THE CLEVELAND CLIFFS IRON COMPANY.

REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1921.

STAFF.

The staff of the Geological Department for 1921 is given in Table I below. Mr. Finger resigned June 25th and returned to his home at Fallon, Nevada. He went back to Harvard in the fall to take up graduate work in geology and allied subjects. On account of the general curtailment in ore production the first of June, no one was engaged to succeed him. Mr. Denn was laid off June 5th coincident with the laying off of several members of the Engineering Department staff on account of the general curtailment.

### Table I.

<table>
<thead>
<tr>
<th>NAME</th>
<th>OCCUPATION</th>
<th>DURATION OF EMPLOYMENT IN 1921.</th>
<th>DAYS LOST</th>
<th>% OF WORKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.L. Derby, Jr.</td>
<td>Geologist in charge of Department.</td>
<td>Entire year</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A.W. Finger</td>
<td>Assistant Geologist</td>
<td>6 months</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>E.A. Allen</td>
<td>Assisting Geologists, testing diamond drill holes, collecting and labeling core, etc.</td>
<td>Full time for 10 months, 1/4 time for 1/2 months.</td>
<td>6</td>
<td>4 1/2</td>
</tr>
<tr>
<td>Gustav Afuhs</td>
<td>Draftsman</td>
<td>Entire year</td>
<td>3 1/2</td>
<td>4 1/2</td>
</tr>
<tr>
<td>F.N. Denn</td>
<td>Collecting core, etc.</td>
<td>Full time for 1/2 of a month, 1/2 time for 1/2 months.</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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

### Table II.

- Total days of eight hours worked - - 276 1/2 days.
- Sundays - - - - - - - - 52 "
- Days resulting from Saturday afternoons 26 1/2 "
- Holidays - - - - - - - - 10 "

Total 365 days.

Table III, below, shows the average number of men regularly employed on the staff of the Geological Department during the last five years:

### Table III.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>AVERAGE NUMBER OF MEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1917</td>
<td>3.35</td>
</tr>
<tr>
<td>1918</td>
<td>4.65</td>
</tr>
<tr>
<td>1919</td>
<td>5.44</td>
</tr>
<tr>
<td>1920</td>
<td>4.06</td>
</tr>
<tr>
<td>1921</td>
<td>3.56</td>
</tr>
</tbody>
</table>

GEOLOGICAL DEPARTMENT 480
DIVISION OF WORK AMONG THE MEMBERS OF THE DEPARTMENT.

H. L. Smyth. The work of the Geological Department continued under the direction of Mr. H. L. Smyth as Consulting Geologist.

E. L. Derby, Jr. The major part of my time during the past year was taken up with the general oversight and supervision of the work of the Department. This included, besides the usual routine office work, surface drilling explorations in the Ishpeming, Dead River, Crystal Falls and Gwinn Districts; underground drilling in the Holmes, Morris, Republic and Spies Mines; and the underground surveys in the Athens, Barnes-Hecker, Cliffs Shaft, Francis, Gwinn, Holmes, Haas, Morris-Lloyd, Negaune, Princeton, Republic, Salisbury, Spies and Stephenson Mines. I have accompanied the men making these surveys frequently and have kept in touch with and supervised their detailed studies of the results of these surveys constantly. After Mr. Fingers left I made all the underground surveys of the new development work in the mines.

My time, not taken up with these duties, was spent chiefly as follows:

In January, I accompanied Mr. Elliot in an examination of the workings of the Baraga ore body on Arctic Parcel No.1 of the Breitung-Hematite Mine and made an estimate of the ore for his report. I also made a geological survey of the Section 16 Mine workings, adjacent to the Holmes Mine boundary.

In February, I made a special report on the so-called South Deposit of the Meadow Mine in connection with an anticipated surrender of the lease on this property. I also made a joint examination of and submitted a joint report on the Section 16 Mine with Messrs. Jopling and Eaton, including an estimate of the ore remaining in the property.

I left for Washington, D. C., March 20th as a member of this Company’s Committee which submitted the valuations of all the Company’s mines to the Metals Valuation Section of the Internal Revenue Department for the purpose of depletion. I spent the greater part of the time until May 30th in Washington in company with the other members of this Committee, Messrs. Geffine and Jaynes of the Cleveland office, negotiating with the Government officials to establish these valuations, estimates of tonnage and depletion factors.

GEOLOGICAL DEPARTMENT.
In August, I went again to Washington where, with Messrs. Geffins, Jaynes and Bush, we practically finished establishing with the Government the valuations, rates of depletion, etc., on the Company's mines. Mr. Bush and myself spent several days at the Cleveland office in preparation for this work on our way to Washington. I returned August 21st and made a new estimate of the ore in the Athens Mine. I also made a joint examination and report with Mr. Jopling of the Coppa Felspar Quarry, three miles South of the Barron Mine and just East of the County Road to Republic.

In September, I made joint examinations and reports with Messrs. Jopling and Stickel of the maps of the Osana Mine, formerly known as the James Mine, lying directly North of the Virgil property at Iron River and of the underground workings of the Bates Mine, also at Iron River.

In October, and in company with Mr. Jopling, I made an examination of and reported on the Bar River iron property in Ontario, about 25 miles East of the Canadian Soo, which was offered to the Company by the Saint Antonio Mining & Exploration Company of the Canadian Soo. I estimate the ore in the Lloyd and East Lloyd Mines and the Company's fee interest in the Morris Mine; also an estimate of the ore discovered by drilling in Section 3 at Ishpening.

A. W. PINGER. Mr. Pinger continued as an assistant geologist until he resigned June 25th. He made regular underground geological surveys at all the Company's operating mines in Michigan and posted these surveys on the geological maps and cross-sections. He usually assisted in all such surveys made by me. He assisted in taking water samples for the determination of the sulphur content of the ore when these tests were made at the Section 3 exploration at Ishpening. He also geologized the outcrops located by the engineers on their topographical surveys in Sections 11 and 14, 47-27 and made a geological survey of the E2 of the SE2 of Section 24, 46-27, about four miles South of Palmer, in connection with land offer No. 1277. He did a small amount of surface geological work in Section 2, 47-27. He also made the daily reports of diamond drilling while I was in Washington from March 20th to May 30th.
E. A. ALLEN. Mr. Allen continued as an assistant in the Department throughout the year. During November, he spent approximately half his time and in December about two thirds of his time driving the Ford truck for the Engineering Department and assisted the engineers in their surveys. This was after the discontinuance of most of the drilling to which he previously gave considerable time. After Mr. Denn was laid off, Mr. Allen collected, labeled and filed all drill core and sludge samples from the explorations. He assisted in taking the water samples for sulphur determinations at the Section 3 exploration. He made the regular monthly carbon report and the annual inventory of all diamond drill equipment. He frequently assisted both Mr. Finger and myself in the underground geological surveys and laid out many of the tracings which later were used as new geological maps and cross-sections of extensions and new levels at the various mines. He assisted in geologizing the outcrops located by the engineers in Sections 11 and 14, 47-27 and mentioned above in connection with Mr. Finger. He also assisted Mr. Finger in the survey of the SE_2 of the SE_4 of Section 24, 46-27. Finally Mr. Allen made all the Mapa Compass surveys where necessary of the diamond drill holes drilled during the year.

GUSTAV AFSUS. Mr. Afsus continued as a draftsman throughout the year. His work, as in former years, has consisted chiefly in preparing cross-sections of drilling, monthly drill reports and geological maps and cross-sections but he has frequently assisted in making ore estimates. He colored all the annual report sheets of the Company's drilling during the year. The rest of his time was occupied with the routine work of the office.

P. M. DENN. Mr. Denn was a full time member of this Department only from January 17th to February 7th, inclusive. During the rest of the period until he was laid off on June 7th, due to the general curtailment, only one quarter of his time was in this Department, the remainder being occupied as a chauffeur for the Engineering Department. His time credited to Geological Department was completely taken up with collecting, labeling and filing of diamond drill core and sludge samples from current drilling and in looking after the core room.

GEOLGICAL DEPARTMENT.
SURFACE GEOLOGICAL SURVEYS.

ISHPELING DISTRICT.

The principal surface geological work done during the year was the survey of the S2 of Section 11, 47-27 and the R3 of the N2 and the unflooded portion of the S2 of the NW4 of Section 14, 47-27 at Lake Sally. The rock outcrops, test pits and contours were located by the members of the Engineering Department, and the rock determinations and geological notes were made by Messrs. Pinger and Allen of the Geological Department. This survey has not been completed, nor have all the maps of the portions already surveyed been posted.

PALMER DISTRICT.

Messrs. Pinger and Allen also made a geological survey of the E4 of the SE4 of Section 24, 46-27, about four miles South of Palmer, in connection with land offer No.1277.

UNDERGROUND GEOLOGICAL SURVEYS.

Until Mr. Pinger resigned in June, we were able to keep the geological surveys of the current mine work up to date in all mines except the Cliffs Shaft and Republic, which are hard ore mines and readily accessible and can be caught up as the opportunity arises. Since then, however, we have had to have the assistance of several engineers at their respective mines but have been able in this way to keep the work pretty well caught up on account of the few mines operating following the general curtailment of production.

ANGELINE MINE.

Practically all the ore that could be profitably recovered from this mine was removed and the property abandoned May 31st. The last geological survey was made the first of April and very little mining was done afterwards.

ATHENS MINE.

The Athens Mine continued to be a steady producer, although the operations were reduced to five shifts per week March 26th and to six half shifts per week May 17th. Regular geological surveys were made and the geological maps and cross-sections posted. The only development work accomplished was the extension of the 6th level Southwesterly. Mining was confined to four areas, namely, above and just below the 8th level, above the 6th level, all near the

GEOLLOGICAL DEPARTMENT.
West end of the property, and a small area above the 4th level near the East end.

**BEARDS-HECKER MINE.**

Very little work was done at this property due to the large volume of water encountered when the three main levels cut into the ore formation. Two of these levels, the 1st and 3rd, were being extended at the beginning of the year but soon after this time it was decided to seal all levels with concrete dams and they were finished and all work stopped on March 17th. A drainage ditch on the surface was dug from the mine around North Lake to a swamp South-east of the lake as it was thought the water being pumped from the mine was finding its way back into it through the North Lake drainage. After this ditch was completed the dams on the three levels of the mine were opened and a vigorous campaign of pumping waged the balance of the year. The last geological survey was made February 18th.

**CLIFFS SHAFT MINE.**

This mine continued to produce steadily until the general curtailment took place March 26th. Following this, production was cut down to five shifts per week until the property was closed May 31st. The only geological surveys made, with the exception of the 8th level drift in "A" Shaft connecting with the old Incline Mine, were of the "B" Shaft workings and were accomplished the latter part of February. The connection with the Incline Mine and all the accessible workings of both the Incline and No.3 Mines were geologized the latter part of April.

**FRANCIS MINE.**

The Francis Mine produced continuously throughout the year but curtailment to five shifts per week took place March 26th and to six half shifts per week June 6th. Geological surveys were made quite regularly and the geological maps and cross-sections posted. A small amount of ore was removed above the 4th level but the remainder came from between the 4th and 5th levels. Considerable tonnage additional ore was developed on the South side of the basin and towards the West end of the mine at the elevation of the 4th level and above it. For some time we have anticipated a fold over to the South of...
this side of the basin with a possible repetition of this basin which may be ore bearing. The developments on the 4th level in this vicinity show the beginning of this folding so that during the next year development work will be pushed to prove up this ground. The connection by drift and raise between the 5th level Francis and 10th level Gwinn, which started in 1920, was accomplished early in 1921 and the ventilation thereby much improved.

GARDNER-MACKINAW MINES.

This property was closed November 30, 1920 and no work has been done since.

GWinin MINE.

Production at this property was placed on a five shift per week basis March 26th and on May 21st it was closed entirely. The 11th level development was continued and ore had just been cut at the South end when operations ceased. Most of the ore continued to be mined between the 9th and 10th levels, practically all of the balance coming from higher elevations but with a small amount from new sub-levels between the 10th and 11th main levels. As explained in the case of the Francis Mine, the 10th level connection with the 5th level Francis was made by a raise and the ventilation greatly improved. The last geological surveys were made January 20th.

HOLMES MINES.

The Holmes Mine was a continuous producer throughout the year, although production was first reduced to ten shifts per week March 5th and to six shifts per week June 1st. Geological surveys were made regularly and the geological maps and cross-sections posted. During the year the 3rd and 4th levels developments were practically completed and the development on the sub-levels half way between the 2nd and 3rd levels and half way between the 3rd and 4th levels were nearly completed. Practically all the ore mined came from above the first level and between the 1st and 2nd levels. All ore is now completely mined out above the 1st level.

MAAS MINE.

This property continued to be one of the large producers, although six half operations were reduced to five shifts per week March 26th and to four per week June 1st. No new main level development work was done but mining was carried on over a very wide area, extending all the way from allittle
below the 1st level to the territory between the 3rd and 4th levels. Until Mr. Pinger left, regular geological surveys were made and the geological maps and cross-sections posted. Since then this work has been done intermittently by Mr. Hayden, Engineer.

MORRIS-LLOYD MINE.

Mining was continuous at this property but production was cut to ten six half shifts per week March 5th and to six shifts per week June 1st. The principal new development has been on the 7th level Morris Mine, which is located 250' below the 6th level. Several important ore bodies are being developed on this level on No. 2 lease, one of which extends East on to this Company's land. This latter is the ore discovered by diamond drill holes Nos. 29, 32 and 34 drilled several years ago from the 6th level. Geological surveys were made and the geological maps and cross-sections posted regularly until Mr. Pinger left. Since then I have kept the Morris Mine development up to date and have had Mr. Trosvig, Engineer at the property, get the remaining information, which has been posted on the maps of this Department.

MENOMINEE MINE.

The Menominee Mine continued to be one of the largest producers on the Range, although production was curtailed to five shifts per week March 26th six half and to six shifts per week May 17th. The only main level development was on the 11th level, which was practically completed during the year. Most of the ore mined came from the territory between the 9th and 11th levels. As in the Maas Mine, geological surveys were made and the geological maps and cross-sections posted regularly until Mr. Pinger left. Since then this work has been done intermittently by Mr. Moulton, Engineer.

PRINCETON MINE.

This property produced continuously until August 27th when it was closed. Production was reduced, however, to a five shift per week basis March 26th six half and to six shifts per week June 1st. Geological surveys were made and the geological maps and cross-sections posted regularly until Mr. Pinger left. The last survey was made June 15th.

REPUBLIC MINE.

The Republic Mine produced continuously but was reduced to ten shifts.
per week March 5th and to three shifts per week June 1st. Practically all the ore mined has come from the Pascoe Shaft workings and principally from the large stopes on the 2370' and 2470' levels. The latter level, which was just being started at the beginning of the year, was considerably developed and disclosed the continuation of the large ore body on the 2370' level in even larger proportions than on the latter level. No regular geological surveys were made during the year but all extensions were posted on the geological maps.

SALISBURY MINE

This property was worked in a small way until it was closed March 5th. Practically all the ore removed was taken from the South Deposit above the 14th level. No regular geological work was done.

SPIES MINE

The Spies Mine operated steadily until it was closed May 31st in accord with the plan of general curtailment. No new development work was done and practically all the ore in the main stope had been mined at the time of closing. There is a relatively small amount of ore remaining in the North lens. The last geological survey was made on January 10th.

STEPHENSON MINE

This property produced continuously but production was reduced to five six half shifts per week March 26th and to 2 shifts per week June 1st. Some new ore was developed at the Southeast end of the mine on the 4th level and below. The majority of ore mined came from between the 4th and 5th levels, although considerable was mined between the 5th and 6th levels. Geological surveys were made and the geological maps and cross-sections posted regularly. Mr. Sterling, Engineer at this mine, has assisted in this work materially since Mr. Pinger left.
EXPLORATIONS.

Drilling explorations were carried on during 1921 in the following districts and mines:

FROM SURFACE.

DISTRICT.

Ishpeming, 
Swim, 
Crystal Falls, Menominee.

RANGE.

Marquette, 
Swanzy.

FROM UNDERGROUND.

MINES.

Holmes, 
Morris, 
Republic, 
Spies,

DISTRICT.

Ishpeming, 
North Lake, 
Republic, 
Iron River.

No options for exploring and no mining leases were acquired during the year.

Mining Leases Nos. 43 and 45, covering the Meadow and Fowler Mines, respectively, were surrendered.

Table IV, which follows, gives the footage drilled, the ore encountered and the cost per foot of drilling for both surface and underground explorations. It will be noted that the average cost of surface drilling was $4.76 per foot, exclusive of certain items which are not actually drilling expenses but are charged to explorations. By including these items the average cost was $5.97 per foot. This large differential is due mainly to the taxes on the Neely property of $6858.06, which are charged to the exploration but clearly is not an item of drilling expense. It is also to be noted that the costs of the Stephenson drilling include part of the drifving expense in connecting the 6th level with drill hole No. 66. The average cost of underground drilling in the same way was $3.73 and $5.90, respectively. The average cost of all drilling was $4.37 and $5.14, respectively. These costs are less than those of last year by 12.7% and 6.9%, respectively, in spite of the fact that there was more than 1600' less drilling in 1921 than in 1920; resulting in a corresponding increase in the overhead expense for 1921.
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DRILLING</th>
<th>DIAMOND</th>
<th>TOTAL</th>
<th>FIRST CLASS</th>
<th>SECOND CLASS</th>
<th>LEASED CORE</th>
<th>CORE PT.</th>
<th>TOTAL COST</th>
<th>COST PER FT.</th>
<th>TOTAL COST</th>
<th>COST PER FT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead River East</td>
<td>17, 45-36</td>
<td>20</td>
<td>90</td>
<td>96</td>
<td>200</td>
<td>66</td>
<td>141</td>
<td>$654.40</td>
<td>$8.46</td>
<td>$654.40</td>
<td>$8.46</td>
</tr>
<tr>
<td>Levering Section 3</td>
<td>2, 47-27</td>
<td>140</td>
<td>300</td>
<td>300</td>
<td>60</td>
<td>90</td>
<td>210</td>
<td>11,607.97</td>
<td>$56.04</td>
<td>2,044.43</td>
<td>4.21</td>
</tr>
<tr>
<td>Neely Lease</td>
<td>1, 45-58</td>
<td>169</td>
<td>2</td>
<td>736</td>
<td>504</td>
<td>9</td>
<td>70</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pinehaven Mine</td>
<td>1, 45-58</td>
<td>32</td>
<td>32</td>
<td>64</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**TOTAL SURFACE DRILLING**

<p>| | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>938</td>
<td>24</td>
<td>9117</td>
<td>2027</td>
<td>955</td>
<td>100</td>
<td>271</td>
<td>$87,199.30</td>
<td>$50.97</td>
<td>$87,199.30</td>
<td>$4.48</td>
</tr>
</tbody>
</table>

**TOTAL UNDERGROUND DRILLING**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DRILLING</th>
<th>DIAMOND</th>
<th>TOTAL</th>
<th>FIRST CLASS</th>
<th>SECOND CLASS</th>
<th>LEASED CORE</th>
<th>CORE PT.</th>
<th>TOTAL COST</th>
<th>COST PER FT.</th>
<th>TOTAL COST</th>
<th>COST PER FT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holden Mine</td>
<td>1, 45-57</td>
<td>97</td>
<td>97</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>21</td>
<td>3,902.45</td>
<td>2.69</td>
<td>3,902.45</td>
<td>2.69</td>
</tr>
<tr>
<td>Kerri-Lloyd Mine</td>
<td>1, 46-28</td>
<td>1465</td>
<td>1465</td>
<td>100</td>
<td>51</td>
<td>181</td>
<td>19,857.76</td>
<td>20.83</td>
<td>19,857.76</td>
<td>20.83</td>
<td></td>
</tr>
<tr>
<td>Republic Mine</td>
<td>1, 46-29</td>
<td>812</td>
<td>812</td>
<td>100</td>
<td>50</td>
<td>81</td>
<td>10,855.74</td>
<td>10.85</td>
<td>10,855.74</td>
<td>10.85</td>
<td></td>
</tr>
<tr>
<td>Spies Mine</td>
<td>1, 45-56</td>
<td>1055</td>
<td>1055</td>
<td>100</td>
<td>50</td>
<td>105</td>
<td>3,775.72</td>
<td>3.77</td>
<td>3,775.72</td>
<td>3.77</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL UNDERGROUND DRILLING**

<p>| | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6482</td>
<td>177</td>
<td>522</td>
<td>522</td>
<td>250</td>
<td>500</td>
<td>250</td>
<td>$82,384.08</td>
<td>$5.04</td>
<td>$82,384.08</td>
<td>$5.04</td>
</tr>
</tbody>
</table>

**TOTAL GRAND TOTAL DRILLING**

<p>| | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6482</td>
<td>177</td>
<td>522</td>
<td>522</td>
<td>250</td>
<td>500</td>
<td>250</td>
<td>$82,384.08</td>
<td>$5.04</td>
<td>$82,384.08</td>
<td>$5.04</td>
</tr>
</tbody>
</table>

**TOTAL COST**

<p>| | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$170,581</td>
<td>409</td>
<td>14,339</td>
<td>14,339</td>
<td>650</td>
<td>1050</td>
<td>650</td>
<td>$170,581</td>
<td>$5.04</td>
<td>$170,581</td>
<td>$5.04</td>
</tr>
</tbody>
</table>

**NOTES**

Cost of exploration includes taxes, office expenses, engineering, analysis, legal and personal injury.
Cost of mining excludes $.
To compare with contract price.

The contract drilling for the year comprises the surface drilling on the Neely Lease and was done by the Cole and Donald Exploration Company.

1. Includes taxes - $66,004.06
2. Includes part of drilling on 4th level to expand hole No. 66.
up on the South side. This crotch has a general pitch to the Southeast. Accordingly, No.32 was located 300' South and 300' East of No.29, being also 300' South of No.30. This location, it was estimated after taking into account an expected Southerly deviation, should encounter the Southwesterly extension of this ore body if it continued this far. We were successful in this supposition since the hole encountered no less than 140' of good ore between the depths of 2655' and 2795', being 5' more than encountered in any of the other successful holes.

A very conservative estimate of the ore in this South body yields practically two million tons and it is more than likely that there is several times this amount in the deposit. At all events, the tonnage disclosed is enough to encourage and warrant its development, consequently further exploring was deemed unnecessary.

DEAD RIVER DISTRICT.

DEAD RIVER HOIST, SECTION 17, 48-26.

A series of standpipes were sunk late in 1920 Southwest of the main Dead River on the site of the proposed new storage dam at the Hoist to determine the depth to ledge and ascertain its character. The last of this series of pipes was sunk in January 1921 and the information compiled for Mr. McClure's use.

GWYNN DISTRICT.

STEPHENSON MINE SURFACE, SECTION 29, 45-25.

An 8" standpipe was sunk to ledge at the center of the ledge basin over the Section 29 ore body during 1920, the plan being to drill to the elevation of the 6th level and drain this basin through the mine with its pumping equipment. During 1920, also, a 7 5/8" hole was chopped in the ledge with the Keystone outfit to a depth of 356' where, on account of the difficult and slow progress, the hole was reduced to 6". During January 1921 the hole was extended from its depth of 482' at the beginning of the year to a depth of 514'. The hole deviated inward about 35' in this distance but it was finally holed into by a crosscut from the objective point on the 6th level of the mine.

GEOLOGICAL DEPARTMENT.
After hoiling, a great deal of difficulty was experienced in pulling back the standpipe to allow the basin water to drain into the mine; in fact, the hole became so badly plugged with boulder material at the ledge surface that a raise is now being put up from which the ground will be thoroughly blasted. It is hoped this will cause a steady flow of water until the basin is drained.

CRYSTAL FALLS DISTRICT.

NEELY LEASE, SECTION 12, 42-33.

Drilling on this lease was commenced in August 1920 and continued to the first part of March 1921. The purpose of this work was to explore for an ore connection between the main Neely ore bodies and the ore developed on the Oliver property just South of the boundary between these two properties. All told, nine holes were drilled aggregating 2600'. Six of these, Nos.37 to 42, inclusive, were completed in 1920.

Although the results of this drilling do not definitely prove there is continuous ore between the two deposits on account of the irregular character of the ore encountered, it is quite likely that such does exist. To prove it, however, would entail an unwarranted amount of drilling. On the other hand, we did develop an appreciable extension of this Oliver ore on to the Neely property as our estimate shows a total (developed by this drilling) of 122,400 tons of recoverable ore averaging 60.04% iron and .20% phosphorus and all lying within 285' of surface.

UNDERGROUND EXPLORATIONS.

HOLMES MINE.

Drilling was resumed in the Holmes Mine early in January. A series of six horizontal holes, Nos.12 to 17, inclusive, were drilled from the main West drift on the 3rd level. Three of these were drilled to the Northeast to locate the true greenstone footwall and explore for possible ore extensions on the foot. The other three were drilled to the Southwest to locate the quartzite hanging wall and possible ore extensions in this direction. Hole No.13, which was drilled Northeast, was the only one to encounter any appreciable ore. In this case, the hole started in ore and continued in it to a depth of 15'.
A series of three holes, Nos. 16 to 20, inclusive, was then drilled horizontally from the West end of the 4th level. The drift at this point was in massive greenstone, which was apparently the footwall, but Mr. Eaton desired to test it further by drilling these holes. One was drilled Northwesterly in the line of the drift and the other two at right angles, one Northeasterly and the other Southwesterly. The Northeasterly hole encountered nothing but greenstone footwall and the other two passed from this footwall into hanging slate and quartzite without encountering iron formation. This completed the drilling at the Holmes Mine for the year.

MORRIS-LLOYD MINE.

Drilling was carried on in this property intermittently during the year. Hole No. 64 was being drilled horizontally and S. 25° E. from the 3rd level East Lloyd Mine the first of January, 1921. The purpose here was to try and develop a lens of ore in this vicinity in which a raise could be located to tap the working sub-levels above so that the ore could be handled directly on the 3rd level without a previous transfer, as at present. The attempt was unsuccessful, the only ore encountered being a skin on the side of an old stope on the South side of the level.

A second hole, No. 65, was then drilled horizontally from approximately the same position but on a course of S. 47° E. No ore was encountered. A third hole, No. 66, was also drilled horizontally from this level but from the South end of the main South crosscut. It was drilled S. 10° E. to cross the main East Lloyd fault, penetrate the slate on the South side of the fault and into the iron formation beyond to test the latter for possible ore lenses. The hole was bottomed without finding an enrichment at a depth of 405' after drilling through 179' of iron formation South of the fault.

Drilling was then resumed from the West end of the main West drift on the 6th level Morris Mine. It has been the plan here to crosscut the formation for 200' or 300' with horizontal holes spaced at intervals of from 300' to 400' as drifting progressed. Three such holes were drilled, Nos. 67 to 69, inclusive. Nos. 67 and 68 were drilled South. No. 68 was drilled North to locate the footwall, which was encountered at a depth of 26'. No. 69 en-
countered three narrow seams of ore, two of which are of mineable width. This drilling was then temporarily discontinued to allow a further advance-
ment of the main level drift.

Later in the year one hole, No.70, was drilled with a dip of -65°N.,10°W., from the end of the Southwest crosscut through the West ore body on lease No.9. The purpose here was to explore for the downward continuation of this ore body, which, from the 4th level down to the 6th level, had been continuous with a Westerly pitch. The hole was planned to locate the footwall of this ore, if extension was found, somewhere near the 7th level elevation, 250' below the 6th level, in order to plan the lay out of the former level to develop this ore.

Strangely enough no merchantable ore was encountered in No.70 but at about this time ore was cut in the 7th level drift, the development of which may solve the problem of the downward extension of the 6th level ore. Consequently, further drilling was given up to await these developments.

REPUBLIC MINE.

Drilling in the Republic Mine was continuaus throughout the year. During that time 22 holes, Nos.467 to 488, inclusive, were completed, one old hole, No.465, was deepened and hole No.489 was drilled to a depth of 95'. The total footage amounted to 2525'.

All holes were drilled horizontally from current working levels, or levels immediately adjacent to them, according to a plan of systematic ex-
ploration which may be divided into three parts. In the first place, an attempt is made on all new levels to locate the downward extension of known ore lenses immediately above where they are not found by drifting along the quartzite hanging contact but have probably dropped back into jasper footwall. Secondly, the hanging contact known zone is explored for new ore bodies by drilling in cases where rock drifting is unwarranted until a discovery of ore is made. Lastly, a systematic exploration of the jasper formation is made back to a horizon 100' to 200' from the hanging contact as it has been the experience in this mine that all ore bodies of any consequence occur within this zone.
Three holes, Nos. 477, 478 and 479, were drilled from the 2370' level No. 9 Winze. All the rest were drilled from Pascoe Shaft levels as follows: No. 465 from the 2270' level; Nos. 467 and 468 from the 1710' level; No. 469 from the 1950' level; Nos. 470, 471 and 472 from the 2370' level; No. 473 from the 2370' level; No. 474 from the 2470' level, and Nos. 475 and 476 and 480 to 482, inclusive, from the 2370' level.

Two of these holes, Nos. 467 and 469, discovered new merchantable ore lenses. The first is on the 1710' level and the second on the 1950' level, both in the Pascoe Shaft, and they open up possibilities for considerable additional ore in their probable extensions.

SPIES MINE.

Six holes, Nos. 9 to 13, inclusive, and aggregating 1495', were drilled from the bottom or 3rd level of the Spies Mine. The work began early in March and was completed the last of May.

Three of these holes, Nos. 9, 10 and 11, were drilled from the North end of the hanging wall crosscut along the Virgil boundary to explore for a downward continuation of the ore in the East-West drift on the 3rd level in this vicinity, also to follow up the indications of an ore body disclosed by the ore encountered in holes Nos. 1 and 3 drilled in 1920. No. 10 was drilled with a dip of -45° 3′ 55′46′ W. on to the Virgil property; No. 9 was vertical, and No. 11 had a dip of -45° S. 45° E. The results were disappointing, although it is possible that No. 11 was stopped too soon. Holes Nos. 11, 12 and 13 were all drilled horizontally from the Northwest end of the 3rd level to explore along the North footwall. These results were also disappointing except for a 10' seam of good ore in No. 12 in its extension on to the Virgil and near the Northeast corner of this property. This may lead to something more encouraging when the opportunity for following it up is at hand. On account of the unfavorable position of this ore with respect to drilling for its extension from the present 3rd level workings in the Spies Mine, this part of the Virgil property should be explored by drilling from surface. It is likely this will be done in connection with the general exploration of the Virgil property.
EXPLORATIONS BY OTHER COMPANIES.

Mr. Ernest Allen, who heretofore has made periodic visits to the explorations of other companies on the Michigan and Wisconsin iron ranges, did not visit any such explorations during 1921. Very little drilling was done by other companies and on account of the business depression and resulting curtailment, Mr. Duncan thought it inadvisable to send Mr. Allen out.

The only new outside exploration which came to our attention was that instituted by the Palms-Book Land Company, three or four miles Southeast of Amasa, Michigan, on the Menominee Range. Two holes were drilled on Section 26, 44-33 on the Michigan Mineral Land Company's property, in which this Company has an interest. A third hole is now being drilled just to the North of Section 22.

Mr. Aufhus has copied for our files outside exploration results of any importance which have come to this office in the form of land offers, etc.

EXAMINATIONS OF MINERAL LAND OFFERS.

Two mineral land offers were examined and reported on during the year as follows:

Mrs. Anna Cornish's property, No. 1377.

Bar River property, No. 1291.

The Cornish property is located about four miles South of Palmer in Section 24, 45-27. There is a small remnant of a basin of iron formation lying on the granite on this property but nothing to warrant further investigation so the offer was declined.

The Bar River property is located in Ontario, Canada, about 25 miles East of the Canadian Soc, and is controlled by the Saint Antonio Mining & Exploration Company of the Canadian Soc. Mr. Jopling and myself both examined the property and found only lean ferruginous decomposed quartzite, which the Saint Antonio people had evidently mistaken for a favorable iron formation. This offer was also declined.
Tables No. V and No. VI, which follow, show a detailed statement of charges to geological expense for the year and a comparative statement of these charges for the last three years. They are self-explanatory:

**TABLE V.**

**DETAILED STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR YEAR 1921.**

<table>
<thead>
<tr>
<th>GEOLOGICAL DEPARTMENT.</th>
<th>Salaries</th>
<th>Travel</th>
<th>Operating</th>
<th>Supplies</th>
<th>Office Expense</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$16,643.16</td>
<td>$552.85</td>
<td>$1,075.18</td>
<td>$1,190.29</td>
<td>$ 45.91</td>
<td>$19,506.79</td>
</tr>
</tbody>
</table>

**DETAILED OF LARGEST ITEMS GROUPED AS TRAVEL, OPERATING AUTOS AND SUPPLIES.**

**TRAVEL.**

- Rail travel, - - - $234.11
- Horse maintenance, - - $318.14

**OPERATING AUTOS.**

- Tires and new parts for Buick, - - - $146.31
- Depreciation on Buick, - - - 190.00
- " " auto for Eng. & Geol. Dept., - - 45.18 (Geol prop.)
- " " truck for Eng. & Geol. Dept., - - 67.58 " "

**SUPPLIES.**

- Rental of Maas Compass, - - - $100.00
- Tracing cloth, - - - - $2.99
- Annual report negatives and paper, - - 469.44

**EXPENSES OF H. L. SMITH.**

<table>
<thead>
<tr>
<th>Travel</th>
<th>Supplies</th>
<th>Misc.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$568.12</td>
<td>$35.44</td>
<td>$150.00</td>
<td>$773.56</td>
</tr>
</tbody>
</table>

**SUMMARY.**

- Expenses of Geological Department, - - $19,506.79
- " " H. L. Smith, - - 773.56
- Grand total, - - $20,280.35
**TABLE VI.**

**COMPARATIVE STATEMENT OF CHARGES TO THE GEOLOGICAL DEPARTMENT FOR LAST THREE YEARS.**

<table>
<thead>
<tr>
<th>Item</th>
<th>1921</th>
<th>1920</th>
<th>1919</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries, -</td>
<td>$16,643.16</td>
<td>$18,846.76</td>
<td>$18,890.02</td>
</tr>
<tr>
<td>Travel, -</td>
<td>552.25</td>
<td>412.74</td>
<td>833.06</td>
</tr>
<tr>
<td>Operating autos, -</td>
<td>1,075.18</td>
<td>1,189.45</td>
<td>1,000.09</td>
</tr>
<tr>
<td>Supplies, -</td>
<td>1,150.29</td>
<td>1,365.96</td>
<td>1,309.03</td>
</tr>
<tr>
<td>Visiting Outside Explorations, -</td>
<td>0</td>
<td>197.66</td>
<td>72.41</td>
</tr>
<tr>
<td>Miscellaneous, -</td>
<td>45.91</td>
<td>199.33</td>
<td>5.51</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$19,506.79</strong></td>
<td><strong>$22,211.87</strong></td>
<td><strong>$22,116.19</strong></td>
</tr>
<tr>
<td>Expenses of H. L. Smyth, i.e., travel, supplies and miscellaneous, -</td>
<td>773.66</td>
<td>686.19</td>
<td>642.52</td>
</tr>
<tr>
<td><strong>Grand total</strong></td>
<td><strong>$20,280.35</strong></td>
<td><strong>$22,898.06</strong></td>
<td><strong>$22,758.71</strong></td>
</tr>
</tbody>
</table>