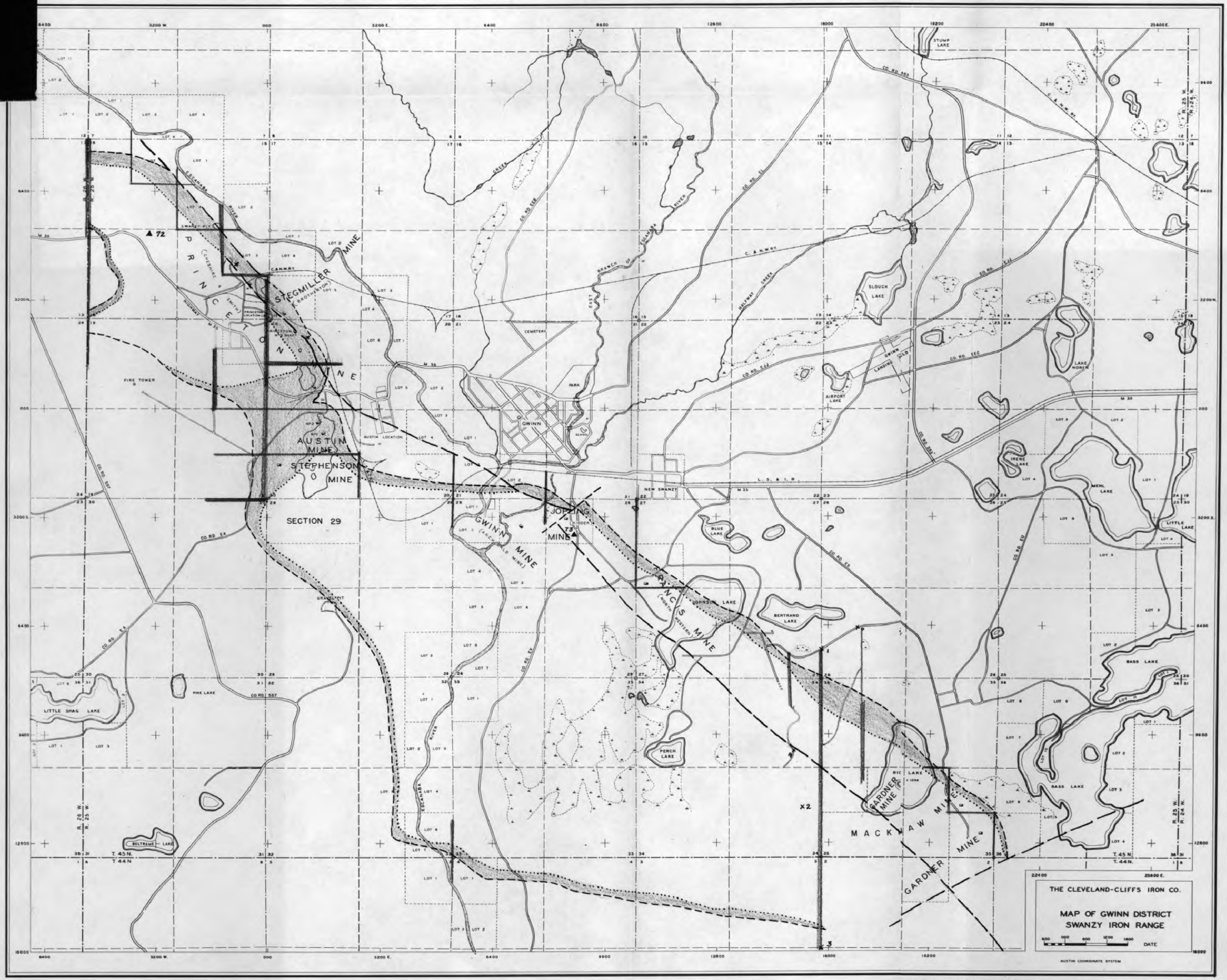
The cost of the exploration was $1,573.99.

FIGURE 1

JUNE 1955


C & N W RY
& L S & I RY
EMPIRE MINE
SHAFT
NEW VOLUNTEER MINE
MAITLAND MINE
OLD MAITLAND MINE
Palmer
SHAFT
PALMER LAKE
VILLAGE OF PALMER
Volunteer
A SHAFT
B SHAFT
OLD VOLUNTEER MINE
C SHAFT
Isabella
ISABELLA MINE
PLATT MINE
Fault
Fault
ROAD
Dike
STARWEST MINE
OLD RICHMOND MINE
PRIMROSE MINE
MINOWAN
MOORE MINE
RICHARDS MINE
Palmer
CHICAGO AND NORTHWESTERN R.R.
Fault
OLD RICHMOND MINE
16000
19200
22400
25600

FIGURE 2



GEOLOGIC MAPPING — JUNE 30, 1957
MAGNETOMETER TRAVERSE — JULY 31, 1957
GRAVIMETER TRAVERSES
▲ MAGNETIC BASE STATION
X GRAVIMETER BASE STATION

FIGURE 3

9. East Central Upper Peninsula (Cameo Project) - Robert W. Riedel
Party Chief

Exploration continued on the Cameo Project during the first few months of 1957 with geophysical prospecting. This work consisted mainly of finishing projects that were started in 1956. With the cessation of field work, attention was focused on the plotting and drafting of the geophysical profiles. A large amount of field data from 1956 and earlier had been collected but had not been recorded on the profiles. This work continued until July.

One of the highlights of the Cameo Exploration was the completion of the Cameo Summary Report in July. In addition to containing a lot of detailed information, this report is an evaluation of all the work that has been done to date on the Cameo Project.

Another highlight in the Cameo Exploration was the starting of drilling in the South Sturgeon-Indian Lake Area. This drilling began on October 1st and continued through December 17th at which time the program was stopped due to an overall cutback in our exploration work. The target area was not reached, however; it is hoped that when the economic picture improves that this drilling will be continued again.

a. South Sturgeon-Indian Lake (E & A, CC-832)

The geophysical mapping in this area was a continuation of the program started in 1956. Some work was done on the Federal Lands west of Cooks; however, most of the work in 1957 was focused on the area North of the Village of Cooks in Section 19, 41-17. This was the area on which it was decided that drilling would begin so a very detailed study was made in an attempt to place the first drill hole in the most advantageous location. Setting up was in progress during the last half of September, but actual drilling was started on October 1st and was continued through December 17th. At that time the project was stopped as part of an overall cutback in our exploration program.

The first hole was angled to the North and was designed to cut the high anomaly area which is believed to be an iron-formation dipping steeply to the south. It became necessary to stop this hole at 877' because of extreme deviation to the East and a continual steepening of the hole. The hole was started at -65° Due North and when it was stopped, it had steepened to -72° and was bearing N. 23° E. It appears that it would be very difficult, if not impossible, to drill an angle hole through the thick Paleozoics and hold it on the proper course. A decision was made to drill a vertical hole with the stopping of Hole No. 1.

Hole No. 2 was started vertically right on the highest point of the anomaly. This hole had reached a depth of 422' by December 17th when the project was stopped. The hole was capped and the casing left in the hole in the hopes that it can be reentered at a later date.

b. Ford River-Escanaba - O.E. 1165

Geophysical mapping was started on the Ford River Area in 1956 and was continued in the early months of 1957. This area contains three

parallel East-West anomalies of up to +11,000 gammas and 1.5 - 2.0 milligals and there are believed to be others from the eastward extension of the Old Menominee Range. Old diamond drilling cut hematitic iron-formation in two places on these anomalies. The geophysical field work accomplished in 1957 in this area consisted of 52 miles of magnetometer traverse with 1453 stations and 29¼ miles of gravity traverse with 830 field stations.

c. Gladstone-Cornell (E & A, CC-834)

No geophysical field work was conducted in this area during 1957; however, during the year Mr. Thomas Longacre completed a Master's Thesis entitled "Geophysical Investigations in the Cornell Area Michigan" which covers the work done in 1956. Mr. Longacre concludes that the anomaly is caused by an iron-formation striking East-West which changes along the strike in depth and size.

d. Rapid River - O.E. 1162

A geophysical mapping program that was started in 1956 was continued in this area during the early part of 1957. One major moderate to high (+1,000 to +12,000 gammas) magnetic anomaly strikes through this area with an accompanying gravity anomaly of up to 2.95 milligals. This anomaly has a continuity which makes it look quite promising. A small amount of geophysical field work was conducted on this anomaly in addition to the calculating and plotting of the 1956 work.

B. Minnesota

1. General

Mr. E. Richard Randolph continued as Minnesota Resident Geologist during the year. In addition to Mr. Randolph's supervising the field programs and working with exploration matters on the various properties, he also assumed field supervision of the Wisconsin Project as we were short of field personnel when Mr. Riedel was transferred to Port Arthur.

The temporary summer personnel consisted of two field parties working in both Minnesota and later in Wisconsin. Late in the fall one of the Michigan field parties, consisting of Mr. Keith Roberts, temporary geologist, was transferred to Wisconsin under Mr. Randolph's supervision. Mr. Ray Costellano took the place of Mr. Morris Comstock as draftsman and field assistant to Mr. Randolph. He was laid off in the staff reductions late in the year.

Throughout the year Mr. Burton H. Boyum, Chief Geologist, visited the Minnesota offices and field location in connection with the exploration program working with Mr. Randolph and the Minnesota Ore Committee.

Use was made of six foremen for field work when they could be spared from the active properties.

2. Mesabi Range

a. Operating Properties

1'. Canisteo Mine - Drill Holes C-877 through C-889 were drilled during the year by Henry Schultze and Company. A total

of 1821' of drilling was completed; 638' was on the Snyder Lease and 1183' on the Bovey Lease. The costs were higher than in 1956.

Mr. Randolph conducted some experimental seismic work. He has established some relationships between the velocity in the various types of earth materials. This method appears promising.

2'. Hill Trumbull Mine - Holes W-153 were drilled in the early part of the year on the Walker Lands by the Atkins-Walker Company. The costs were almost identical to 1956.

3'. Sally Mine - Early in the year Mr. Randolph experimented with the Joy Blast Hole Drill Model 60 and a Hughes Tool Company air-cooled corebarrel equipped with a bit with rotary cutters yielding a 3 5/8" core. Although the work was done in -30° temperature, the experiment indicated that the method has good potential for coring any soft material which can be drilled with the cutters.

b. Exploration Projects

1'. Land Offer 2960 - Haley-Todd - This property adjoins Oliver Iron Mining Division's newly opened Stephens Mine. Exploration was planned for direct-shipping material. Two and three-fourths miles of line were brushed and three and three-fourths miles of magnetometer line were run including some traverses on Oliver Lands. Seismic profile 2400' long was completed. The total cost of magnetics was $600.00 or $160.00 per line mile. Costs of seismics was $673.00 or $160.00 per line mile. Costs of seismics was $673.00 or $48.07 per depth determination. Overburden depths averaged approximately 50'.

2'. Land Offer 2948 - Haley-Potter - Exploration was directed for potential cretaceous ore. Land ownership is a problem. Three and one-fourth miles of traverse line were brushed and surveyed and prospected magnetically. The total cost was $290.00 or $89.00 per line mile.

3'. Grand Rapids Area - McKinney Lands - Land Offers 2918, 2928, 2934, 2945 and 2946 Combined - Field work consisted of magnetic and electromagnetic traverses which was completed in 1956, structural drilling was commenced in 1956 and completed in 1957. Three holes were drilled by the Henry Schultze Company. Material encountered is of interest for its M.O.C. potential. A summary of the test results indicate an available weight recovery of 36.9% yielding a concentrate average of 64.4% iron and a 6.3% silica. An ore estimate utilizing a 30% weight recovery indicates 23 million tons of M.O.C. concentrates available in this group area.

4'. Land Offer 2932 - Barlow - Drilling was commenced in 1956 and completed in 1957 with Hole No. 2 drilled by the Atkins-Walker Company. Results were discouraging and the program discontinued. The high costs are explained by the relatively small footage and high moving in and out charges.

3. Other Minnesota Areas

a. O. E. 1107 - Northeastern Itasca County

Work continued in 1957 on this large area. The published aeromagnetic maps were utilized and supplemented by 76 superdip lines on the ground totaling approximately 62 miles. Seismic determinations were also made indicating the range of glacial drift from 50' to 100'. The total cost of the magnetic work was $3,400.00 or approximately $43.39 per line mile of magnetics and $50.00 per determination for seismics. Negotiations have continued and it is hoped that drilling will be done in 1958. E & A, CC-840 was obtained for the drilling in the amount of $14,000.00.

b. O. E. 1109 - Southeastern Minnesota

Early in 1957 two reconnaissance field trips were made to this area to become acquainted with the geologic setting and to ascertain the most promising geophysical methods. One 2-man field party spent four weeks in this area checking outcrops and talking with various people to secure promising areas. The total cost amounted to $433.00. Promising areas are near Waukon, Mankato and Zumbro Falls.

c. O. E. 1110 - Southwestern Minnesota

This is the area of the Sioux quartz in which the Pipestone Quarries have been found. A magnetic traverse from the Minnesota-Iowa line North approximately 50 miles to Sanborn disclosed two distinct anomalies. The total cost of this 50 mile traverse was $104.00 or approximately $2.00 per station mile. (See Figure 4).

C. U. S. General

1. Wisconsin

a. General

The Geological Department has recommended for a number of years, that we pursue the Wisconsin area. The Ashland Mining Company, Jones & Laughlin, Oliver Mining Division, Inland Steel and Pickands-Mather, have all been active here. An abbreviated aeromagnetic survey was conducted in August under E & A, CC-922 in the amount of $9,917.00. A total of 1,344 miles were traversed for an average cost of $7.38 per line mile. Plotting was done by Cliffs personnel and field work was commenced to investigate the airborne surveying anomalies.

The two field parties from Minnesota were transferred to Wisconsin and late in the year, a Michigan party was transferred to Wisconsin. Field work commenced in the Western part of the State and progressed easterly. Figure 5 shows the disposition of the air anomalies, the areas investigated on the ground and the Outside Exploration numbers assigned to the various anomaly areas.

b. O. E. 1151 - Black River Falls, Wisconsin

The principal holdings in this area are the Inland Steel Company through its wholly-owned subsiduary, the Jackson County Iron Company.

Figure 4

SOUTHERN MINNESOTA

OE 1109 – 1110

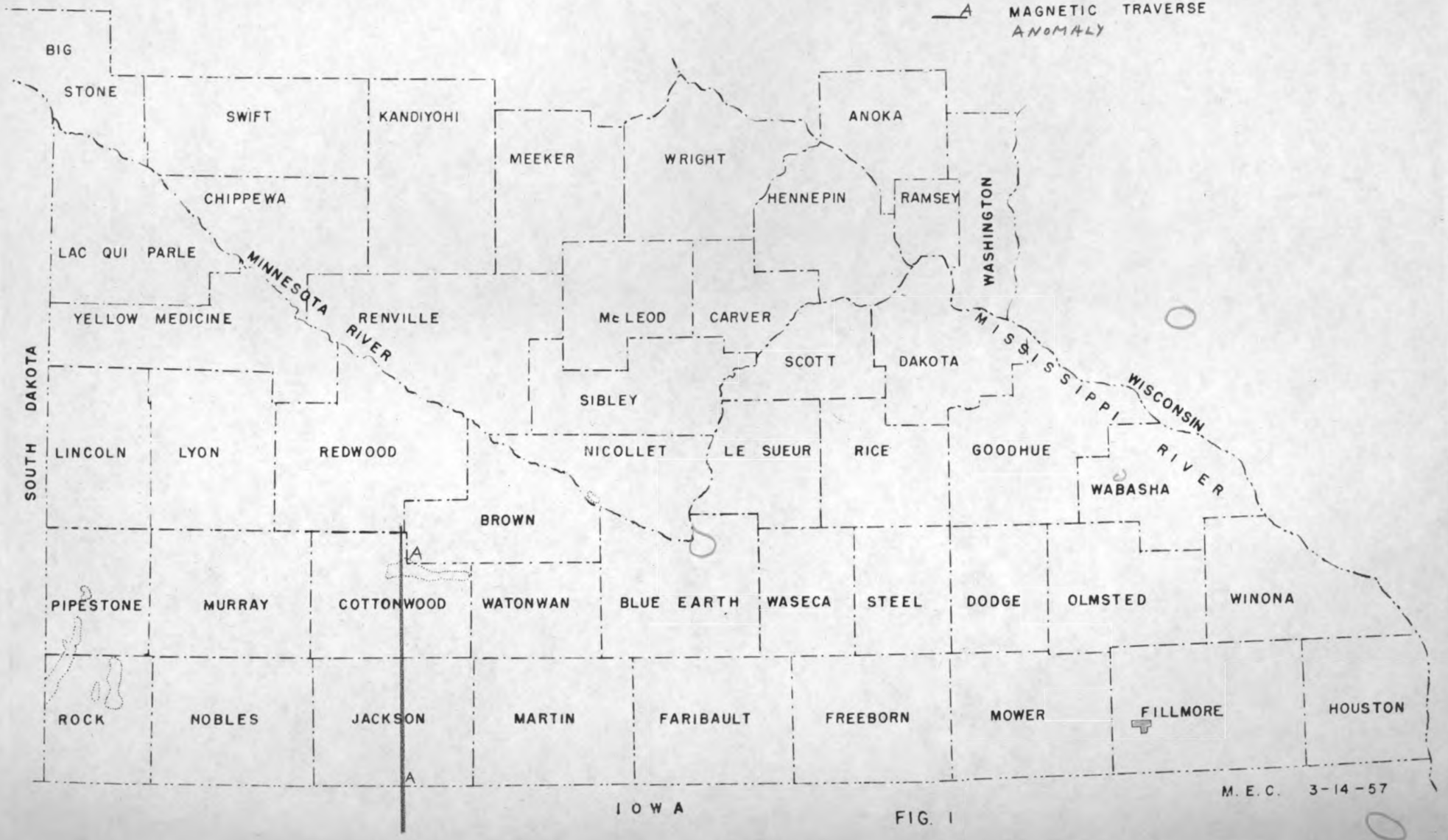
SCALE OF STATUTE MILES

12 6 0 12 24 36 48

LOCATION OF SPRING VALLEY AREA MINES

SIOUX QUARTZITE OUTCROP

A MAGNETIC TRAVERSE ANOMALY



M. E. C. 3-14-57

FIG. 1

Figure 4

563 23

Geological and geophysical work was done over the Inland Steel Lands to provide us with basic information. Additional anomaly areas on lands thought to be open, was conducted.

c. O. E. 1250 to 1257 - Central Wisconsin

These areas are shown on Figure 5 . They were investigated by geologic mapping, ground magnetics, refraction seismic and gravimetric prospecting. Most of this work was done by Mr. Keith Roberts, temporary geologist, working without a field assistant. The total cost of 38.7 miles of magnetic and gravimetric work was $2,136.45 or $55.26 per mile or $2.75 per station. Seismic depth determination correlated with a scattered well depth indicated a range of 250' to 300', particularly in the area of Big Flats, O. E. 1251.

Mr. Roberts encountered the work of three students from the University of Wisconsin, Messrs. Richard Haubrick, Robert Meyer and Jack Mack in O. E. 1252 near Necedah in Juneau County. These students had progressed a considerable way in the delineation of this anomaly and had made considerable progress with the County Board in leasing the County Lands. We have pursued this, not only because we are interested in the anomaly, but also because it provides an opportunity to introduce Cliffs terms in both the Option and Lease Form since there is no standard State of Wisconsin format.

d. O. E. 1194 - Northern Wisconsin

Less attention was placed on this area because of the competition. The total cost was $1,466.00 including about 53 miles of magnetic traversing for a net cost of $27.00 per line mile at approximately $2.00 per station.

2. Missouri

Four Land Offers were investigated during the year by Mr. Robert W. Riedel; namely, Land Offers 3667, 3687, 3690 and 3691. None of these was large enough to warrant pursuing and all were declined.

Consideration was given during the year to conducting primarily exploration to find ore accumulations similar to that being developed by the Meramec Mining Company, a joint venture of St. Joe Lead and Bethlehem Steel. Granite City Steel and American Zinc have pooled their efforts in investigating Missouri areas with the same thought in mind.

Figure 5

WISCONSIN

MAC 7-23-57

3. Indiana

In the fall of 1956 the Department learned of some magnetic anomalies in Indiana. This was assigned O. E. 1192. In the fall of 1957 Dr. John S. Sumner, Consulting Geologist from Salt Lake City was engaged to review available information on the possible iron ore in both Indiana and Illinois. His report was received on December 3. The depth of the Paleozoic cover ranges from 2400' to 5000'. The magnitude of the magnetic and gravity anomalies is significant. Until such time that the Company is interested in underground material at these depths in Indiana and Illinois, we have adequately investigated these anomaly conditions.

4. South Dakota

The iron deposits in the Black Hills Region have been known for a number of years. Some field work was conducted there in 1952 and activities resumed in 1957. Competition was lively, being principally from the Colorado Fuel and Iron Company and the Pittsburgh-Pacific Company (half owned by Inland Steel). One field party with James Tusa as Field Geologist conducted mapping, sampling and ground magnetics on a number of claims, particularly Land Offers 3683, 3701, 3702, 3703, and O.E.'s 1221 and 1230. In several areas the iron-formation was quite enough to be of interest for open pit mining but was not amenable to concentration by standard magnetic flotation or M.O.C. processes. In other instances, the iron-formation was amenable, but was too narrow or discontinuous.

5. Montana

During the summer two field parties investigated a number of prospects in Montana. Geologists were Professor Kiril Spiroff and Mr. John Paulsen. Land Offers investigated were 3581 and 3710, together with O.E.'s 1207, 1211, 1213 and 1222 through 1226 inclusive. The most significant area was that of L.O. 3710, the Carter Creek Iron Deposit of the Minerals Engineering Company near Dillon, Montana.

The Department recommended participation by Cliffs in this deposit and the details are contained in General Exploration Report No. 37 by Burton H. Boyum and Eric J. Rex. Several meetings were held with officials of the Minerals Engineering Company. The property was optioned to a Canadian Company, North American Utilities, in December, 1957.

6. Idaho

The field parties of Spiroff and Paulsen also investigated L.O.'s 3585, 3602, 3660 and 3686 in Idaho. None of these prospects were sufficiently encouraging to warrant additional investigation.

7. Washington

Messrs. Boyum and Rex investigated the nickeliferous iron deposit at Cle Ulum, O.E. 1209 in May. The nickel is so intimately associated with the iron that it is not possible to make a satisfactory iron or

nickel product. Details are contained in U. S. Bureau of Mines Report of Investigation No. 4189.

8. Oregon

Land Offer 3692 was the Red Flats nickeliferous iron deposits near Gold Beach, Oregon. A considerable amount of time was spent on this Land Offer, both with the principals, Mrs. Rose Nunnemacher and with the Southwestern Engineering Company of Los Angeles. The latter Company has the U. S. distributorship for the Krupp-Renn process. The material treated by this process yields a product containing 92% to 95% iron and 4% to 8% nickel. This was declined by the Policy Committee in November.

9. California

Mr. Rex investigated the Beach Sands at Crescent City, L.O. 3646 and the Offer was declined because of the intimate amount of titanium and chromium in the iron concentrates. Other work continued in the Mojave Desert by Mr. Rex. Worthwhile areas had been staked previously by the Columbia-Geneva Division, U. S. Steel Corporation.

10. New Mexico

The copper deposit of Fierro also contains a significant amount of iron. Our O.E. 1193 covers these deposits. Discussions were held with Mr. Jack Ehrhorn, U. S. Smelting, Refining and Mining Company, Salt Lake City. Metallurgical testing and microscopic work were conducted by Cliffs without any definite conclusions other than to continue to keep advised of developments at these properties.

11. Colorado

Brief reconnaissance was made of L.O.'s 3649 and 3673. The deposits were not worthy of additional work.

D. Canada

Our Canadian exploration has been handled by two companies, Cliffs of Canada Ltd., wholly owned by The Cleveland-Cliffs Iron Company, taking the place of Canadian Cliffs Ltd., in March, 1957. The other Company is Albanel Minerals Ltd. owned 55% by The Cleveland-Cliffs Iron Company and 45% by M. J. O'Brien Company of Ottawa, Ontario.

1. Cliffs of Canada Ltd.

a. General

Headquarters of Cliffs of Canada is at Port Arthur, Ontario where a contract exists between Cliffs of Canada and the firm of Bartley, Greer and Associates. Resident Manager is Dr. M. W. Bartley. In addition to Dr. Bartley, are his associates, Dr. W. L. C. Greer, Neil Black and Ed Meade. Six temporary field parties also worked during the season in Ontario, Manitoba, Saskatchewan, Alberta, British Columbia,

the Yukon Territory, Nova Scotia, and Baffin Island. Significant explorations are highlighted below:

b. Ontario

1'. L.O. 3227-C, Rainy River District, W. H. Meakin - Preliminary surface sampling was encouraging and an option secured from the owner, Mr. William H. Meakin. Four holes, totaling 2,423' were drilled for an overall cost of $4.53 per foot. The option is still in force but the results are discouraging and the claims will be dropped undoubtedly.

2'. L.O. 3218-C, Kenning Township, Triana Exploration - An option was secured on this property and ground geology and geophysical work conducted. The option was dropped as the field work indicated the tonnage reserves to be small.

c. Saskatchewan

Black Lake, Triana, L.O. 3204-C - An option was secured from Triana Exploration Ltd. for their property at Black Lake in Northwestern Saskatchewan. Two field parties investigated this area with ground geology and geophysics. The iron-formation did yield acceptable concentrates but the iron-formation proved to be narrower than anticipated.

d. British Columbia and Yukon Territory

Mr. Stanley K. Leaming was engaged on March 1 to conduct exploration for iron ores in British Columbia and the Yukon Territory. Unfortunately, the Provincial Government inacted adverse legislation and this reduced interest in this program. He did examine a number of prospects, however, without finding anything worth pursuing. His work in the Yukon Territory concluded that the most promising area was in the McKenzie Mountains.

e. Quebec

Land Offer 3244-C is O'Keefe, Audrea Lakes Claims and Land Offer 3245-C is Julian Lake Claims. These properties were offered by Canadian-Javelin Ltd. Dr. Bartley visited a portion of the lands in September. Additional discussions were held with the Javelin officials and test work was conducted both at the Ishpeming Metallurgical Laboratory and at the Ontario Research Foundation.

f. Baffin Island

Dr. James M. Neilson, Consultant, spent a portion of the summer on the field investigation of O.E. 1400-C, the Ultra-Sharkey Company, Mr. Larry Labow, Field Superintendent. Dr. Neilson concluded that the economic possibilities are too remote to be of interest in the immediate future.

g. Nova Scotia

Canadian Scotia Manganese, L.O. 3233-C came to Cliffs of Canada through McPhar Geophysics Ltd. of Toronto. This property was investigated by geological and geophysical means by the McPhar Company for their client, Canadian Scotia Ltd. When the client was unable to pay, they attempted to interest Cliffs of Canada. Investigation indicated that the prospect would be a "long shot" with potential hazard in the exploration of the manganese reserves. The property was declined.

2. Albanel Minerals Ltd.

The year 1957 was an active one for Albanel Minerals Ltd. Mr. Walter R. Sutton was Project Supervisor. A number of temporary field assistants were engaged for the summer season. Diamond drilling and metallurgical test work were actively pursued. Seventy-three drill holes were completed in 1957 for a total of 19,463'. Total drilling to date amounts to 34,435', thus, over one-half of the total drilling to date was accomplished in 1957.

In December, Messrs. Boyum and Sutton completed a revised estimate of the beneficiating ores utilizing straight magnetic separation. The three principal claim groups have total potential reserves in the magnitude of an excess of 150 million tons of concentrates with a weight recovery approximating 32%. Additional tonnage of lessor magnitude and with greater rock stripping are indicated elsewhere bringing the total to over 200 million tons of concentrate.

During the year additional exploration was conducted in two significant areas other than the basic iron claim groups along Lake Albanel. The first is the titaniferous iron northeast of Albanel adjacent to Lac Benoit. A considerable amount of field work, chemical analysis and microscopic work as well as metallurgical concentration tests were performed on this material. The general setting is outlined in Geophysical Report No. 8 by Burton H. Boyum.

The other area is southwest of the basic iron group and northeast of the town of Chibougamau. The airborne geophysical work and recommendations are contained in Geophysical Report No. 13 by Mr. Burton H. Boyum. The overall exploration summary is contained in General Exploration Report No. 28, also prepared by Mr. Boyum.

E. South America

Correspondence was pursued on various Land Offers and Outside Explorations in Central and South America during the year. Only one examination was made and that was of the iron deposits in Peru by Mr. Burton H. Boyum. Three separate deposits were visited; namely, Ica and Acarí (O.E. 1216) and Marcona Iron Mines (O.E. 1218). Details are contained in General Exploration Report No. 35 and in the Trip Report dated December 9, 1957. While the Ica and Acarí deposits, as presently explored, are not sufficiently large to warrant participation by Cliffs, the recommendation is made that Cliffs consider a joint program in Peru with the owners of these deposits, the Pan-American Commodities, S. A.

III. EXPLORATION DRILLING DIVISION - Gerald J. Anderson, Supervisor
Roy W. Hillmer, Drilling Engineer

A. General Highlights

Continued progress was made on the diamond bit costs. The combined efforts of the Department and the Wheel Trueing Tool Company produced a small stone bit with top quality bortz that considerably reduced the cost of drilling the extremely hard iron-formation.

1. Joy 225A, Truck Mounted Rig

The "225" was used to a considerable extent in soil sampling and probing to determine ledge contours. In all, this rig put down a total of 56 shallow holes in the Humboldt, Republic, Empire, and Cascade areas. To do this same job with any other conventional rig would have been an economic impossibility.

A driving and tricone drilling technique was employed. The tools available on this rig made this a relatively simple operation. These 56 holes meant drilling through 786' of overburden or 77% of all overburden drilled in 1957.

2. New Equipment

Two new Joy 22 HD NW swivelhead machines were obtained. These two units are powered by GMC diesel engines. One of these rigs replaced the Buda powered 22 HD that was destroyed in the fire at Hole #168. All of the diesel equipment, DH 5 units and the two 22 HD units are now GMC units with interchangeable parts.

The Royal Bean 435, Wakesha FCU powered pumping unit that replaced the unit destroyed at Hole #168, was converted to LPG fuel. This is a simple conversion that merely necessitates a carburetor conversion. This pumping unit is being operated as an experimental unit in an attempt to combat high pump engine maintenance costs. To date, after six months of continual usage, no repairs or replacement parts have been necessary.

3. Bi-metal Fine Quality Bortz Bits

The bi-metal fine quality bortz bits are made up from $14.00/kt. bortz set in two separate matrices. The I.D. matrix is considerably harder than the face and O.D. matrix. These bits have greatly contributed to reduced costs. Sprague and Henwood's over-all bit costs were $9.81/ft. for drilling in the Tilden Fire Tower area, whereas the Department's bit costs were $5.37/ft. for drilling in similar ground in the Tilden West area.

The value of these bits is quite obvious in the costs experienced in the Isabella area. The cost of BX drilling in this area was $5.56/ft. The BX costs in the Tilden West area were $5.87/ft. The value of this increased footage per unit and consequently increased footage per shift is further expressed in the direct drilling costs in the two areas, Isabella, $16.44/ft. vs. Tilden West, $21.27/ft.

4. Diamond Drill Rig Fire

On March 8, 1957, a diamond drill rig and associated equipment were destroyed by fire while set up on a subsidence hole on Mather Mine "B" Shaft surface. The fire apparently started from an overheated stove while the men were away from the rig working on a pipeline. By the time the fire was discovered, it was too late for fire extinguishers, and by the time the Negaunee Fire Department arrived, the rig was completely destroyed. The loss was covered by insurance and the rig and pumping unit were replaced with new equipment during the year.

5. Comments on Table V

The following tabulated data shows a comparison of the 1956 bit costs with the 1957 costs:

	Area	1956 Cost/Ft.	% of Total Drilling	1957 Costs/Ft.	% of Total Drilling
1.	Rock, Osier, Perkins, Trenary vs. South Sturgeon (1957)	$1.57	20.52	$1.00	4.09
2.	Cascade East End	6.37	14.17	6.61	15.35
3.	Richmond	6.15	17.00	5.41	8.47
4.	Tilden Fire Tower vs. Tilden West (1957)	8.58 (contract)	16.46	5.37	13.23

In 1956, the over-all bit cost was $4.92/ft. whereas in 1957 the cost was $4.94/ft.

The table would indicate that the 1957 costs should have been less than 1956. This would be true on a foot per foot basis; however, the percentages indicate an increased proportion of Cascade drilling. Since this drilling was at depth, it is understandable that the bit costs are higher as short runs with a partly used bit are not practical.

6. Comments on Table X

The costs "A" and "B" in Section 4 and Section 10 are rather erratic. In deep hole drilling of this type, it is often impossible to correlate certain costs with its respective footage. This results in charges being placed against the holes after they are completed, i.e. extensive repair work, casing not recovered, and damaged rods and core barrels. In order to evaluate more accurately the costs of Hole #53 and Hole #29, the following data has been compiled. This data embraces the total footages in each hole.

Hole Number	Total Footage	Total Cost "A"	Cost/Ft. "A"	Total Cost "B"	Cost/Ft. "B"
Hole #53 Sec. 4	3,940	$89,299.90	$22.66	$91,298.19	$23.17
Hole #29 Sec. 10	5,345	142,107.72	26.59	156,299.39	29.24

B. Specific Details (Michigan)

1. Diamond Costs

The following Table V represents an analysis of the diamond bit costs at the various locations and the respective hole sizes.

TABLE V

PER FOOT COSTS OF DIAMOND BITS USED IN 1957 SURFACE DRILLING

Area	Hole Number	AX Ft.	AX Amt.	AX Per Ft.	BX Ft.	BX Amt.	BX Per Ft.	NX Ft.	NX Amt.	NX Per Ft.	Total Footage	Total Diamond Bit Costs	Average Cost/Ft.
New Richmond	45	-	-	-	290	$1,319.33	$4.55	-	-	-	290	$ 1,319.33	$4.55
Section 27, 47-26	52	-	-	-	465	2,894.58	6.22	-	-	-	465	2,894.58	6.22
	54*	-	-	-	-	-	-	275	$1,047.20	$3.81	275	1,047.20	3.81
	55*	-	-	-	-	-	-	126	1,104.00	8.76	126	1,104.00	8.76
	56	-	-	-	-	-	-	36	122.30	3.40	36	122.30	3.40
	57	-	-	-	180	1,175.07	6.53	-	-	-	180	1,175.07	6.53
	58	-	-	-	-	-	-	585	2,916.70	4.99	585	2,916.70	4.99
Area Total	7 Holes				935	$5,388.98	$5.76	1,022	$5,190.20	$5.08	1,957	$10,579.18	$5.41
Empire Phase II	20-35**	-	-	-	2,534	$5,360.82	$2.12	460	$1,664.62	$3.62	2,994	$ 7,025.44	$2.35
Section 19, 47-26	36	-	-	-	529	2,487.57	4.70	7	30.56	4.37	536	2,518.13	4.69
Area Total	17 Holes				3,063	$7,848.39	$2.56	467	$1,695.18	$3.63	3,530	$ 9,543.57	$2.70
Isabella													
Section 29, 47-26	5	-	-	-	407	$2,085.43	$5.12	11	$ 47.48	$4.32	418	$ 2,132.91	$5.10
Section 32, 47-26	1	-	-	-	547	2,878.80	5.26	16	14.19	.89	563	2,892.99	5.14
	2	-	-	-	582	3,302.37	5.67	4	26.87	6.72	586	3,329.24	5.68
	3	-	-	-	697	3,457.38	4.96	-	-	-	697	3,457.38	4.96
	4	-	-	-	399	2,913.05	7.30	1	91.29	91.29	400	3,004.34	7.51
Area Total	5 Holes				2,632	$14,637.03	$5.56	32	$ 179.83	$5.62	2,664	$14,816.86	$5.56
Ogden-Schoolhouse Lake													
Section 13, 47-27	1	-	-	-	407	$ 555.36	$1.36	8	-	-	415	$ 555.36	$1.34
	2	-	-	-	117	288.50	2.47	6	$ 90.25	$15.04	123	378.75	3.07
Section 24, 47-27	3	-	-	-	536	1,512.70	2.82	5	33.78	6.76	541	1,546.48	2.86
Area Total	3 Holes				1,060	$2,356.56	$2.22	19	$ 124.03	$6.53	1,079	$ 2,480.59	$2.30
Tilden Fire Tower													
Section 25, 47-27	6***	-	-	-	96	$ 456.59	$4.76	-	-	-	96	$ 456.59	$4.76
	7***	-	-	-	97	610.69	6.30	-	-	-	97	610.69	6.30
Section 26, 47-27	60***	-	-	-	456	3,941.02	8.64	-	-	-	456	3,941.02	8.64
Area Total	3 Holes				649	$5,008.30	$7.72				649	$ 5,008.30	$7.72

Note: See Comments on Table V

TABLE V (CONT.)

PER FOOT COSTS OF DIAMOND BITS USED
IN 1957 SURFACE DRILLING

Area	Hole Number	AX Ft.	AX Amt.	AX Per Ft.	BX Ft.	BX Amt.	BX Per Ft.	NX Ft.	NX Amt.	NX Per Ft.	Total Footage	Total Diamond Bit Costs	Average Cost/Ft.
Tilden West													
Section 22, 47-27	1	602	$2,760.96	$4.59	168	$1,665.79	$9.92	6	$ 224.88	$37.48	776	$ 4,651.63	$6.00
	2	488	1,971.37	4.04	34	849.10	24.97	6	20.01	3.34	528	2,840.48	5.38
	3	-	-	-	528	2,976.82	5.63	3	59.85	19.95	531	3,036.67	5.72
Section 27, 47-27	24	-	-	-	187	645.38	3.45	23	436.38	18.97	210	1,081.76	5.15
	25	-	-	-	577	2,110.65	3.66	8	-	-	585	2,110.65	3.61
	26	398	1,607.82	4.04	155	1,477.99	9.54	7	90.77	12.97	560	3,176.58	5.67
	27	-	-	-	312	1,788.74	5.73	7	170.51	24.35	319	1,959.25	6.14
Area Total	7 Holes	1,488	$6,340.15	$4.26	1,961	$11,514.47	$5.87	60	$1,002.40	$16.71	3,509	$18,857.02	$5.37
Section 4, 47-27	53	-	-	-	-	-	-	2,652	$13,392.60	$5.05	2,652	$13,392.60	$5.05
Area Total	1 Hole							2,652	$13,392.60	$5.05	2,652	$13,392.60	$5.05
Section 10, 47-27	29	-	-	-	395	$2,498.96	$6.33	-	-	-	395	$2,498.96	$6.33
Area Total	1 Hole				395	$2,498.96	$6.33				395	$2,498.96	$6.33
Mather "B" Surface	168	73	$ 194.56	$2.67	472	$2,371.22	$5.02	844	$4,684.64	$5.55	1,389	$ 7,250.42	$5.22
Area Total	1 Hole	73	$ 194.56	$2.67	472	$2,371.22	$5.02	844	$4,684.64	$5.55	1,389	$ 7,250.42	$5.22
Mather "A" Surface	Seismic	-	-	-	-	-	-	12	$ 67.80	$5.65	12	$ 67.80	$5.65
Area Total	2 Holes							12	$ 67.80	$5.65	12	$ 67.80	$5.65
Humboldt	8	-	-	-	639	$1,471.50	$2.30	40	$ 192.20	$4.81	679	$ 1,663.70	$2.45
	1-6†	-	-	-	-	-	-	16	123.15	7.70	16	123.15	7.70
Area Total	7 Holes				639	$1,471.50	$2.30	56	$ 315.35	$5.63	695	$ 1,786.85	$2.57
Republic	1-15†	-	-	-	-	-	-	85	$ 475.99	$5.60	85	$ 475.99	$5.60
Area Total	15 Holes							85	$ 475.99	$5.60	85	$ 475.99	$5.60
Cascade East End	42*	-	-	-	872	$3,159.50	$3.62	-	-	-	872	$ 3,159.50	$3.62
	47***	626	$2,938.43	$4.69	-	-	-	-	-	-	626	2,938.43	4.69
	48	-	-	-	-	-	-	876	$10,799.33	$12.29	876	10,799.33	12.29
	59	-	-	-	-	-	-	1,533	10,730.79	7.00	1,533	10,730.79	7.00
	60-82†	-	-	-	-	-	-	88	1,133.18	12.88	88	1,133.18	12.88
Area Total	27 Holes	626	$2,938.43	$4.69	872	$3,159.50	$3.62	2,497	$22,663.30	$9.08	3,995	$28,761.23	$7.20
South Sturgeon-Indian Lake	1	-	-	-	-	-	-	863	-	-	863	-	-
	2	-	-	-	-	-	-	83	-	-	83	-	-
Area Total	2 Holes							946	$ 946.00††	$1.00	946	$ 946.00	$1.00
GRAND TOTAL ALL DRILLING	98 Holes	2,187	$9,473.14	$4.33	12,678	$56,254.91	$4.44	8,692	$50,737.32	$5.84	23,557	$116,465.37	$4.94

* Contract - by Odgers Drilling Company
** Empire Holes 20-35 grouped due to transfer of bits from hole to hole
*** Contract - by Sprague and Henwood Drilling Company
† Ledge Contour Holes
†† Estimated

2. Diamond Inventory - Hand Set

The following Table VI shows the distribution of carbon during the year 1957.

TABLE VI

DIAMOND INVENTORY (Hand Set), December 31, 1957

CARBON (Hand Set)

	Kts.	Amount
On Hand 1/1/57	477.79	
Sold - Odgers	145.53 at $60/kt.	$8,731.80
	33.11 at $25/kt.	827.75
TOTAL	178.64	$9,559.55
On Hand - Scrap	44.16 at $10/kt.	441.16
Usable Carbon	254.99	
TOTAL ON HAND*	299.15 kts.	

* This material is to be broken into the following classifications to obtain a realistic book value:

Scrap	$10.00/kt.
0-1 Carats	15.00/kt.
1-3 Carats	25.00/kt.
3 Plus	60.00/kt.

3. Diamond Inventory - Mechanical Setting

The following tabulation in Table VII shows the over-all distribution of all types of diamond used and on hand during 1957.

TABLE VII

DIAMOND INVENTORY (Mechanical Setting), December 31, 1957

	SCRAP CARBON		SCRAP BORTZ		LONGYEAR		"F" GRADE		"R" GRADE		"G" GRADE		TOTAL	
	Kts.	Amount	Kts.	Amount	Kts.	Amount	Kts.	Amount	Kts.	Amount	Kts.	Amount	Kts.	Amount
On Hand 1/1/57	265.53	$3,903.37	7,824.95	$14,017.25	175.90	$1,934.90	-	-	30,475.02	$192,204.83	759.79	$4,887.30	39,501.19	$216,947.65
Purchased 1957	-	-	-	-	-	-	1,269.10	$17,767.40	23,512.56	260,351.28	-	-	24,781.66	278,118.68
Transfer	-	-	4,755.52	8,246.87	-	-	-	-	662.76	3,819.97	-	-	5,418.28	12,066.84
TOTAL	265.53	$3,903.37	12,580.47	$22,264.12	175.90	$1,934.90	1,269.10	$17,767.40	54,650.34	$456,376.08	759.79	$4,887.30	69,701.13	$507,133.17
Used 1957 (loss)	-	-	2,019.15	3,634.40	-	-	338.02	4,732.28	24,715.75	274,060.92	97.03	1,067.33	27,169.95	283,494.93
Transfer	-	-	-	-	-	-	-	-	-	-	662.76	3,819.97	662.76	3,819.97
Scrap Credit	-	-	-	-	-	-	-	-	-	8,246.87	-	-	-	8,246.87
On Hand 12/31/57	265.53	$3,903.37	10,561.32	$18,629.72	175.90	$1,934.90	931.08	$13,035.12	29,934.59	$174,068.29	-	-	41,868.42	$211,571.40

DISTRIBUTION OF INVENTORY IN CARATS

	SCRAP CARBON	SCRAP BORTZ	LONGYEAR	"F" GRADE	"R" NEW	"R" USED	TOTAL "R"	"G" GRADE	TOTAL
Loose (Mfr's Possession)	249.19	8,503.79	-	634.86	26.00	10,270.07	10,296.07	-	19,683.91
Loose (CCICo. Possession)	16.34	19.73	-	-	-	2.85	2.85	-	38.92
Salvage Reports Pending	-	-	-	-	-	293.75	293.75	-	293.75
Bits in Stock or Issued	-	2,037.80	175.90	296.22	-	19,341.92	19,341.92	-	21,851.84
TOTAL	265.53	10,561.32	175.90	931.08	26.00	29,908.59	29,934.59	-	41,868.42

4. Contract Drilling

Table VIII summarizes the footages drilled and the costs per foot of the drilling conducted by contractors during the year.

TABLE VIII

1957 CONTRACT DIAMOND DRILLING

Section	Township & Range	Hole Number	Contract Company	AX Footage	BX Footage	NX Footage	Total Footage	Over-all Drilling Cost	Contractor's Charges/ft. *
27	47-26	47	Sprague & Henwood	626	-	-	626	$22,200.33	$35.46
25	47-27	6	Sprague & Henwood	-	96	-	96	4,132.88	43.05
		7	Sprague & Henwood	-	97	-	97	4,968.08	51.21
26	47-27	60	Sprague & Henwood	-	456	-	456	9,922.78	21.76
27	47-26	54	Odgers Drilling Co.	-	-	275	275	4,755.00	17.29
		55	Odgers Drilling Co.	-	-	126	126	3,278.00	26.02
		42	Odgers Drilling Co.	-	872	-	872	28,925.70	33.17
TOTAL							2,548	$78,182.77	$30.68

* Does not include road building, clearing site and supplies furnished by CCI, such as pipe lines, fishing tools and aquagel; nor does it include a proportion of the supervisory time and clerk's time, plus the handling of core. This means Sprague and Henwood's actual costs on Hole 47 were $43.01/ft. and Odgers' costs on Hole 42 were $40.72/ft. The Department's costs in the same area were $34.77/ft.

5. Plant Account

Table IX shows the comparative status with reference to depreciation of the Department owned equipment.

TABLE IX

	Schedule A	Schedule B	Schedule C	Total
December 31, 1956	$23,132.26	$280,873.91	$206,657.45	$510,663.62
December 31, 1957	23,132.26	302,914.21	210,446.46	536,492.93

Income from "Per Shift Charges"		
Total Year 1956		$ 66,557.78
Total Year 1957		69,417.55
Expenses from "Per Shift Charges"		
Repairs and Maintenance		24,025.36
Depreciation		44,268.27
Equipment	$26,339.22	
Rods	17,929.05	
Net Gain for Year 1957		1,123.92
Total Equipment Book Value 1957		536,492.93
Depreciation Reserve Fund 1957		278,100.46
Depreciation Rods and Equipment from above		44,268.27
Net		$233,832.19

6. Summary of Surface Drilling

The following Table X is a summary of the surface drilling including the cost analysis. Each of the areas is discussed separately under Section II.

TABLE X

SUMMARY OF SURFACE DRILLING - COST ANALYSIS

LOCATION	HOLE NUMBER	RIGS	OVERBURDEN	DIAMOND DRILLING	TOTAL	1ST CLASS ORE FOOTAGE	1ST CLASS ORE %	MET. ORE FOOTAGE	MET. ORE %	TOTAL COST "A"	COST/FT. "A"	TOTAL COST "B"	COST/FT. "B"
a. Marquette Range													
1'. New Richmond													
Metallurgical	55-58	C.C.I. & Odgers	66	858	924	-	-	774	83.77	$ 25,446.96	$27.54	$ 28,089.60	$30.40
Direct Shipping	42,52,54	C.C.I. & Odgers	-	1,034	1,034	3	0.29	-	-	28,470.08	24.53	31,563.97	30.53
Sub Total			66	1,892	1,958	3	0.15	774	39.53	53,917.04	27.54**	59,653.57	30.40
2'. Empire Phase II	20-36	C.C.I.	625	3,407	4,032	-	-	3,339	82.81	55,868.45	13.86	77,082.57	19.11
3'. Isabella	5 (Sec. 29) 1-4 (Sec. 32)	C.C.I.	65	2,645	2,710	-	-	2,512	92.69	44,555.73	16.44	45,157.25	16.66
4'. Ogden-Schoolhouse Lake	1-2 (Sec. 13) 3 (Sec. 24)	C.C.I.	64	1,067	1,131	-	-	1,016	89.83	15,756.37	13.93	17,416.49	15.40
5'. Tilden Fire Tower	6-7 (Sec. 25) 60 (Sec. 26)	Sprague & Henwood	-	652	652	-	-	652	100.00	23,675.69	36.31	23,914.23	36.68
6'. Tilden West	1-3 (Sec. 24) 24-27 (Sec. 27)	C.C.I.	137	3,399	3,536	-	-	2,785	78.76	75,218.59	21.27	78,411.07	22.18
7'. Section 4, Deep	53	C.C.I.	-	2,652	2,652	10	0.38	-	-	68,915.19	25.99*	70,915.19	26.74
8'. Section 10, Deep	29	C.C.I.	-	395	395	-	-	-	-	36,282.10	91.85*	36,282.10	91.85
9'. Mather "B" Surface	168	C.C.I.	99	1,283	1,382	-	-	-	-	26,137.71	18.91	26,810.80	19.40
10'. Mather "A" Seismic	Seismic Holes	C.C.I.	277	12	289	-	-	-	-	1,559.19	5.40	1,559.19	5.40
11'. Humboldt	8	C.C.I.	20	709	729	-	-	709	97.25	15,733.21	21.58	15,733.21	21.58
Test Holes	1-6	C.C.I.	96	15	111	-	-	-	-	1,414.14	12.74	1,414.14	12.74
Sub Total			116	724	840	-	-	709	84.40	17,147.35	20.41	17,147.35	20.41
12'. Republic Test Holes	1-15	C.C.I.	272	45	317	-	-	-	-	4,003.02	12.61	4,003.02	12.61
13'. Cascade East End													
Metallurgical	59	C.C.I.	20	661	681	-	-	661	97.06	25,353.63	37.23	25,986.96	38.16
Direct Shipping	42,47,48,59	C.C.I., Odgers & Sprague & Henwood	-	3,112	3,112	543	17.45	-	-	127,988.68	39.20	130,784.43	40.08
Test Holes	60-82	C.C.I.	232	47	279	-	-	-	-	3,901.14	10.28	4,386.18	15.69
Sub Total			252	3,820	4,072	543	13.33	661	16.23	157,243.45	37.23**	161,157.57	38.16
Sub Total Marquette Range	96 Holes		1,973	21,993	23,966	556	2.32	12,448	51.94	580,279.88	24.21	619,510.40	25.85
b. South Sturgeon-Indian Lake													
1'. Cooks	1-2	C.C.I.	376	923	1,299	-	-	-	-	30,066.50	23.14	31,665.72	24.38
GRAND TOTAL ALL DRILLING	98 Holes		2,349	22,916	25,265	556	2.20	12,448	49.26	$610,346.38	$24.16	$651,176.12	$25.77

Cost "A" - Direct Drilling Charges
Cost "B" - Includes both direct and indirect charges

* See Comments
** Includes Contract Drilling

C. Minnesota

The following Table XI is a summary of Minnesota drilling.

TABLE XI

SUMMARY OF MINNESOTA DRILLING

	TOTAL FOOTAGE	COST "A"	COST/FT. "A"	COST "B"	COST/FT. "B"
1. McKinney Lake Lands (Grand Rapids)					
a. Trask	824				
b. Wagner-Blankenburg	286				
	1,110	$17,232.00	$15.52	$21,329.00	$19.22
2. Barlow	319	5,897.00	18.49	8,130.00	25.49
3. Canisteo					
a. Snyder	638				
b. Bovey	1,183				
	1,821	30,759.28	16.89	35,206.36	19.33
4. Hill-Trumbull Walter	397	6,530.28	16.45	8,367.80	21.08
TOTAL MINNESOTA	3,647	$60,418.56	$16.57	$73,033.16	$20.03

D. Canada

The following Table XII is a summary of Canadian diamond drilling.

TABLE XII

SUMMARY OF CANADIAN DRILLING

		TOTAL FOOTAGE	COST "B"	COST/FT. "B"
Cliffs of Canada, Ltd. L.O. 3227-C	4 holes	2,423	$10,961.17	$ 4.53
Albanel Minerals, Ltd.	73 holes	19,463	192,442.41	9.89

IV. EXPLORATION OF MICHIGAN OPERATING PROPERTIES

A. Underground

1. Summary of Drilling

The following tabulation, Table XIII, is a summary of underground drilling.

TABLE XIII

UNDERGROUND DRILLING

LOCATION	HOLE NUMBER	RIGS	FOOTAGE DRILLED	1ST CLASS ORE FOOTAGE	%	TOTAL COST "A"	COST/FT. "A"	TOTAL COST "B"	COST/FT. "B"
Bunker Hill	71,72,73,74*,75,76*,77, 78,79,80,81,82,83,84, 85,86,87,88,89	C.C.I. & Mine	4,596	861	20.57	$31,890.28	$ 6.94	$39,056.69	$ 8.50
Cambria-Jackson	238-243	Mine	697	268	38.02	Costs carried by Mather Mine "B" Shaft			
Maas	101*,102,103,104,105,106, 107,108,109,110,111,112,113	C.C.I. & Mine	5,318	1,115	22.49	42,733.16	8.04	48,626.86	9.14
Mather Mine "A" Shaft	210,359,360,375,376,377,378, 379,380,394,395,396,397,400, 402,403,406,409,414,417,418, 419,423,432,439,446	C.C.I. Odgers (210)	8,105	2,037	25.13	87,409.68	10.78	99,363.58	12.26
Mather Mine "B" Shaft	371,372,373,374,381,382,383, 384,385,386,387,388,389,390, 391,392,393,398,399,401,404, 405,407,408,410,411,412,413, 415,416,420,421,422,424,425, 426,427,428,429,430,431,433, 434,435,436,437,438,440,441, 442,443,444,445,447,448,449, 450,451,452,453	Mine	13,662	6,560	48.02	88,691.71	6.18	102,540.91	7.14

* Percussion Test Holes

Cost "A" - Direct Drilling Charges
Cost "B" - Includes both direct and indirect charges

2. Recap of Underground Drilling by Organization

The following tabulation, Table XIV, is a recap by organization of underground drilling.

TABLE XIV

ORGANIZATION	NO. OF RIGS	FOOTAGE	PER CENT
a. C.C.I. Co.			
1. Department	3	9,914	29.58
2. Mine	6	23,161	69.11
b. Contract	1	438	1.31
TOTAL	10	33,513	100.00

3. Geological Summaries of Underground Properties

a. Bunker Hill Group - Ted Engel, Jr., Geologist

Athens - Mapping incidental with mining development was the extent of geological investigation in the Athens property during the year. This mapping and information gained from two Bunker Hill diamond drill holes along the 2000 W. Coordinate, indicate that the North Orebody plunges westward more steeply than previously supposed.

Bunker Hill - A full time diamond drilling program continued throughout the year resulted in an increase in the ore reserves by 1,364,272 tons. This program was concentrated in the following three areas:

1. Extending the known reserves of the Boundary Orebody westward.
2. Outlining the North Orebody between 12th and 14th Levels.
3. Checking the outline and grade of the South Orebody along the 2645 W. Coordinate.

Two holes were drilled from 10th to 12th Levels, one as a power cable hole, and the second as a water drain for the chain conveyor incline.

The following is a summary by East-West Sections of the drilling program:

2000 W. Section - In order to facilitate mining development from 14th Level, U.H.'s No. 78 and 79 were drilled from the 4100 Cross-cut into the North Orebody to locate the footwall ore contact and a thick vertical dike which appears to bisect the ore section.

2200 W. Section - Multiple faulting and a thick intrusive intersecting the ore section divides the North Orebody into several small ore areas in the Bunker Hill property. U.H.'s No. 80 and 81 were drilled from 12th Level and No.'s 83 and 85 from 14th Level to outline any mineable ore along this coordinate.

2300 W. Section - U.H.'s No. 86, 87 and 88 were drilled along this coordinate from 14th Level to correlate with the information gained in the 2200 W. drilling in order to outline this area for mining purposes.

2600 W. Section - U.H. No. 89 was drilled along this coordinate to determine a position on three dikes associated with the Boundary Orebody and to test for a zone of iron-formation occurring along the south side of this structure.

2645 W. Section - Drilling along this coordinate was directed towards testing the grade and outlining the very narrow tabular-like section of the South Orebody occurring between the Bunker Hill fault and the Main Athens dike.

2800 W. Section - Geological investigation along this coordinate was designed to outline the westward plunging Boundary Orebody in order to extend the known reserves of this structure to the west. U.H.'s No. 71, 72, 73 and 75 were drilled for this purpose. Since a sharp decrease in the ore concentration of the North Orebody had been realized along the 2400 W. Coordinate; U.H. No. 77 was drilled along the 2800 W. Section to check for a favorable change in this condition.

The results of the 1957 diamond drilling program indicate the following:

1. The Boundary Orebody becomes increasingly larger as it plunges at about 22° westward. The Pioneer & Arctic Bunker Hill property line cuts diagonally NE-SW across this ore structure, thus causing the Bunker Hill portion of the reserves to wedge out to the west near the 3000 W. Coordinate.

2. The North Orebody between 12th and 14th Levels is cut into small ore areas by intrusives and faulting. Two faults cross this ore structure, one near the 2100 W. and the second near the 2300 W. Coordinate. Between these two faults a sizeable ore section occurs. However, west of the fault along the 2300 W. Coordinate, a rapid decrease in ore enrichment is observed. Drilling along the 2800 W. Coordinate varifies this lack of ore in the North Orebody as it plunges to the west.

3. The South Orebody west of the 2400 W. Coordinate is restricted to a narrow tabular-shaped area between the nearly vertical Bunker Hill fault and Main Athens dike. Between 10th and 12th Levels this ore section is interrupted by lenses of second class ore and small intrusives. Below 12th Level, drilling has shown a generally high iron analysis and few interruptions in the ore section.

Maas Mine - A full time diamond drilling program was concentrated in the following three areas during 1957:

1. Drilling along the 3300 W. Coordinate of the Maas structure.
2. Investigation of the Intermediate structure along the 3000 W. Coordinate.
3. Development drilling in the 7500 Cross-cut area.

One hole was drilled from 2nd to 6th Level in the vicinity of the 6th Level crusher site to be used for ventilation and cage hoisting cable in the raises from 6th to 2nd Level.

The following is a summary by North-South Sections of the drilling program for 1957:

3300 W. Section - Diamond drilling along this coordinate was designed to outline the Maas structure as it extends westward. U.H. 's No. 102, 103, 104, and 108 were drilled from the 700 drift for this purpose. A complete lack of ore along this coordinate is indicated by this drilling.

3000 W. Section - General geological conditions indicate that a major fault occurs just south of the Maas Orebody in the Pioneer and Arctic property. Diamond drilling was initiated along this coordinate to explore for a possible ore structure which may be formed by this fault anticline. U.H.'s No. 109, 110, 111, and 113 were drilled from the south end of the 760 Cross-cut to explore this area.

2845 W. Section - U.H. No. 112 was drilled along this coordinate from the -100 Sub-Level to determine the position of Dike No. 82 and the hangingwall-ore contact for mining purposes.

2800 W. Section - Evidence of iron-formation lenses contained within the ore section were indicated by previous drilling in this area. Two holes No.'s 105 and 106 were drilled from the -185 Sub-Level to check for such lenses and to determine positions on Dikes No's. 82 and 83.

The results of the 1957 diamond drilling program in the Maas Mine indicate the following:

1. The complete lack of ore along the 3300 W. Coordinate in the Maas structure appears to be the result of a gradual trend of decreasing ore concentration in this orebody from the 2400 W. Coordinate westward. This condition appears to be the result of a gradual increase in the elevation of the argillite footwall from the 2400 W. to the 3300 W. Coordinates.

2. A major fault, referred to as the Intermediate fault, occurs just south of the Maas Orebody. This fault dips to the south at about 60° and strikes generally East-West with a trend to a NW-SE strike east of the 3000 W. Coordinate. The displacement along this fault is more than 800 feet as no footwall has been intersected as yet along the down thrown side. A structure favorable for ore concentration may exist between this fault and the North limb of the Engine House anticline. However, no ore has yet been intersected in the 3000 W. drilling.

3. Several lenses of iron-formation occur within the ore section of the Maas Orebody from the 2400 W. Coordinate westward. These lenses of iron-formation accompany the general trend of decreasing ore enrichment in the western portion of this structure.

Development drilling and geological mapping in the 7500 Cross-cut area has indicated that the two dikes, No's. 82 and 83, have intersected at about 2800 W. and cause serious complications in the mining of this area.

b. Cambria-Jackson Mine - Paul Bluekamp, Geologist

Diamond Drilling - Six diamond drill holes were drilled from the Cambria-Jackson Mine in 1957. Three holes were drilled to outline ore below the 8th Level and three holes were drilled to explore for ore along the East-West dike. The exploration holes found no mineable orebodies. The total ore reserve as of December 31, 1957 was 232,759 tons.

c. Cliffs-Shaft Mine - James P. Meyers, Geologist

No drilling for hard ore was conducted upon the Cliffs-Shaft Mine surface in 1957. No drilling for hard ore was conducted underground at the Cliffs-Shaft Mine in 1957.

The mine geologist was employed on the following items throughout the year:

1. Routine mapping duties.
2. General geological activities.
3. Mine duties.
4. Engineering work.
5. All geological cross-section maps were posted and brought up to date.
6. Checking the results of exploration being carried out under the Deep Soft Ore Program.
7. Various reserve studies.
8. Various reports to the lessor.
9. Special mine studies enumerated in the following section.

Production Estimates - A number of production estimates were prepared at various times throughout the year for various purposes. These estimates reflect changes in plans because of grade, feasibility of mining, etc.

Secondary Grade Ore Production - The production of a secondary grade of ore was reviewed and studied a number of times throughout the year. Grades, reserves, value, and numerous other aspects of secondary production were investigated.

Considerable time was spent on several revisions of a detailed cost study made in 1956. This study covers the estimated remaining life of the mine. The revisions were necessitated by changes in economics, changes in required production schedules, etc. The study in its revised form continues to serve as a guide in preparing yearly budgets and planning operations.

d. Mather Mine

1'. "A" Shaft - Lee Erickson, Geologist

The 1957 diamond drilling program for the Mather Mine "A" Shaft totaled 8,105 feet with the drilling cost per foot approximately $12.25. Of the year's drilling, approximately 10% was outlining ore between 7th and 8th Levels; 28% for investigation above 9th Level and 62% to outline reserves below 9th Level.

The 1957 estimate indicates an increase in ore reserves of 3,462,678 tons as compared to a loss of 587,641 tons in 1956.

Estimated net reserves as of December 31, 1956	-	8,238,042
Production January 1, 1957 to December 31, 1957	-	1,350,201
Net Reserves as of December 31, 1957 by subtraction	-	6,887,841
Estimated net reserves as of December 31, 1957	-	10,350,519
Net increase in reserves	-	3,462,678

Reserves on the 8th Level and above were decreased, whereas, reserves between the 8th and 9th Levels and below 9th Level were increased. The decrease in reserves above the 8th Level was due mainly to contamination by intrusives.

Production for the year was 1,350,201 tons. Of the year's production .88% came from the 5th Level, 31.89% from the 7th Level, 57.11% from the 8th Level, and 10.12% from the 9th Level.

Diamond Drilling

7th Level - U.H. No. 210, located on the 13,400 W. Section, was drilled from the 7100 Cross-cut to a depth of 1,841 feet without disclosing any ore. Because the dip of the hole had decreased considerably, it was decided a good possibility that the hole was above the orebody. A wedge was set at 840 feet in an effort to increase the inclination and the hole was redrilled to 1,070 feet. At this depth the hole was discontinued because the dip could not be maintained even with the aid of knuckle joints and tapered reamers.

8th Level - Eight diamond drill holes were drilled from the 8th Level during the year. U.H.'s No. 375 and 377, located on the 11,450 W. Section, were drilled from the -1100 Sub-Level to further investigate

and outline the iron-formation hangingwall that was revealed by mining operations. U.H. No. 380, located on the 10,600 W. Section, was drilled from the -950 Sub-Level to find the Northern limit of the orebody overlying the 8800 Cross-cut. U.H.'s No. 395, 400 and 402, located on the 12,250 W. Section, were drilled from the -1025 Sub-Level so that additional development could be planned above the 8300 Cross-cut. U.H.'s No. 418 and 423, located on the 12,350 W. Section, were drilled from the -1000 Sub-Level to further outline the orebody west of the Mather Fault above the 8300 Cross-cut. This drilling proved the orebody to pinch out to the west of the 12,350 W. Section at approximately 2350 South.

9th Level - During the year, sixteen holes were drilled from the 9th Level. Six of these holes were drilled to outline the orebody above the 9900-A and 9900-B Cross-cuts. The remainder of the holes were drilled to disclose the extent of the orebody below 9th Level. A summary of the drilling is as follows:

U.H.'s No. 359 and 360 were drilled from the 9900-A Cross-cut to test for ore above the level and west of the N-S dike on the 10,350 W. Section. This drilling proved the orebody to pinch out to the south. U.H. No. 417 was drilled to the south from this same location to investigate possible enrichment south of a small fault.

U.H.'s No. 379 and 394 were drilled from the 9900-B Cross-cut to outline the orebody above the level and east of the N-S dike on the 10,100 W. Section. 103 feet of first class ore was disclosed in Hole No. 379 which was drilled to the north. The drilling of Hole No. 394, drilled to the south, indicated little enrichment due, probably, to an E-W trending fault located near the collar of the hole. U.H. No. 406 was drilled from the end of the 9900-B Cross-cut on the 10,000 W. Section for correlation purposes with drilling that had been completed on the 9,950 W. Section.

Five holes were drilled from the 9620 West drift on the 11,350 W. Section and five holes were drilled from the 9620 East drift on the 10,850 W. Section. All were drilled to outline reserves below the 9th Level with the exception of U.H.'s No. 419 and 432. U.H. No. 419, on the 10,850 W. Section, was drilled at +90° in an attempt to locate the large sill overlying the level. U.H. No. 432 was drilled at an inclination of +2° to the north for the purpose of correlating the information gained from Surface Hole No. 45, on the 11,400 W. Section, and U.H.'s No. 274 and 308 on the 11,350 W. Section. Some enrichment was indicated along the E-W Fault and extending above the 9th Level elevation, but not a sufficient amount for mining.

U.H.'s No. 397, 403, 409 and 439 were drilled at various inclinations from the 9620 West drift to outline the orebody below the level along the 11,350 W. Section. The interpretation of the information gained from this drilling made it possible to correlate the ore thus disclosed on this section with that in Surface Hole No. 44 on the 11,400 W. Section.

U.H.'s No. 376, 378, 396 and 414 were drilled at various inclinations from the 9620 East drift to outline the orebody below the level along the 10,850 W. Section. U.H.'s No. 376, 378 and 414 disclosed some ore built up along the E-W Fault and bounded on the south by a

fairly large NW-SE trending intrusive. Extremely vuggy ground was encountered in U.H. No. 396, which was drilled to the south, and after considerable difficulty with caving ground and cementing operations, the hole had to be abandoned. A top-timber drift was then driven to the south and at the close of the year, drilling operations were again underway along the 10,850 W. Section 200' further south than the previous drilling along this section.

Subsidence Studies

Microseismic Activity - Microseismic activity over the old 5th and 6th Level workings was recorded throughout the year from geophones located in surface subsidence Holes No. 65, Hole No. 68 and Hole No. 69. Hole No. 65 and Hole No. 68 are located over the 5th Level workings and Hole No. 69 is located over the 6th Level workings. In comparing the number of microseismic counts recorded from the three holes during the year, it was concluded that the major portion of the activity was over the 6th Level workings. During the first part of the year the number of microseisms recorded from Holes No. 65 and 68 was low, whereas, the number recorded from Hole No. 69 was by comparison relatively high. For the remainder of the year, the microseismic count gradually increased from Holes No. 65 and 69 while the count from Hole No. 68 remained about the same as in the previous months.

Because of the very low level (magnitude) and the low count of the microseisms recorded from the area under observation as compared with other areas studied, it is considered that the Mather "A" subsidence area has remained relatively stable during the year. However, with the increase in activity indicated during the past few months, the area will be observed closely and any or all methods applicable for determining the position of the cave and the rate of cave progression towards surface will be given careful consideration.

Cementing Hole No. 69 - During the latter part of April, the water level in Hole No. 69 was tested with electrodes and it was revealed that the cement plug, located at a depth of 1,150 feet from the collar, had washed out. The plug had been put in during November, 1956 and, although the seal was not entirely satisfactory, the hole did support a small head of water allowing the geophone to function.

In order for a geophone to function it is necessary that it be under a sufficient head of water. Since the hole would no longer support a head of water, it was necessary to re-cement so that microseismic recording could be continued. Cement was pumped into the hole beginning from the bottom, 1,150 feet from collar, and the hole would not support a head of water until the final cement plug was set at 1,072 feet from the collar. This Hole No. 69 intersected the Mather Fault in the vicinity of 1,076 feet from the collar and this fact explains the necessity for the cement plug to be set at 1,072 feet from the collar.

Dye Test - Hole No. 69 - Before cementing Hole No. 69 a dye test was conducted with the use of Uranine Water Soluble (Sodium Fluoresein) dye. The dye was put in the hole and a continuous flow of water, regulated and controlled at 10½ g.p.m. was pumped into the hole until completion of the project. Water samples were collected

underground on the 6th and 7th Levels near the Mather Fault zone. The rate of percolation of the surface water through the Mather Fault zone to underground openings was computed when the dye was first detected in the water samples taken underground and approximated 10 feet per hour. From this experiment it was concluded that the Mather Fault is of considerable importance in regard to the Mather "A" subsidence program as a possible water course.

Velocity Survey - During the month of October a velocity survey was made in subsidence Hole No. 65 to obtain velocity data through the rock in the vicinity of the subsidence area. The data collected will be used to reinterpret the reflection work of 1956 conducted by Mr. L. O. Bacon of Michigan College of Mining and Technology and will be used with the microseismic studies. Personnel involved in the velocity project were L. O. Bacon of Michigan College of Mining and Technology, G. Durfee of the U. S. Bureau of Mines and G. Ulrickson and L. Erickson of The Cleveland-Cliffs Iron Company. A velocity cable was purchased by The Cleveland-Cliffs Iron Company for the project and the recording equipment (refraction gear) was furnished by the Michigan College of Mining and Technology Physics Department.

The results of the survey produced another possible means by which the subsidence problem may be handled. The velocity recorded in the diorite sill overlying the cave area was extremely high. "The extremely high velocity of the diorite at Mather "A" is attributed to the stressed condition of the rock. The diorite sill can be represented approximately by a uniformly loaded beam. The upper surface of the sill is in compression while the lower surface is in tension and somewhere near the center it is essentially unstressed. This condition provides a possible method of determining the rate of subsidence. Providing that the above conditions are correct and exist, the zone of no stress should gradually move up the hole (i.e. the sill) as subsidence takes place. Repeated interval velocity surveys should detect this condition if normal velocity of diorite is approximately 14,000 ft./sec."*

During November, the Bureau of Mines electronic counter equipment was set up at subsidence Hole No. 65 to verify or disprove the high velocity of the diorite recorded by the velocity survey. Considering the difference in instrumentation of the two sets of gear used, the resulting velocity was very acceptable and in close agreement with that previously recorded.

Conclusions - The subsidence studies undertaken during 1957 gave valuable information needed in order to continue the subsidence program. By conducting a velocity survey, average velocities of various rock types were obtained and can be used for future seismic reflection surveys. Also, the information was needed if, or when, the magnitude and frequency of the microseisms, generated by rock fracture due to caving, reach a point where triangulation can be used to establish the source of the rock disturbances. Another important outcome of the velocity survey was that it produced another possible means by which the subsidence problem may be handled; that of following the rate of subsidence by the stressed condition of the rock.

*Report On Velocity Survey at Mather "A" and "B" Areas - Ishpeming, Michigan by L. O. Bacon.

From the microseismic activity during the year it is concluded that the rate of subsidence does not seem to be too rapid and the ground fracturing above the old 5th and 6th Level workings remains approximately the same as for the previous year; at an elevation between 1,100 feet and 950 feet from surface.

2'. "B" Shaft - Paul R. Bluekamp, Geologist

Diamond Drilling - A total of 14,359 feet of diamond drilling was done in 1957 as compared to 10,777' in 1956 and 6,034' in 1955. The major portion of the drilling was carried out from the 9th Level, the remainder being distributed, in order of decreasing amounts, on 8th, 10th, 5th, and 6th Levels. The main objectives in the drilling program were:

1. Detailing 5th, 8th, and 9th Level ore.
2. Outlining 9th and 10th Level ore east of the Cambria Fault.
3. Exploring for 9th, 10th, 11th, and 12th Level Ore West of the Cambria Fault.

5th Level - Three holes were drilled to detail the 5th Level ore in the 8200 W. area. The ore outline was found to be as expected and similar to that found East and West of the area.

6th Level - Two holes were drilled to determine the Western extremity of the 6th Level orebody. The ore was found to pinch out between the 8600 W. and 8650 W. Sections.

7th Level - One hole was drilled from 6th Level to outline the 7th Level ore on the 8550 West Section. The outline was as expected, however, the ore grade was found to be mostly second class.

8th Level - Most of the drilling was done to outline ore at the West end of the 8700, 8800, and 8900 Cross-cuts. The ore outlines were much as expected. In drilling from the 8997 top timber an upward extension of the 9th Level ore South of the Negaunee Fault was found. This ore reached up to the diorite sill above 8th Level and was about 150' thick horizontally. The laterial extent of this ore above 8th level elevation is not known, but it is estimated at 150'.

9th Level - The drilling on this level is divided into two phases: The first is the outlining of the ore from the shaft pillar to the Cambria Fault. It was found that this orebody ranges from 200 to 300 feet in thickness, is 200 feet high on each end, and dips down in the center portion to a height of only 40 feet.

The second phase of the 9th Level drilling was the exploration for ore on the Negaunee Fault between the Cambria Fault and the North-South dike. This drilling disclosed a small orebody at the junction of the Cambria and Negaunee Faults which consists of a rather low grade ore. This orebody thins out as it progresses westward and then increases in thickness again as it approaches the North-South dike. The grade of this ore becomes higher as it progresses westward.

10th Level - The 10th Level drilling program consisted of three phases: The first phase was a small program to outline some of the 10th Level ore East of the Cambria Fault. It was found that an

intrusive-iron-formation complex was lying between the fault-footwall and the orebody. This complex was 100 feet thick, about 500 feet wide, and extended from 8th to 10th Level on the 8800 W. Section.

The second phase was the exploration for a downward extension of the 9th Level ore to 10th Level and the location of the argillite footwall in the area west of the Cambria Fault. It was found that the footwall contact with the Negaunee Fault was just below 9th Level, 200 feet higher than the contact west of the Cambria Fault. A downward extension of the 9th Level ore about 100 feet thick is located on this footwall.

The third phase of the 10th Level drilling was the exploration for Mather Mine "A" Shaft ore below 10th Level, south of the Negaunee (East-West) Fault. Two of these holes entered intrusive material at about -2000', but no definite footwall or mineable ore was found.

Ore Reserves - The net ore reserves reported to the Tax Commission on December 31, 1957 were 12,961,580 tons, an increase of 299,488 tons from the previous year. The reserves were increased because of ore found during the extensive diamond drill program in 1957.

Subsidence - As in 1956 a considerable amount of time was spent on subsidence studies in an attempt to trace the progress of the cave at Mather Mine "B" Shaft. The cave, after advancing above the 4th Level, seems to have slowed down. A new diamond drill Hole No. 168 was drilled directly over the cave area to a depth of 1186' without encountering any broken ground, only a partial loss of circulation was encountered which indicates that the cave proper is more than 1200 feet from surface.

Geophones operated in all three surface Holes No. 153, 167 and 168 with a small amount of activity recorded in each. The seismic time interval shots between Holes No. 153 and 167 indicate no fracturing above the 1000' depth.

Pumping - Pumping of the North Jackson underground workings continued through 1957. The average rate of pumping, which declined from 22 million to 11 million gals./mo. in 1956, leveled off at about 10 million gals./mo. in 1957.

A fourth pump was installed in the Partridge Creek Area, three of the pumps operate full time and a fourth operates intermittantly. The pumping rate is about 600 g.p.m. Readings from the observation well show a water table drop of 11' 2" in this area during 1957.

B. Open Pit

1. Geological Summaries of Open Pit Properties

a. Humboldt - James W. Villar, Geologist

The importance of detailed pit planning became very apparent during the year. It is anticipated that in the future a major emphasis will be devoted to this type of project. Special studies, such as revising plans to temporarily by-pass a portion of the lean fine-grained iron-formation

occurring near the footwall in the Center and North Areas will be undertaken in detail. This particular study was initiated in light of recent metallurgical tests disclosing far more favorable results by employing the duplex rougher flotation M.O.C. process than by standard flotation.

Tentative six-month production areas are being outlined as well as the most economical and advantageous schemes of development. Furthermore, both annual and long-range stripping programs with related access developments are being continually investigated.

In order to provide a more realistic framework for the recent economic studies of Humboldt, a re-estimate of the concentratable iron-formation and related stripping was undertaken. The new estimate was further actuated in light of compiling additional geological, metallurgical and mining data. Areas including proven and probable reserves have been redefined in order to set up more concrete standards. Furthermore, revised factors and local modifications are now included which should resolve a better approximation.

Standard 1" = 50' geological bench maps were continued relative to the progressing faces at the 1585', 1560' and 1545' elevations. Structural and lithological features are being recorded in detail. As pit development matures, the value and validity of these maps are greatly accentuated. Presently, within the South Area of the pit, control is excellent and the degree of certainty relative to production forecasts for the next lower bench will be greatly increased. Furthermore, as a result of numerous geological complexities, economical mining schemes are directly dependent upon obtaining definite control on these varying features.

In order to facilitate pit mapping, all primary blast hole cuttings (jet piercer drill) are being analyzed for Fe. content. These values are plotted on plan and contoured at 5% intervals. Although these percentages are not precisely representative, the contoured map provides an excellent record of localized trends in the fluctuation of Fe. content.

In conjunction with pit mapping, samples of the various types of iron-formation are continually collected and submitted to the Research Laboratory for metallurgical testing. This test work is directed largely towards improving recoveries on the more difficult types of iron-formation.

Diamond Drilling - One diamond drill hole, Hole No. 6, Section 2, 47-29, was completed during the year. The hole substantiated the inferred offset of the iron-formation and provided valuable criteria for determining hanging and footwall contacts. This information has been employed in devising plans for both immediate and long-range pit development.

For the most part, the iron-formation encountered was lean, averaging merely 25.40% Fe. for an approximate 250' zone of oxidation. However, a significant percentage of the iron crude is magnetite which may prove economically beneficial in light of a possible revision in the process of concentration.

Foxdale Investigation - A detailed magnetic survey in the vicinity of the old Foxdale Mine was completed and all associated plans and profiles compiled. Magnetic intensity contours are definitely consistent

with the inference that iron-formation extends beyond the termination proposed by correlating the quartzite contacts encountered by Holes No. 3 and 7, Section 11. Detailed mapping of structural elements in the exposed portion of the Southern end of the pit further substantiates a possible extension of the iron-formation. As a result of these observations, supplemented by geophysical data and a review of old reports, the Foxdale Mine appears to be a continuation of the iron-formation extending between Holes No. 3 and 7, Section 11. A possible explanation could be an extraordinary tight fold further offset by the resultant of numerous minor slips. At this time, it appears that all the feasible methods of indirect exploration have been exhausted. It will be necessary to undertake a diamond drilling program in order to prove or disprove the existence of concentratable iron-formation. Such a program is being outlined for the forthcoming year.

b. Republic Mine - James W. Villar, Geologist

In light of recent demands for additional economic studies and as a result of revising certain factors, a review was made of the Republic ore reserves. The new tonnage estimates were taken from the original volume determinations (J.P.Meyers, October, 1952) and recalculated in accordance with newly defined categories. Also employed was a new conversion factor of eleven cubic feet of iron-formation per ton of crude ore. The original estimates were further modified to eliminate the iron-formation removed as of January 1, 1958, and with respect to revising the hangingwall contact in the vicinity of the Pascoe and Gibson Shafts.

Standard 1" = 50' geological bench maps were maintained for the newly exposed faces at the 1600' elevation. New control points were recorded for both hangingwall and footwall contacts. In addition, several included schists and zones of iron-formation not responding favorably to concentration were delineated. This data will be combined with various structural features and projected to the next lower bench in order to facilitate future operational planning.

A Special study was undertaken for the purpose of investigating various mineralogical, metallurgical and balling characteristics of the Republic concentrate. Production records at the Pellet Plant reveal extreme fluctuations which are consistent with using ore from distinctive areas in the pit. Several data sheets were compiled, but the validity of the correlation was seriously impeded by operational fluctuations and the lack of control in tracing the concentrate used. Polished surfaces of the iron-formation from various pit locations disclosed a distinctive variation in the size and physical characteristics of the iron oxide. The fine-grained material, representing only a minor portion of the total reserves, has proven to be the most fruitful for pelletizing. Microscopic examination of this type revealed isolated and disseminated grains of iron oxide in contrast to the segregated bands of the coarser material. The fine-grained nature is also reflected in the size analyses of the concentrate produced. Although the percentage of -325 mesh material (after regrind) is not always consistent with the rate of pellet production, the varying effect may be due to the percentage of even finer increments. Suggestions for a more definite classification of material prior to balling was presented to the Research Laboratory for consideration.

V. LAND OFFERS AND OUTSIDE EXPLORATIONS

A. Land Offers

During 1957 the Geological Department continued to process various mineral Land Offers submitted to the Company. A total of 100 new Land Offers were submitted by various persons or companies in 1957. Other Land Offers were carried forward from previous years on a current status. They are not included in the tabulation of the distribution of the five principal geographical areas tabulated below:

Area	No.	Percent of Total
1. Michigan	6	6.0
2. Minnesota	5	5.0
3. Canada	37	37.0
4. U. S. General	50	50.0
5. South & Central America	2	2.0
Total	100	100.0

The largest percentage, actually half, is that of U. S. General, reflecting the Department's emphasis on this geographical area. The graph showing the five-year summary of rate of offers indicates that this is an all-time high for U. S. General and is also a high for the past four years in Canada. The other geographical areas, Michigan, Minnesota and South and Central America, reflect a steady decline. The geographical distribution of the Land Offers are shown in the attached figures for the United States and for Canada.

The following tabulation lists the expenditures:

Area	1957	1956	
1. Michigan	$ 2,150.23	$ 5,696.69	
2. Minnesota	8,978.78	8,304.88	
3. U. S. General	20,563.68	51,350.83	
4. Canada	6,439.47	8,379.12	(U.S. Origin)
	64,715.73	35,605.23	(Canadian Origin)
5. South & Central America	5.00	839.67	
Total	$ 102,852.89	$ 110,176.42	

B. Outside Explorations

We use the term "Outside Explorations" for mineral areas and deposits which are not actually offered to Cliffs, but are studied as:

1. Deposits or areas for later acquisition on the basis of their potential.
2. As a source of valuable information.

The distribution of Outside Explorations new in 1957 is as follows:

GRAPH SHOWING RATE OF MINERAL LAND OFFERS 1953–1957 incl.

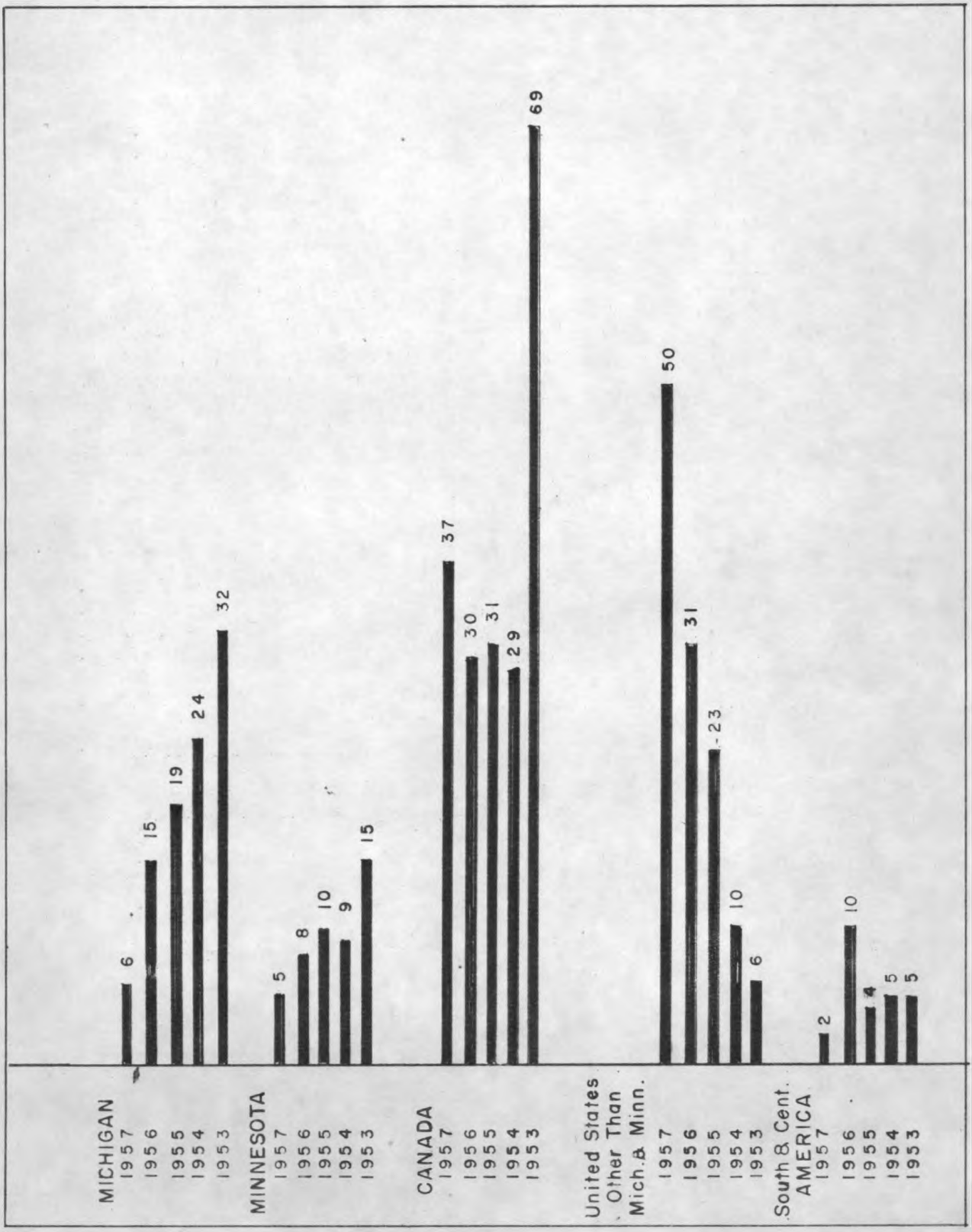
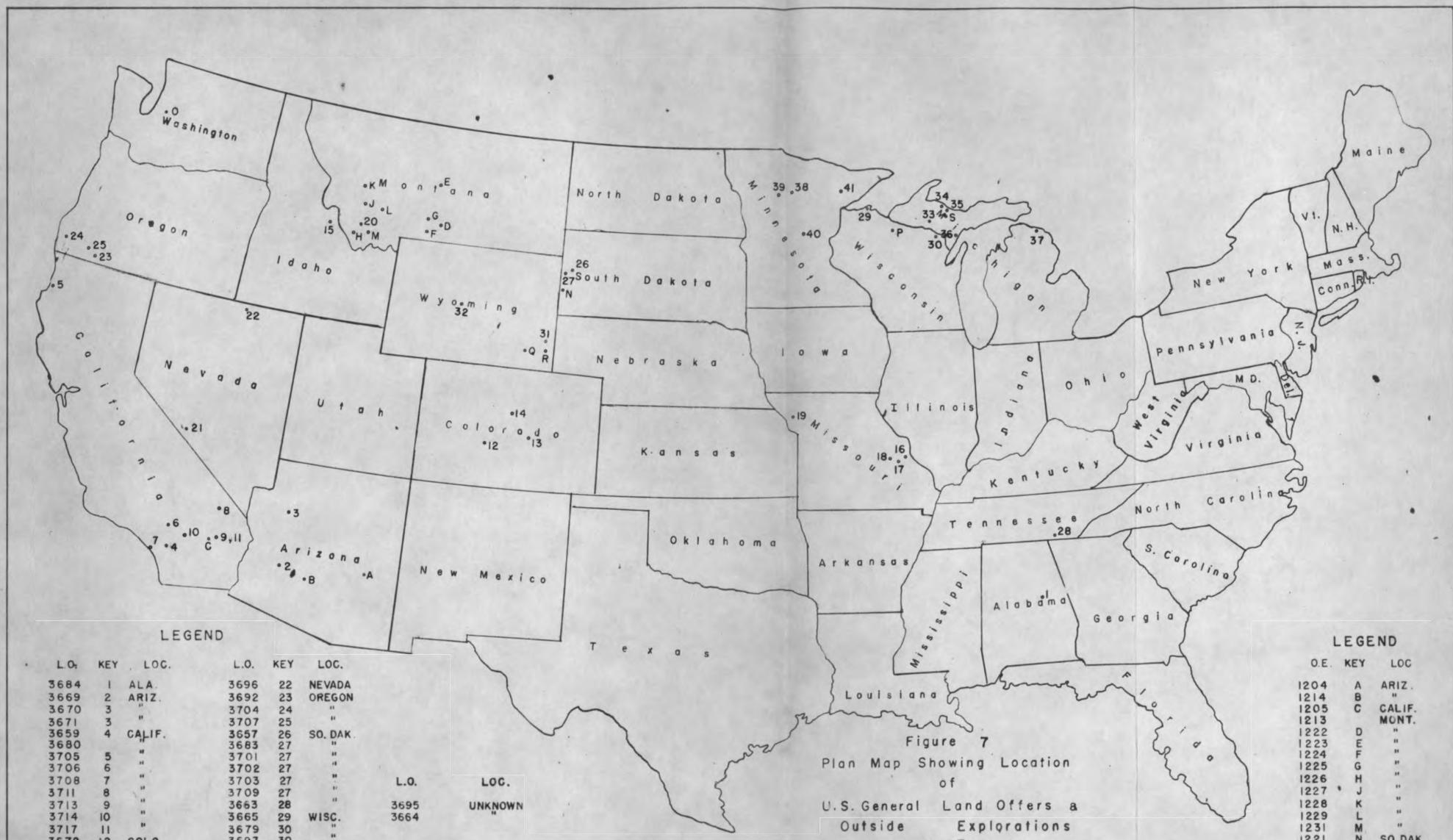


Figure 7



LEGEND

L.O.	KEY	LOC.
3684	1	ALA.
3669	2	ARIZ.
3670	3	"
3671	3	"
3659	4	CALIF.
3680		"
3705	5	"
3706	6	"
3708	7	"
3711	8	"
3713	9	"
3714	10	"
3717	11	"
3672	12	COLO.
3673	13	"
3675		"
3676	12,13	"
3677	12,13	"
3699	14	"
3660	15	IDAHO
3685	15	"
3686	15	"
3698	15	"
3667	16	MISSOURI
3687	16	"
3690	17	"
3691	18	"
3700	19	
3710	20	MONT.
3689	21	NEVADA
3696	22	NEVADA
3692	23	OREGON
3704	24	"
3707	25	"
3657	26	SO. DAK.
3683	27	"
3701	27	"
3702	27	"
3703	27	"
3709	27	"
3663	28	"
3665	29	WISC.
3679	30	"
3697	30	"
3678	31	WYO.
3688	32	"
3658	33	MICH.
3662	34	"
3674	35	"
3681	35	"
3693	36	"
3694	37	"
2961		MINN.
2962	38	"
2963	39	"
2964	40	"
2965	41	"
3675		U.S. GEN. (WEST)
3666		"

L.O.	LOC.
3695	UNKNOWN
3664	"

Figure 7
Plan Map Showing Location
of
U.S. General Land Offers a
Outside Explorations
1957

LEGEND

O.E.	KEY	LOC
1204	A	ARIZ.
1214	B	"
1205	C	CALIF.
1213		MONT.
1222	D	"
1223	E	"
1224	F	"
1225	G	"
1226	H	"
1227	J	"
1228	K	"
1229	L	"
1231	M	"
1221	N	SO. DAK.
1230	N	"
1209	O	WASH.
1243	P	WISC.
1215	Q	WYO.
1220	R	"
1202	S	MICH.
1208	S	"
1219	S	"
1207		U.S. GEN. (WEST)
1211		"
1212		"
1241		"
1201		UNKNOWN
1217		"

Area	No.	Percent of Total
1. Michigan	3	5.7
2. Minnesota	-	-
3. Canada	20	37.7
4. U. S. General	25	47.2
5. South & Central America	5*	9.4
Total	53	100.0

* Includes 2 Outside Explorations in Mexico.

The total number of Outside Explorations increased for the year 1957 being almost double that of 1956. This reflects both the activity in U. S. General and in Canada; and our desire to keep informed on the activities of other persons, both by way of opportunities for our Company and also the activities of our competitors.

The following tabulation shows the expenditures on Outside Explorations by the five principal geographical locations:

Area	1957	1956	
1. Michigan	$ 15,545.03	$ 59,867,31	
2. Minnesota	12,665.04	1,416.65	
3. U. S. General	41,706.51	14,280.36	
4. Canada	4,090.40	1,272.23	(U.S. Origin)
	56,105.19	36,123.06	(Canadian Origin)
5. South & Central America	2,201.59	712.68	
Total	$ 132,313.76	$ 113,672.29	

Figure 8

Plan Map Showing Location of Canadian Land Offers and Outside Explorations 1957

LEGEND

L.O.	KEY	LOC.
3250	1	B.C.
3251	2	"
3252	3	"
3253	4	"
3247	5	MAN.
3245	6	NFLD.-LAB.
3243	7	NEW BRUN.
3233	8	NOVA SCOTIA
3226	9	ONT.
3227	10	"
3228	11	"
3230	12	"
3231	13	"
3232	14	"
3234	15	"
3235	16	"
3236	17	"
3237	18	"
3238	19	"
3239	20	"
3242	21	"
3255	22	"
3258	23	"
3259	24	"
3260	25	" — QUE.
3224	26	QUEBEC
3229	27	"
3240	28	"
3241	29	"
3244	30	"
3246	31	"
3249	32	"
3254	33	"
3256	34	"
3257	35	"
3261	36	"
3248	37	YUKON

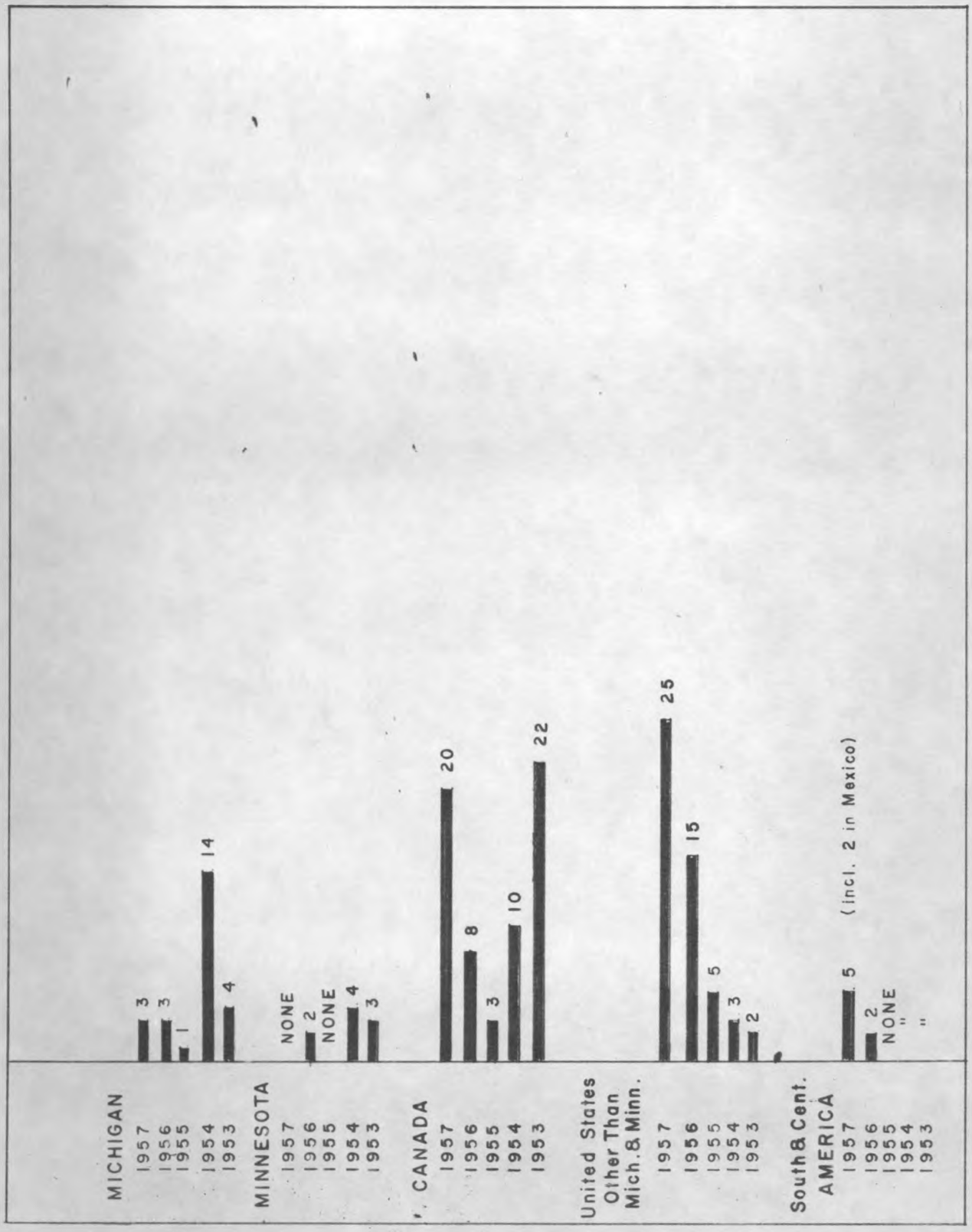
O.E.	KEY	LOC.
1139	A	ALBERTA
1405	B	"
1400	C	BAFFIN ISLE
1138	D	B.C.
1144	E	"
1147	F	"
1146	G	MANITOBA
1402	H	NEW BRUN.
1149	J	ONTARIO
1403	K	"
1408	L	"
1141	M	QUEBEC
1142	N	"
1143	O	"
1401	P	"
1404	Q	"
1407	R	"
1145	S	SASK.
1406	T	"
1148	U	YUKON

' DENOTES GENERAL EXPLORATION

" " EXACT LOC. UNKNOWN

Figure 9

GRAPH SHOWING RATE OF OUTSIDE EXPLORATIONS 1953-1957 incl.



VI. MICROSCOPY - Tsu-Ming Han, Geologist

During the year the Microscopy Section of the Research Laboratory continued to be shared by Geology and Metallurgy. The projects completed for the Geological Department during 1957 were as follows:

A. Michigan

1. Ogden Schoolhouse Project

The study of a few core samples from DDH No. 1, Section 13, Ogden Schoolhouse revealed that the rocks are a magnetite-bearing cherty carbonate resembling most of the Empire magnetite-bearing rocks. However, the average magnetite grain size is finer than that from the Empire Area (Plates 1 and 2).

2. Materials from Exploration Projects and Operating Mines

Samples of drill core and hand specimens were intermittently received from geologists for microscopic examinations. This material was received from various operating mines including Mather Mine "A" and "B" Shafts, Cliffs-Shaft and the Republic Mine and from various exploration projects including Cascade and Tilden. This work was generally done coincidental to the drilling program.

B. U. S. General

1. California

Land Offer 3646 - A study was made of three beach sand samples collected near Crescent City, California. The examination revealed that the samples do not have favorable concentrating characteristics for recovery of iron, chromium, and titanium respectively. This is due mainly to the exsolution of one mineral from another and the isomorphous substitution of one atom by another in the mineral structure.

2. Montana

Land Offers 3602 and 3634 - A series of specimens from an area near Stanford, Montana were submitted by Mr. Rufus Rantala for laboratory examination. The investigation was to compare the mineralogical composition and mineral texture between the specimens collected from glacial deposits and those occurring in place. This was done in an attempt to discover whether the drift material originated from the known orebody. The study concluded that the drift materials originated from the same rock types that occurs in place. Therefore, the drift might either be originated from the known orebody or from the same type of orebodies in the adjacent area by glacial erosion and transportation.

Land Offer 3710 - A mineralographic examination was conducted on Sample No. MX-2051 from the Carter Iron Deposit. It was concluded that the material is a thin-banded iron-formation. Although the ore particles might be liberated by -200 mesh grind, direct magnetic separation cannot recover all the ore particles from the sample because of the presence of appreciable amounts of specular hematite (Plate 3).

3. South Dakota

Land Offer 3683 - A sample from the Black Hills Region identified as MX-1866 was received for microscopic examination. The study revealed that the sample is a specular hematite and martite-bearing chert. An iron concentrate may be produced from the sample by employing the standard M.O.C. process.

Land Offer 3668 - A number of specimens from the Black Hills Region were submitted by Mr. Eric Rex for metallurgical and ore genetic studies. The specimens were probably formed from the replacement of a graphic slate by goethite which are not favorable for ore beneficiation at the present time.

C. Canada and Alaska

1. Project 17 - Titaniferous Ore Samples

More than 25 titaniferous ore samples from Benoit Lake and Albanel Lake Areas, Quebec were intermittently received for investigation. The purpose was to determine the mineralogic relationships and metallurgical characteristics of these samples. The study revealed that ilmenite and magnetite appeared to be the chief opaque minerals in the titaniferous samples. Based on the mineral association, the samples may be classified into four groups:

a. Ilmenite associated with titanomagnetite.
b. Ilmenite associated with magnetite.
c. Hematite-bearing ilmenite associated with magnetite.
d. Hematite-bearing ilmenite (Plates 4-6).

Although the titanomagnetite is concentratable, it is highly titaniferous which generally constitutes more than 14% mechanically inseparable TiO_2. All the ilmenite, hematite-bearing ilmenite, and magnetite are concentratable, but the percentage of these minerals in most of their respective samples seems too low to be economically treated at the present.

2. O.E. 1136 - Ford Lake, Hopes Advanced Bay, Quebec, Canada

A suite of specimens from Ford Lake Area were received from Mr. B. H. Boyum, Chief Geologist, for microscopic examination. The results of the examination showed that (a) the ore minerals are present as specular hematite and magnetite; (b) a minus 100 mesh grind will probably produce an acceptable concentrate containing less than 10% silica; and (c) direct magnetic separation, flotation, or flotation-magnetic separation combined methods are probably not applicable for concentrating the ore particles from this type of ore. However, M.O.C. concentration or isodynamic separation might be successful (Plates 7 and 8).

3. O.E. 1148 - Yukon, Alaska

Three specimens from the Yukon Territory listed under O.E. 1148 were examined. The specimens appeared to be magnetite-chert, magnetite-carbonate-chert, and hematite-chert. Most of the ore particles in the magnetite-chert can be liberated by a 325 mesh grind, while those in the last two are extremely fine-grained and cannot be liberated even after a -400 mesh grind is employed.

D. Peru

A series of ore specimens from the Acarí-Ica Iron Deposits, Peru, collected by Mr. Burton H. Boyum, Chief Geologist, were studied. The results indicated that the materials were from partially oxidized iron ore vein deposits of a fissure-filling type. The ore specimens are high grade generally containing more than 60% iron and less than 7% silica (Plate 9).

E. Special Research

A paper entitled "The Genetic Relationship between Hematite and Magnetite with a Special Note on Martite" was presented by the writer at the Institute on Lake Superior Geology held at Michigan State University in May.

ILLUSTRATIONS

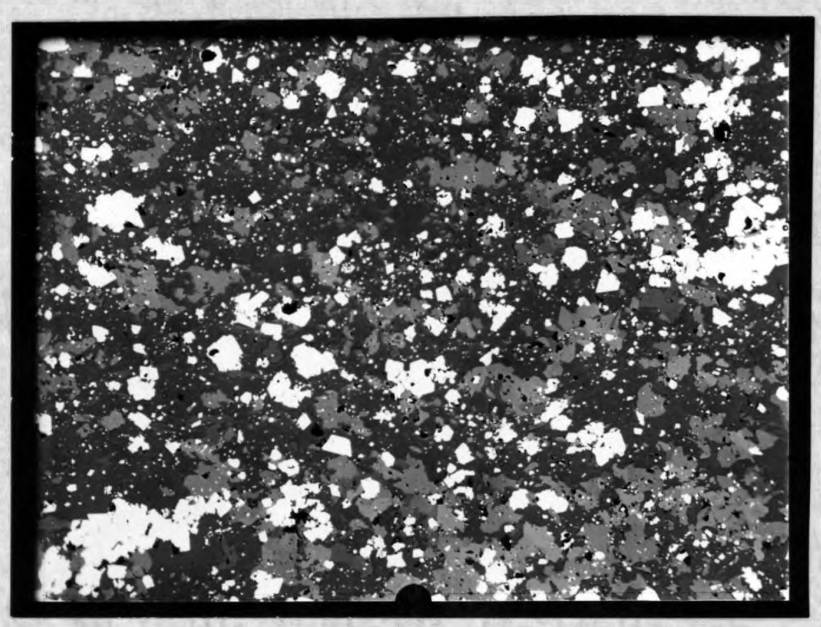


Plate 1
Ogden-Schoolhouse
D.D.H. No. 1
Section 13
Depth: 100'

Fine and medium grained magnetite in cherty carbonate. 100x
Magnetite, white; carbonate, light gray; chert, gray; and pits, black.
Common grain size: 325 mesh and minus 5 microns.
Polished Section No. 965. Photomicrograph No. 1056.

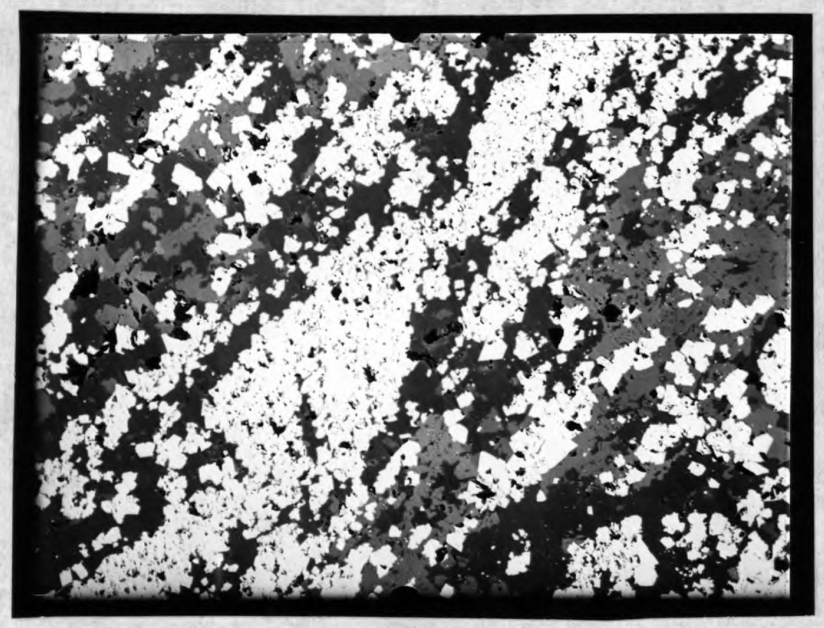


Plate 2
Ogden-Schoolhouse
D.D.H. No. 1
Section 13
Depth: 250'

Medium grained magnetite in cherty carbonate. 100x
Magnetite, white; carbonate, light gray; chert, gray; and pits, black.
Common grain size: 325 mesh.
Polished Section No. 968. Photomicrograph No. 1059.

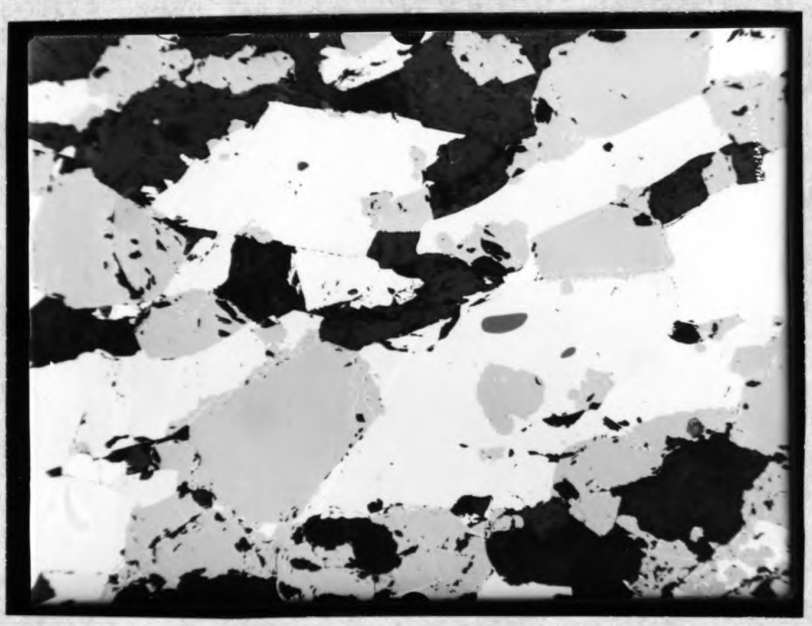


Plate 3
Land Offer 3710
Carter Iron
Deposit, Montana

The relationship between hematite and magnetite in the rich ore bands. 90x
Magnetite, grayish white; hematite, white; gangue, gray; and pits, black.
Polished Section No. 1675. Photomicrograph No. 1039.

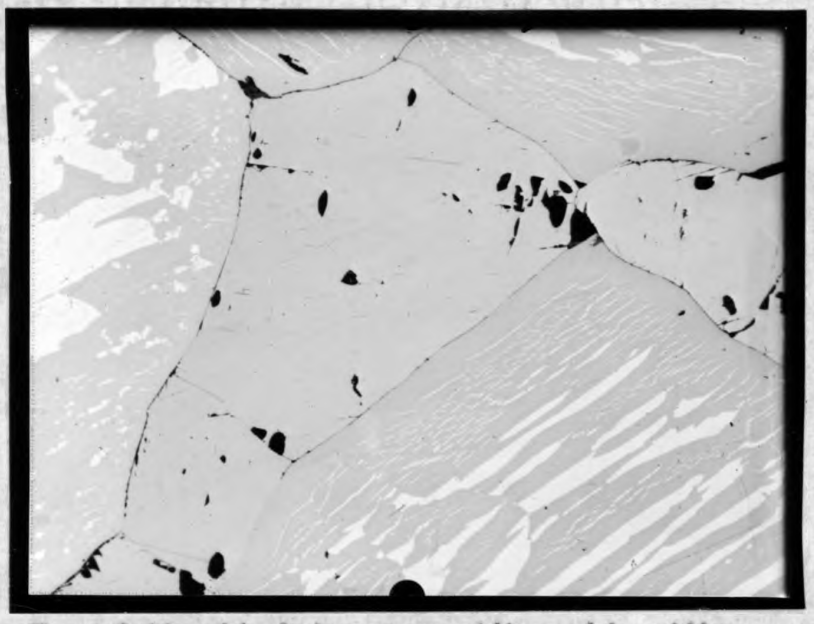


Plate 4
Project 17
Albanel Lake
Quebec, Canada

The relationship between magnetite and hematite-bearing ilmenite. 120x
Hematite, white; magnetite, light gray; ilmenite, light gray but containing hematite.
Polished Section No. 1667. Photomicrograph No. 1024.

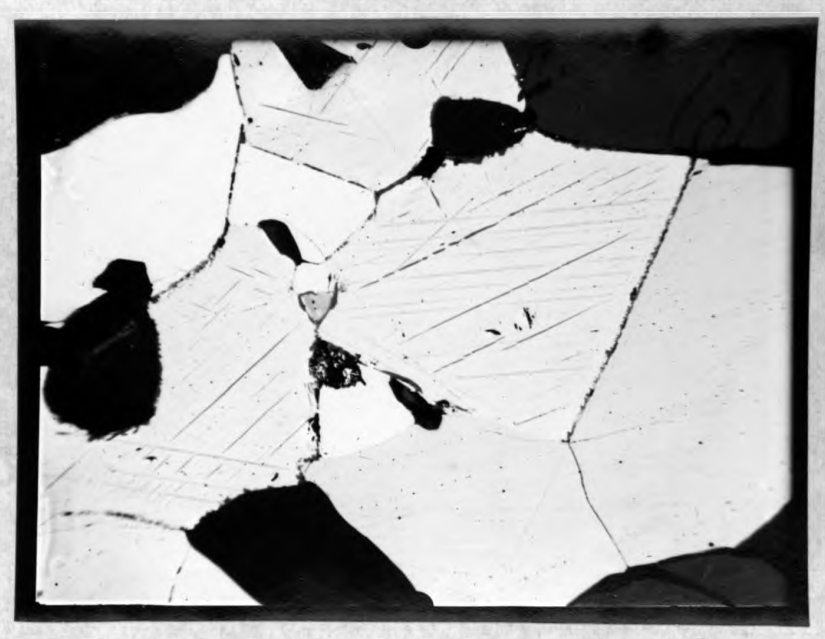


Plate 5
Project 17
Benoit Lake Area
Quebec, Canada

The relationship between the titanomagnetite and ilmenite. 80x
Magnetite, white with black and light gray parallel lines; ilmenite, grayish white and smooth surfaced; and gangue, dark gray.
Polished Section No. 1650. Photomicrograph No. 979

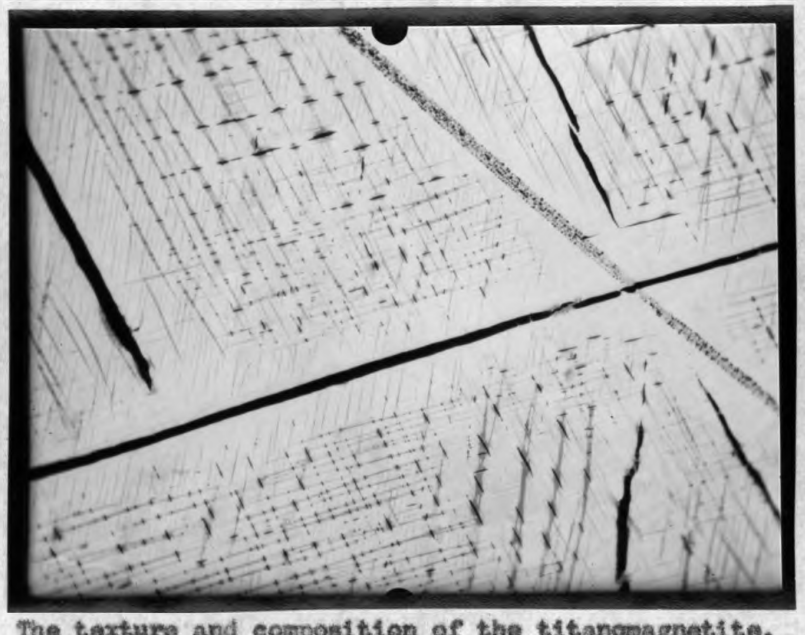


Plate 6
Project 17
Benoit Lake Area
Quebec, Canada

The texture and composition of the titanomagnetite. 500x
Magnetite, white; pleonaste, coarse black lines and small black dots; ulvospinel, fine gray lines; and ilmenite, a long and thin gray line with black dots.
Polished Section No. 1650b. Photomicrograph No. 981a.

Plate 7
O.E. 1136
Specimen No. 11756
Ford Lake, Hopes
Advance Bay,
Quebec, Canada

Showing the texture of the ore particles, and the relationship and ratio between hematite and magnetite. 120x
Common grain size: Minus 100 plus 200 mesh.
Hematite, white; magnetite, grayish white; chert gray; and pits, black.
Polished Section No. 958. Photomicrograph No. 1030.

Plate 8
O.E. 1136
Specimen No. 11760
Ford Lake, Hopes
Advance Bay,
Quebec, Canada

Showing the outlines of oolites, and the texture of specular hematite. 120x
Common grain size: 200 mesh.
Hematite, white; carbonate and silicates, light gray; chert, gray; and pits, black.
Polished Section No. 963. Photomicrograph No. 1033.

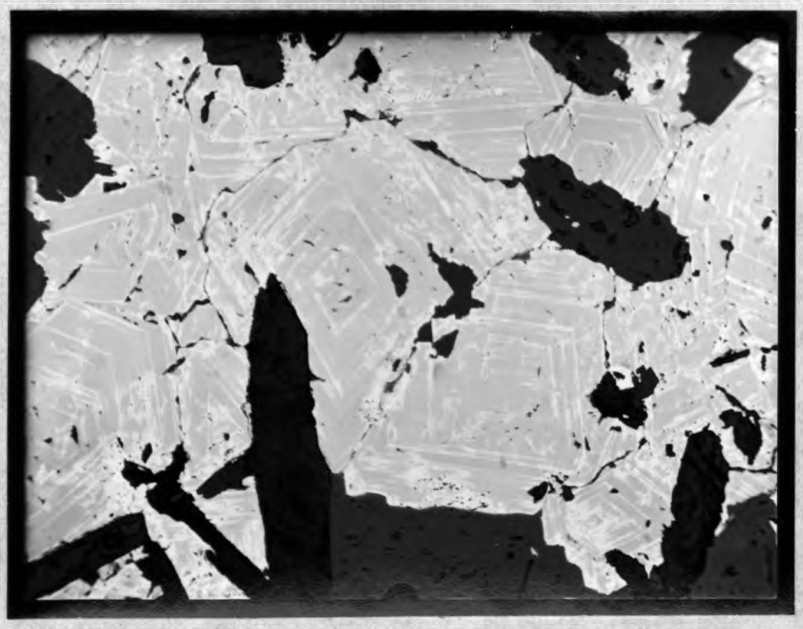


Plate 9
O.E. 1216
Specimen No. 12100
Acari Iron Deposit
Peru

The texture of partially oxidized magnetite. 130x
Magnetite, grayish white; hematite, white; gangue, dark gray; and pits, black.
Polished Section No. 975. Photomicrograph No. 1075

VII. OTHER DEPARTMENTAL HIGHLIGHTS

A. Research in Exploration

During the year 1957 the Department continued its program of research in Exploration techniques and equipment. Experimentation was done in the field of geophysics, core drilling and geological distribution of iron ore. The principal items of investigation may be summarized as follows:

1. Induced Polarization

During the month of October a geophysical crew from McPhar Geophysics, Inc. was engaged in experimental work with their Induced Polarization equipment (E & A, CC-924). The experiments were conducted in four areas on the Marquette Range. These were Section 4, 47-27, the New Richmond Lease, the Tilden Area and the Titan Area at the Ohio Mine. In the Section 4 Area the equipment was used mainly to pick out contacts between the various rock types. The hard ore horizon could be traced very readily with the gear. The iron-formation - argillite contact on the north was also picked up. In the New Richmond and Tilden Areas an attempt was made to see if this equipment could be used to delineate between the Class I, II and III M.O.C. material. In the New Richmond Area the results looked quite encouraging, however, in the Tilden Area there were many question marks. There is quite a difference in the mineralogy in the two properties particularly in the martite-goethite ratio. It appears that where the Class I material was attributed to the high ratio of martite the equipment responded quite well. Where the Class I material was due to crystalline hematite, results were questionable.

Since this technique is new and has been used less than two years in base metals exploration, the costs are not definite. It may be said in summary that if an electromagnetic induction anomaly is produced by a certain geologic condition, that the results by induced polarization will be more marked. The costs, however, may be considerably greater.

2. Experimental Core Drilling

Additional tests were carried out early in the year at the Sally Mine utilizing a Joy Blast Hole Drill, Model 60, and a Hughes Tool Company air-cooled double barrel equipped with a bit with rotary cutters. A 3 5/8" core was obtained. The experiment indicated that reasonable samples can be obtained provided the ground can be penetrated by the rotary cutters.

3. Operation Overthrust

Photographic Survey Company Ltd. of Toronto, initiated a program of basic exploration utilizing aerial photography mosaics combined with transparent overlays utilizing the geological and geophysical data available to indicate areas where exploration would be warranted. The Cleveland-Cliffs Iron Company agreed to participate in the program through Cliffs of Canada and we were joined by the Consolidated Mining and Smelting Company of Canada Ltd. on an equal share basis. Our joint headquarters was established in Port Arthur adjacent to the offices of Bartley, Greer and Associates. Mr. Robert W. Riedel was assigned to this office in August to act as the Geologist for the joint venture dividing his time

and expenses equally between the two companies on projects which they elect to pursue. His program is administered through a four-man committee made up of M. W. Bartley and Burton H. Boyum for Cliffs and Neely Moore and Peter Sevensma for Cominco.

Photographic Surveys has been taken over by the parent company being re-named the Hunting Technical and Exploration Services Ltd. The Operation Overthrust Area encompasses a significant amount of Ontario, Quebec, Michigan, Wisconsin and Minnesota. The location of all known mineral prospects and mines is incorporated in the data and a selected bibliography of published information and assessment work is provided. At the end of the year 32% of the 1" = 1 mile of mosaics had been released together with 52% of the 4" = 1 mile mosaics and only 1% of the geological overlays.

Cliffs Project #1 of the Overthrust series consisted of bringing up to date the compilation of iron occurrences in Canada which was done by Dr. M. W. Bartley in 1953. This compilation contains a synopsis of the published geologic and economic data pertaining to most of the known iron deposits. In addition, the locations of all these occurrences as well as all the Canadian Land Offers and Outside Explorations are plotted on the Provincial Geologic maps. A set of these compilation sheets and posted geologic maps now exists in each of the Cleveland, Ishpeming, and Port Arthur offices.

4. Lake Superior Iron Ore Appraisal

Part of our fundamental studies has been to review the relative proportion of iron ore produced to date from each of the Lake Superior Range, together with the remaining potential and the comparative ore density or acreage distribution factors. A part of the time of two of our summer workers, Messrs. Roy Koski and Jen-Ho Fang was spent on this program. This is summarized in General Exploration Report No. 31.

5. Cost Accounting

A significant achievement during the year was in the revised accounting procedures adopted for our Canadian work. The value of this accounting is in better records, greater ease of making Financial Forecasts and budget control and for assessment records. This system is adapted to the machine type of accounting. A sample is attached, herewith.

B. Papers & Publications

1. Departmental Reports

During the year 1957 the following reports were prepared and issued by the Department under the following headings:

a. General Exploration Reports

Report No. 19 - Investigation of Willow Creek Iron Deposit, L.O. 3581, Dewey Whittaker by E. Rufus Rantala.

Report No. 20 - Investigation of Running Wolf Iron Deposit, L.O. 3634, Norman Whittaker by E. Rufus Rantala.

Report No. 21 - Investigation of Mackay, Idaho Iron Copper Deposit, L.O. 3585 by E. Rufus Rantala.

Report No. 22 - Investigation of L.O. 3603, Eklund & Pahl; L.O. 3604, Albright Claims; L.O. 3638, Belt Park; O.E. 1187, Sheep Creek Area, George Jellea, Livingston, Montana, Sarsfield Claim, Iron Park by E. Rufus Rantala.

Report No. 23 - Geologic, Electromagnetic & Magnetometer Studies on Iron Ore Deposits in Fillmore County, Minnesota by E. Richard Randolph.

Report No. 26 - Airborne Magnetic Reconnaissance Survey, San Bernardino County, California, O.E. 1188 by Dr. John S. Sumner.

Report No. 27 - Probable Future Development Trends of Iron Ore in the Western United States by Burton H. Boyum.

Report No. 28 - Exploration Summary, Albanel Minerals Ltd., Lake Mistassini Region, Quebec by Burton H. Boyum.

Report No. 29 - Geology of the Empire Mine Area, Section 19, 47-26 by Keith C. Roberts, James R. Hodge and John E. Anderson.

Report No. 30 - Old Foxdale Mine (Humboldt Mine) by James W. Villar.

Report No. 31 - Lake Superior Iron Ore Appraisal, O.E. 1199 by Roy A. Koski and Jen-Ho Fang.

Report No. 32 - Geology of the Norway-Vulcan Area, by John C. Palmquist and George DeRoche.

Report No. 33 - Geology of the Gwinn District by E. William Behrens, John C. Palmquist, James R. Hodge, John E. Anderson and Stanley J. Chapman.

Report No. 34 - Geology of the Ogden Schoolhouse Area (Sections 13 and 24, 47-27) by Roy A. Koskie, Jen-Ho Fang and John C. Palmquist.

Report No. 35 - Acari Iron Deposit, Peru, O.E. 1216 by Burton H. Boyum.

Report No. 36 - Proposed Drilling Program for Direct Shipping Ore on the Marquette Range by Gerald J. Anderson.

Report No. 37 - Preliminary Report on the Carter Iron Deposit near Dillon, Montana, L.O. 3710 by Burton H. Boyum and Eric J. Rex.

Report No. 38 - Ground Follow-Up of San Bernardino County, California Aeromagnetics, O.E. 1188 by Eric J. Rex.

Report No. 39 - Report on a Portion of the Geophysical Prospecting in Central Wisconsin by Keith C. Roberts.

Report No. 41 - Summary Report on Cameo Exploration by Robert W. Riedel.

b. Geology & Mineralogy

Report No. 18 - The Composition & Texture of the Manganese Ores from Orient Province, Cuba, O.E. 1195 by Tsu-Ming Han.

Report No. 19 - St. Lawrence River Sands, Natashquan, Canada by Tsu-Ming Han.

Report No. 20 - North Star Holman Ore, Minnesota by Tsu-Ming Han.

Report No. 21 - Microscopic Examination of Beach Sand Samples from Crescent City, California.

Report No. 22 - Examination of Sample MX-1866, Specular Hematite-Martite-Chert from Black Hills, South Dakota by Tsu-Ming Han.

Report No. 23 - Microscopic Examination of Titaniferous Magnetite Samples from Benoit Lake Area, Canada (Project 17), by Tsu-Ming Han.

Report No. 24 - Microscopic Examination of Titaniferous Samples from Project 17, Quebec, Canada by Tsu-Ming Han.

Report No. 25 - Mineralographic Examination of Sample No. MX-2051, Carter Iron Deposit, Montana, L.O. 3710 by Tsu-Ming Han.

Report No. 26 - The Relationship of Diagenesis, Metamorphism and Secondary Oxidation to the Concentrating Characteristics of the Negaunee Iron-Formation of the Marquette Range by Gerald J. Anderson and Tsu-Ming Han.

Report No. 27 - Microscopic Examination of Specimens from Ford Lake Hopes Advanced Bay, Quebec, Canada by Tsu-Ming Han.

Report No. 28 - Mineralographic Examination of Some Drill Core Specimens from DDH No. 1, Section 13, Marquette County, by Tsu-Ming Han.

c. Geophysics

Report No. 8 - Albanel Mines Ltd. and Summary Report on Project 17 Airborne Geophysics, Lake Albanel Project, Mistassini Region, Quebec by Burton H. Boyum.

Report No. 9 - Reconnaissance Magnetic Survey over Sioux Quartz Area of Southwestern Minnesota, O.E. 1109 and 1110 by E. Richard Randolph.

Report No. 10 - Mining Geophysics (Given at the Mining Sub-Section AIME at Hibbing Minnesota) by Burton H. Boyum, E. Richard Randolph and Dr. John S. Sumner.

Report No. 11 - The Cleveland-Cliffs Seismic Reflection Project by L. O. Bacon.

Report No. 12 - Schlumberger Electrologging of Small Diameter Drill Holes on the Marquette Range, Michigan by Burton H. Boyum.

Report No. 13 - Airborne Magnetic and Electromagnetic Survey Southwest Portion, Project 17 Area, 1957 by Burton H. Boyum.

Report No. 14 - Summary of Geophysical Calculations by E. Richard Randolph.

d. Diamond Drilling

Report No. 12 - Diamond Bit Performance by Roy W. Hillmer.

Report No. 13 - Experimental Drilling, Hughes Bit, Sally Mine by E. Richard Randolph.

Report No. 14 - Diamond Bit Performance, Section 22, Tilden West, 1957 by Roy W. Hillmer.

Report No. 15 - Operations of a Truck-Mounted Rotary Drill Rig by Gerald J. Anderson and Roy W. Hillmer.

e. Ore Reserves

Report No. 5 - Bunker Group (Athens, Bunker Hill, Maas, Pioneer & Arctic) by Ted Engel, Jr.

Report No. 6 - 1957 Edition of the 1975 Special Reserve Study by Burton H. Boyum.

Report No. 7 - Bunker Hill - Maas Group by Ted Engel, Jr.

Report No. 8 - Cliffs-Shaft Mine First and Second Class Ores by James P. Meyers.

Report No. 9 - 1958 Edition of the 1978 Special Reserve Study by Burton H. Boyum.

Report No. 10 - The Cleveland-Cliffs Iron Company Reserve Study of Low Grade Properties, Marquette Range by Donald R. Lukkari.

f. Subsidence

Report No. 5 - 1957 Subsidence Summary - Mather Mine "B" Shaft by Paul R. Bluekamp.

2. Papers for Technical Meetings

During the year 1957 a number of the Departmental staff presented papers for technical meetings. They are summarized as follows:

Name of Meeting	Title of Paper	Author
Mining Sub-Section, Minnesota Section AIME, Hibbing, Minnesota - January	Mining Geophysics	Burton H. Boyum E. Richard Randolph Dr. John S. Sumner
National AIME, New Orleans, La. - February	The Relationship of Diagenesis, Metamorphism & Secondary Oxidation to the Concentrating Characteristics of the Negaunee Iron-Formation of the Marquette Range	Gerald J. Anderson Tsu-Ming Han
Wyoming Mining Association, Casper, Wyoming - April	Probable Future Development Trends of Iron Ore in the Western United States	Burton H. Boyum
Lake Superior Institute of Geology, Lansing - May	Progress Report on a Geological Investigation of the Iron-Formation, Humboldt, Michigan	James W. Villar
Lake Superior Institute of Geology - Lansing - May	The Genetic Relationships Between Hematite and Magnetite, with a Special Note on Martite	Tsu-Ming Han
Diamond Drill Symposium, University of Minnesota, Minneapolis, Minnesota - October	Operations of a Truck-Mounted Rotary Drill Rig	Gerald J. Anderson Roy W. Hillmer
Diamond Drill Symposium, University of Minnesota, Minneapolis, Minnesota - October	Schlumberger Electrologging of Small Diameter Drill Holes on the Marquette Range, Marquette	Burton H. Boyum
Michigan Mineralogical Society, Cranbrook Institute - October	Notes on the Mineralogical Assemblages at the Humboldt and Republic Open Pits	James W. Villar

For the most part, the preparation of these papers was done on the individuals own time. This effort is very worthwhile, not only to the person preparing the paper but also for the favorable publicity which it affords the Company.

CLIFFS OF CANADA LIMITED
ALBANEL MINERALS LIMITED

CHART OF ACCOUNTS FOR EXPLORATION EXPENDITURES

PRINCIPAL ACCOUNTS

900	General Administrative Expense
1100	Prospecting
1200	Survey Control
1300	Geology
1400	Geophysics
1500	Diamond Drilling
1600	Metallurgical Testing and Analysis
1700	Airborne Geophysics
1800	Camp Construction
1900	Commissary - Provisions, etc.
2100	Development - Dock Site, etc.
3100	General

SUBACCOUNTS

01 Salaries
02 Wages
03 Travel
04 Dues & Subscriptions
05 Telephone & Telegraph
06 Printing, Stationery & Ofc. Supplies
07 Rent - office
08 Heat, Light, Power & Water
09 Furniture, Fixtures & Ofc. Equipment
10 Payroll Taxes (Unemployment)
11 Old Age Benefits Tax
12 Auto Expense
13 Airplane Expense
14 Entertainment
15 Accounting
16 Aircraft Charter
17 Option Payments
18 Claim Rental
19 Management & Advisory Fees
20 Mining Licenses & Mining Claims
21 Maps & Prints
23 Personal Injury
24 Field Equipment & Maintenance
25 Building Alterations
30 Workmen's Compensation
31 Advertising
32 Cliffs News
34 Repairs & Maintenance
36 Insurance
37 Postage & Express
38 Special Supplies
40 Miscellaneous
41 Depreciation
42 Directors Fees & Expenses
43 Annual Audits
44 Donations
45 Transfer Agents Fees
46 Group Insurance
47 Group Annuity
48 Outside Legal Services
49 Property & Franchise Taxes
50 Retirement Payrolls
51 Ishpeming Charges
52. Exchange
53 Contractor

October, 1957