RESEARCH LABORATORY

ANNUAL REPORT - YEAR 1957

The Annual Report for 1957 is subdivided into six main sections. These sections are reported separately and are related to different phases of work conducted by the Metallurgical Department. The sections are as follows: (1) General Information, (2) Pyrolysis and Agglomeration, (3) Research and Development and Flotation Projects, (4) Microscopy Section, (5) FluoSols Reactor Pilot Plant, and (6) Sampling Studies.

The Annual Report for the Research Laboratory highlights various projects worked on during the year. This report does not include any specific test data, conclusions, or recommendations reached by completing any specific investigation. The projects that could be considered minor in nature are not included in the Annual Report; however, in most cases have been referred to in the Monthly Reports.

PART I

GENERAL INFORMATION

DISTRIBUTION OF CHARGES:

Listed below is a tabulation for the last seven years showing the Laboratory staff and total hours as reported on the Cost Sheets. The staff was enlarged during 1957 as a result of the personnel required for the twenty-four hour day, seven days a week operation of the NRC Pilot Plant and the increased work load at the Laboratory.

<table>
<thead>
<tr>
<th>Year</th>
<th>Engineers</th>
<th>Technicians</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957</td>
<td>13</td>
<td>30</td>
<td>98,205</td>
</tr>
<tr>
<td>1956</td>
<td>13</td>
<td>26</td>
<td>68,888</td>
</tr>
<tr>
<td>1955</td>
<td>10</td>
<td>17</td>
<td>55,275</td>
</tr>
<tr>
<td>1954</td>
<td>8</td>
<td>15</td>
<td>50,982</td>
</tr>
<tr>
<td>1953</td>
<td>8</td>
<td>18</td>
<td>66,005</td>
</tr>
<tr>
<td>1952</td>
<td>6</td>
<td>13</td>
<td>47,958</td>
</tr>
<tr>
<td>1951</td>
<td>6</td>
<td>11</td>
<td>31,369</td>
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</table>

The number of hours spent on each specific project is tabulated below. It is interesting to note the percentages of time that were spent on specific projects.
## Summary of Time Distribution

**Research Laboratory Only Excluding MOC Pilot Plant**

**1957**

<table>
<thead>
<tr>
<th>Project</th>
<th>Hours</th>
<th>% of Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOC Flowsheet Development</td>
<td>16,550</td>
<td>28.2</td>
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<tr>
<td>Agglomeration Research</td>
<td>14,713</td>
<td>25.1</td>
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<tr>
<td>Plant Control Samples Humboldt, Republic, Eagle Mills</td>
<td>9,757</td>
<td>16.6</td>
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<tr>
<td>Operating U.G., Mines - Cliffs Group Studies, etc.</td>
<td>6,694</td>
<td>11.4</td>
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<tr>
<td>Drill Core Testing</td>
<td>4,186</td>
<td>7.1</td>
</tr>
<tr>
<td>Outside Explorations, Land Offers, etc.</td>
<td>2,519</td>
<td>4.3</td>
</tr>
<tr>
<td>Flotation Study</td>
<td>2,448</td>
<td>4.2</td>
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<tr>
<td>Research and Study</td>
<td>963</td>
<td>1.6</td>
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<tr>
<td>Special Studies</td>
<td>878</td>
<td>1.5</td>
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**Total**                                           **58,708**  **100.0**

### TIME DISTRIBUTION - YEAR 1957

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<thead>
<tr>
<th>Account</th>
<th>Hours</th>
<th>Account</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Bunker-Hill</td>
<td>931</td>
<td>Land Offer 3667</td>
<td>8</td>
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<tr>
<td>Cambria-Jackson</td>
<td>337</td>
<td>3668</td>
<td>23</td>
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<tr>
<td>Cliffs Shaft</td>
<td>428</td>
<td>3683</td>
<td>78</td>
</tr>
<tr>
<td>Maca</td>
<td>354</td>
<td>3701</td>
<td>23</td>
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<tr>
<td>Mather &quot;A&quot;</td>
<td>1193</td>
<td>3710</td>
<td>25</td>
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<tr>
<td>Mather &quot;B&quot;</td>
<td>1371</td>
<td>BSM Claim</td>
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<td>Tilden</td>
<td>40</td>
<td>Project #15 - Benoit Lake</td>
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<td>Ohio</td>
<td>375</td>
<td>Project #17 - Canada</td>
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<tr>
<td>Humboldt</td>
<td>3165</td>
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<td>Athens</td>
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<td>Ore Improvement Plant</td>
<td>1657</td>
<td>Research Study</td>
<td>963</td>
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<tr>
<td>Republic</td>
<td>3681</td>
<td>Microscopy Section</td>
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<td>Special Jubilee</td>
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<tr>
<td>MOC Plant</td>
<td>13550</td>
<td>Special Tilden</td>
<td>134</td>
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<td>Sharon Steel Co. Tests</td>
<td>646</td>
<td>Special Richmond</td>
<td>78</td>
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<td>Outside Exploration 1136</td>
<td>211</td>
<td>Special Empire</td>
<td>228</td>
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<td>1136C</td>
<td>30</td>
<td>Experiments &amp; Investigations - MINCO</td>
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<td>1148C</td>
<td>33</td>
<td>Accounts Receivable</td>
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<td>1193</td>
<td>28</td>
<td>Cascade - MI-24</td>
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<tr>
<td>1208</td>
<td>28</td>
<td>Empire - MI-17 - (17 Holes)</td>
<td>693</td>
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<tr>
<td>1216</td>
<td>23</td>
<td>Osier - CC-781</td>
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<tr>
<td>Land Offer 3204C</td>
<td>36</td>
<td>Lake Shaft - CC-729 - (1 Hole)</td>
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<tr>
<td>3201C</td>
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<td>- CC-739 - (1 Hole)</td>
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<tr>
<td>3120</td>
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<td>New Richmond - CC-879 - (14 Holes)</td>
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<tr>
<td>2792</td>
<td>3</td>
<td>Tilden - CC-859 - (17 Holes)</td>
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<tr>
<td>3218C</td>
<td>10</td>
<td>Cascade - CC-825 - (8 Holes)</td>
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<tr>
<td>3226C</td>
<td>8</td>
<td>Bellevue - CC-879 - (6 Holes)</td>
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<tr>
<td>3228C</td>
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<td>Isabella - CC-867 (5 Holes)</td>
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<tr>
<td>3244</td>
<td>21</td>
<td>Ogden - CC-868 - (4 Holes)</td>
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<td>7</td>
<td>Cliffs Shaft - CC-770</td>
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<td>3582</td>
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<td>17</td>
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<td>3634</td>
<td>1</td>
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<td>- CC-801-813</td>
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<td>3649</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3651</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3652</td>
<td>10</td>
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<td></td>
</tr>
</tbody>
</table>

**Total Hours - 1957**                                           **58,708**

**Operating MOC Plant-Total**                                           **39,497**

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Chemical Charges:

The following is the distribution of chemical charges made by the Chemical Laboratory during 1957. The total number of determinations for 1957 is roughly 7,000 higher than the analyses made in 1956. This increase is chiefly due to the operation of the MDC Pilot Plant which required control analyses for each shift.

The distribution of the analytical work to various properties and projects presents a good overall picture of the various projects investigated at the Laboratory.

**TOTAL NUMBER OF DETERMINATIONS ANALYZED IN 1957 FROM RESEARCH LABORATORY SAMPLES**

<table>
<thead>
<tr>
<th>Account</th>
<th>Analyses</th>
<th>Account</th>
<th>Analyses</th>
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</thead>
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<tr>
<td>Maas Mine</td>
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<td>E&amp;A CC-739</td>
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</tr>
<tr>
<td>Bunker-Hill Mine</td>
<td>149</td>
<td>770</td>
<td>105</td>
</tr>
<tr>
<td>Cliffs Shaft Mine</td>
<td>42</td>
<td>781</td>
<td>7</td>
</tr>
<tr>
<td>Mather Mine &quot;A&quot; Shaft</td>
<td>463</td>
<td>813</td>
<td>1335</td>
</tr>
<tr>
<td>Mather Mine &quot;B&quot; Shaft</td>
<td>271</td>
<td>814</td>
<td>465</td>
</tr>
<tr>
<td>Cambria-Jackson Mine</td>
<td>49</td>
<td>825</td>
<td>509</td>
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<tr>
<td>Humboldt Mine</td>
<td>1678</td>
<td>859</td>
<td>198</td>
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<tr>
<td>Republic Mine</td>
<td>555</td>
<td>867</td>
<td>755</td>
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<td>Ohio Mine</td>
<td>377</td>
<td>868</td>
<td>233</td>
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<td>Cliffs Group Study</td>
<td>1062</td>
<td>868E</td>
<td>145</td>
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<td>MDC Operating Plant</td>
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<td>MOC-A</td>
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</tr>
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<td>MOC-B Humboldt</td>
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<td>MOC-B Republic</td>
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<td>Pellet Plant, Eagle Mills</td>
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<td>Land Offer</td>
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<td>Marquette Iron Mining Co.-E</td>
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<td>3190</td>
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<td>F</td>
<td>14</td>
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<td>H</td>
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<td>I</td>
<td>287</td>
<td>3202</td>
<td>231</td>
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<td>17</td>
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<td>Agglomeration Research F</td>
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<tr>
<td>Agglomeration Research N</td>
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<td>10</td>
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<tr>
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<tr>
<td>Agglomeration Research S</td>
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<td>Project 17</td>
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<td>Experiments &amp; Investigations E&amp;A NN-117</td>
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<td>3649</td>
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<td>NM-128</td>
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<td>3651</td>
<td>9</td>
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<tr>
<td>CC-659</td>
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<td>3652</td>
<td>29</td>
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<tr>
<td>734</td>
<td>277</td>
<td>3668</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3701</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3710</td>
<td>5</td>
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</table>

Grand Total 32,830
The following analyses were made:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Value</th>
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<tbody>
<tr>
<td>Iron</td>
<td>20,799</td>
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<tr>
<td>Phosphorus</td>
<td>535</td>
</tr>
<tr>
<td>Silica</td>
<td>5,457</td>
</tr>
<tr>
<td>Alumina</td>
<td>109</td>
</tr>
<tr>
<td>Manganese</td>
<td>85</td>
</tr>
<tr>
<td>Sulphur</td>
<td>512</td>
</tr>
<tr>
<td>Ferrous Iron</td>
<td>4,789</td>
</tr>
<tr>
<td>Metallic Iron</td>
<td>25</td>
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<tr>
<td>Zirconium</td>
<td>2</td>
</tr>
<tr>
<td>Titanium</td>
<td>203</td>
</tr>
<tr>
<td>Lime</td>
<td>101</td>
</tr>
<tr>
<td>Copper</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total** 32,830

**Metallurgical Reports and Memoranda:**

The metallurgical reports and memoranda issued by the Metallurgical Department during 1957 are listed below. It is difficult to use this list as an index of the project emphasis. One report may represent only hours of time while another may cover an investigation that took several months to complete.

Excluding short term service projects which sometimes are reported in letter form to management, all work completed at the Laboratory is covered in a report or memorandum.

**METALLURGICAL REPORTS - YEAR 1957**

<table>
<thead>
<tr>
<th>Report No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>192 (Supplement)</td>
<td>Standard MOC Tests - 1956 Surface Samples</td>
</tr>
<tr>
<td>193</td>
<td>Ohio Mine Concentrating Plant Operation - 1956 Season</td>
</tr>
<tr>
<td>194 &amp; Geology Report 19</td>
<td>The Mineralogical and Metallurgical Characteristics of Sample No. MOC-444A, A St. Lawrence River Sand Sample from Natashquan, Canada</td>
</tr>
<tr>
<td>196</td>
<td>Microscopic Examination of a Republic Crude Sample and Its MOC Product Obtained by the Traveling Grate MOC Process</td>
</tr>
<tr>
<td>197</td>
<td>Results of Standard MOC-Magnetic Concentration Tests on Richmond Area DDH's 45, 46, and 49 thru 54, Section 27, 47-26</td>
</tr>
<tr>
<td>198</td>
<td>Results of Standard MOC-Magnetic Concentration Tests on Richmond Area DDH Nos. 55, 56, 57, and 58, Section 27, 47-26</td>
</tr>
<tr>
<td>199</td>
<td>Results of Davis Magnetic Tube Tests on Composites from DDH Nos. 1 and 2A of the Osier Area, Section 18, T43N-R21W</td>
</tr>
<tr>
<td>200 (Supplement)</td>
<td>1956 Ohio Mine ore Structure Study</td>
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<tr>
<td>201</td>
<td>Cliffs Group Quality Improvement Study</td>
</tr>
<tr>
<td>202</td>
<td>Results of Standard MOC-Magnetic Concentration Tests on Composites from Tilden District DDH Nos. 59, 60, Section 26; 4, 5, 6, 7, Section 25; 1 Section 22; T47N-R27W</td>
</tr>
<tr>
<td>203</td>
<td>Laboratory Investigation of Iron Ore Pellets from the Halmberget Operation</td>
</tr>
<tr>
<td>204</td>
<td>MOC-Magnetic Concentration Tests - Holes 2 and 3, Section 22, Tilden District</td>
</tr>
<tr>
<td>205</td>
<td>Microscopic Examination of Various Products by Direct Reduction Fluidizing Method</td>
</tr>
<tr>
<td>206</td>
<td>Results of Standard MOC-Magnetic Concentration Tests on Composites from Tilden District-DDH No. 25, Section 27, T47N-R27W</td>
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Continued...
Results of Standard MOC-Magnetic Concentration Tests on Composites from Cascade District DDH Nos. 47, 48, and 59, Section 27, 47-26
Results of Standard Magnetic Concentration Tests on Composites from Empire Area Drill Holes 20-28, Section 19, 47-26
Summary Report - Albanel Area
Demonstrations of Sintering Techniques to Produce Open Hearth Sinter on a Traveling Grate Using the Updraft Principle
Results of Standard MOC-Magnetic Concentration Tests on Composites from Tilden District DDH Nos. 26 & 27, Section 27, T47N-R27W
Results of Standard MOC-Magnetic Concentration Tests on Composites from Isabella District, DDH Nos. 1, 2, & 3, Section 32, T47N-R26W
Results of Standard Magnetic Concentration Tests on Composites from Empire Area Drill Holes 23, 29-34, Section 19, T47N-R26W
MOC Reactor Pilot Plant Test II A - Treatment of Republic Rougher Concentrate from Crude Having Average Response to Flotation

METALLURGICAL MEMORANDA - YEAR 1957

Memo No.
455

Subject
Standard MOC Tests, Richmond Exploration, DDH Nos. 51 and 52, Section 27, 47-26
Check Sampling - Eagle Mills Republic Pellets Repose Angles
Laboratory Balling Tests Using Reground Returns and Republic Concentrates with Sodium Carbonate as a Possible Chemical Reagent to Neutralize the Calcium Hydroxide in the Returns
Standard MOC Tests, Richmond Exploration, DDH No. 53, Section 27, 47-26
Land Offer 3218C, Mx-C-747, -956, -957, and -958
Land Offer 3201C, Natashquan Auger Drill Samples, Mx-C-444
Land Offer 3202, MxC-919
Undeslimed Flotation Testing at Republic Mill
Outside Exploration 1193, Mx-1920
Land Offer 3652, Mx-1579
Microscopic Examination of Flotation Concentrates, Ungava Bay Ore, Outside Exploration 1136
Undeslimed Flotation Testing at Republic, Progress Report
Complete Analyses, Flotation and Magnetic Concentrates
A Preliminary Laboratory Examination of Klockner-Humboldt-Deutz Briquettes
Concentration Test on Republic MOC Calcine at the Mines Experiment Station
Undeslimed Flotation Testing at Republic
High Tension Separation Tests at Carpeo Research and Engineering
High Tension Separation Tests on Undeslimed Republic Ore
Land Offer 3646, Mx-1683, -1684, -1685
Land Offer 3228C, Mxc-748
Land Offer 3228C, Mxc-748
Microscopic Examination of Beach Sand Samples from Crescent City, California - Land Offer 3646
Magnetic Concentration Tests on Lurgi Kiln MOC Products
Land Offer 3228C, Mxc-1400
B.M.S. Claim, Mx-1921

Continued — —
<table>
<thead>
<tr>
<th>Memo No.</th>
<th>Subject</th>
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</thead>
<tbody>
<tr>
<td>477</td>
<td>Microscopic Examination of Lurgi Kiln Discharge Products</td>
</tr>
<tr>
<td>478</td>
<td>Richmond Group Hole R-5 Albanel Area</td>
</tr>
<tr>
<td>479</td>
<td>The Addition of Ammonia, Sodium, or Calcium Base Sulfite Liquor (Lignosol) to Specular Hematite Green Pellets in an Attempt to Increase the Wet and Dry Strengths</td>
</tr>
<tr>
<td>480</td>
<td>Moisture Segregation, Artificial Magnetite Concentrates</td>
</tr>
<tr>
<td>481</td>
<td>Quality Control Tests of Magnetite Pellets from Nalberget, Sweden</td>
</tr>
<tr>
<td>482</td>
<td>Visit to the Mines Experiment Station at the University of Minnesota to Discuss Future Shaft Furnace Pelletizing Tests and Updraft Sintering Tests</td>
</tr>
<tr>
<td>483</td>
<td>Check Sampling - Eagle Mills Stockpile Sampling</td>
</tr>
<tr>
<td>484</td>
<td>The Effect of the Size Analysis of Republic Concentrate on the Wet and Dry Strengths of Green Pellets</td>
</tr>
<tr>
<td>485</td>
<td>Results of Metallurgical Testing on Drill Core Composite Mx-4108, Rock DDH No. 1, Section 31, 43-22</td>
</tr>
<tr>
<td>486</td>
<td>Review of Various Additives as Possible Binders for Green Pellets made from Republic Concentrate</td>
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<tr>
<td>487</td>
<td>Microscopic Examination of Sample No. Mx-1866 - Specular hematite-merrite-chert from Black Hill, South Dakota</td>
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<tr>
<td>488</td>
<td>Quality Control Tests of Fired Pellets made from Republic Concentrate at Lurgi in Frankfurt, Germany</td>
</tr>
<tr>
<td>489</td>
<td>Land Offer 3683, Mx-1866</td>
</tr>
<tr>
<td>490</td>
<td>Land Offer 3688, Mx-2042 thru Mx-2045, Mx-500 thru 502</td>
</tr>
<tr>
<td>491</td>
<td>Outside Exploration 1209, Mx-2046, -2047, -503</td>
</tr>
<tr>
<td>492</td>
<td>Land Offer 3651, Mx-1682</td>
</tr>
<tr>
<td>493</td>
<td>The Effect of Desliming and/or Reagentizing High Grade Republic Ore on the Wet and Dry Strength Properties of Green Pellets</td>
</tr>
<tr>
<td>494</td>
<td>Results of Concentration Tests on a High Magnetite Humboldt Ore</td>
</tr>
<tr>
<td>494A</td>
<td>Trip Report - Ontario Research Foundation</td>
</tr>
<tr>
<td>495</td>
<td>Standard MOC Tests on Drill Hole 59, Section 27, 47-26, Cascade Area</td>
</tr>
<tr>
<td>496</td>
<td>Observation of Pelletizing and Shaft Furnace Pellet Hardening Tests at Minnesota Mines Experiment Station - Treating Republic (R-70) MOC Concentrate, Reground and Re-concentrated Quality Control Tests on Fired Pellets from the Allis-Chalmers Grate Machine - Rotary Kiln Pelletizing Process</td>
</tr>
<tr>
<td>497</td>
<td>Trip to Meadville, Pennsylvania to meet with Westinghouse Electric's Industrial Heating Division and Study the Various Reducing Atmosphere Producers made by them - Exogas, Endogas, Monogas, Cooled-Exogas, etc. - July 5, 1957</td>
</tr>
<tr>
<td>498</td>
<td>Davis Magnetic Tube Test Checks - Albanel Drill Core</td>
</tr>
<tr>
<td>499</td>
<td>Metallurgical Tests on Republic Crude and Humboldt Rougher Concentrate Samples sent to Lurgi</td>
</tr>
<tr>
<td>500</td>
<td>Mineralogic Examination of Pellets made by the new Allis-Chalmers Process</td>
</tr>
<tr>
<td>501</td>
<td>Trip to the Mines Experiment Station at the University of Minnesota to Observe Shaft Furnace Pelletizing Tests on Artificial Magnetite Concentrate</td>
</tr>
<tr>
<td>502</td>
<td>High Tension Test Work - Meeting with Mr. Dyrenforth, July 16, 1957</td>
</tr>
<tr>
<td>503</td>
<td>The Effect of Adding Underground Fines at the Balling Slimes in Coarse Republic Flotation Concentrate rather than Regrinding the Concentrate</td>
</tr>
<tr>
<td>504</td>
<td>Observing Ore Boat Loading, &quot;Pioneer&quot;</td>
</tr>
<tr>
<td>505</td>
<td>Quality Control Tests on Jones &amp; Laughlin's Benson Magnetite Pellets Produced in an ACL Process Pilot Plant Land Offer 3204-C, Mx-1370 thru 1375</td>
</tr>
<tr>
<td>506</td>
<td>Microscopic Examination of Titeriferous Magnetite Samples from Benoit Lake Area, Canada</td>
</tr>
</tbody>
</table>

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520 & Geology Report 24
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524 & Geology Report 25
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535 (Supplement)  
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537 & Geology Report 27
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Subject

Magnetic Concentration Tests on Humboldt Mill Composites for June
Concentration Test Results on Composites from Albanel Area
Results of Concentration Tests on Mill Samples from the Humboldt Rougher Flotation Test Run and on a Sample of the Rougher Concentrate Stockpile
A Laboratory Examination of a Sample from Venezuela
Observing Ore Boat Loading, "Frontenac"
Preliminary Study of the Bailing and Firing Characteristics of Republic Artificial Magnetite Concentrate Pellets
Review of Amine Flotation of Tilden NOC-Magnetite Concentrates and Outline of Future Studies
Microscopic Examination of Products Produced from Reactor and Laboratory Tests of the Republic Ore
Land Offer 3693 - Mx-1867 thru Mx-1881
Albanel Area Drill Core Composites
Land Offer 3701 - Mx-1882 & Mx-1883
Preliminary Laboratory Examination of Titaniferous Samples from Project 17, Quebec Canada
Metallurgical Results of the Duplex NOC Process as Compared with Flotation and Standard NOC for Humboldt Ores
Heavy Media Bucket Tests - Maas Mine
Mineralogographic Examination of Large NOC Products Produced from the Republic Ore and Humboldt Rougher Concentrate
Mineralogographic Examination of Sample No. Mx-2051, Carter Iron Deposit, Montana - Land Offer 3710
Metallurgical Tests - Miscellaneous Sample Mx-2051
Land Offer 3244, Mx-786, -787, -788
Land Offer 3245 - Sample Mx8-789, -790, -791
The Effect of the Quantity of Bentonite on the Wet and Dry Strength Properties of Green Pellets Produced from Republic Flotation Concentrate and Republic High Grade Crude
Direct Reduction - Krupp-Renn Plant at Wattenstedt
Heavy Media Bucket Tests, Lloyd Mine Stockpile
Metallurgical Results of the Duplex NOC Process for Two Aggregate Samples of Humboldt Rod Mill Feed Composites
Metallurgical Results of the Duplex NOC Process for an Aggregate Sample of Republic Rod Mill Feed Composites
Preliminary Moisture Segregation Study of Artificial Magnetite Concentrate in a Bin
Observing Ore Boat Loading, "Pontiac"
A Qualitative Study of the Effect of Deastring Agents on Republic Flotation Concentrates
Review of Some Conditions that Effect Pelletizing of Republic Flotation Concentrates
Microscopic Examination of Specimens from Ford Lake, Hopes Advanced Bay, Quebec, Canada
The Effect of Using Various Size Matter "B" Fines as the Bailing Slimes in Green Pellets Produced from Republic Flotation Concentrate
A Visit to McLouth Steel Corporation
Observing Ore Boat Loading - "James Norris"
The Effect of Size Analysis on the Wet and Dry Strength Properties of Green Pellets Produced from Republic Artificial Magnetite Concentrate
Effect of the Flotation Reagent - Bentonite Ratio in Republic High Grade Crude on the Bailing Characteristics and Wet and Dry Strength Properties of Green Pellets
Missouri Manganese Sample - Mx-508
Microscopic Examination of Lurgi Pellets Produced from the Republic Ore Concentrate
Mineralogographic Examination of a Pellet from Atikokan, Canada

Continued ---
### Memo No.
546

### Subject
The Microscopic Texture and Chemical Composition of the Hand Rolled Pellets Produced from the Pickands Mather's Laboratory from the Ashland Ore, Butternut, Wisconsin

Results of MOC Concentration Tests on Samples from Rougher Concentrate Shipments to Lurgi

Mineralogic Examination of Some Drill Core Specimens from DD Hole No. 1, Section 13, Marquette County

Observing Ore Boat Loading - "Bruce Angus"

Albanel Area Samples, Project 17

Filter Aids for Reground Republic Flotation Concentrates

Sub-Sieve Size Analyses on Cooler and Dust Box Products from Lurgi Kiln Test H-6 (Humboldt Rougher Concentrate)

Balling Tests on Minus 1/4-Inch Underground Ore Sent to Allis-Chalmers for Pelletizing Tests in the ACL System

Observations of Tests #5 and 6 at the Mines Experiment Station, University of Minnesota, Week of November 11-16, 1957

Empire - Summary of Metallurgical Results on Drill Core Material

The Effect of Adding Ten Percent Cyclone Fines from the Ore Improvement Plant to Various Amounts of Coarse Republic Concentrate and Reground Republic Concentrate on the Strength Properties of Green Pellets

Updraft Pelletizing Tests Using Coke Produced from Island Creek Bituminous Coal as the Source of Fuel

The Quality of Fired Pellets Produced from Minus 1/4-Inch Ore Improvement Plant Fines in the Allis-Chalmers Grate-Kiln System on November 28, 1957

Retesting Albanel & Sandspit Area Composites, Albanel & Sandspit Claim Groups - Project #17

Drying and Indurating Temperatures Necessary to Agglomerate -1/4" 0IP Fines by Allis-Chalmers Grate Kiln System

### Sample Shipments:

Within any one year, various samples are shipped from the laboratory to various companies and laboratories. These samples are requested for a variety of reasons.

The bulk of the samples shipped, however, are for test work. Presented below is a list of the samples shipped during 1957.

<table>
<thead>
<tr>
<th>Date</th>
<th>Company</th>
<th>Amount &amp; Samples</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/3/57</td>
<td>Mr. F. M. Stephens, Jr. Battelle Memorial Institute Columbus, Ohio</td>
<td>2,400# iron ore concentrate</td>
<td>Direct reduction studies</td>
</tr>
<tr>
<td>1/4/57</td>
<td>Mr. J. F. Hunt Carpco Research &amp; Engr. Jacksonville, Florida</td>
<td>320# iron ore R-72 &amp; R-72</td>
<td>High tension tests</td>
</tr>
<tr>
<td>1/4/57</td>
<td>Mr. A. F. Kerschbaum Armco Steel Corporation Middletown, Ohio</td>
<td>2,400# Humboldt and Republic flotation concentrates</td>
<td>Direct reduction studies</td>
</tr>
<tr>
<td>1/7/57</td>
<td>Mr. J. F. Hunt Carpco Research &amp; Engr. Jacksonville, Florida</td>
<td>2 - 5# boxes specular hematite</td>
<td>Pilot plant tests with high tension equipment</td>
</tr>
<tr>
<td>1/10/57</td>
<td>Mr. A. D. Kennedy Institute of Mineral Research Houghton, Michigan</td>
<td>34 - 5# boxes RH-6, 7,8,9,11</td>
<td>Standard MOC test work</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Date</th>
<th>Company</th>
<th>Amount &amp; Samples</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/15/57</td>
<td>Mr. E. D. Martin Inland Steel Company</td>
<td>160# MOC concentrates</td>
<td>Research work</td>
</tr>
<tr>
<td></td>
<td>Hammond, Indiana</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/29/57</td>
<td>Mr. C. A. Johnson Hydrocarbon Research, Inc.</td>
<td>15# MxC-881 beach sand</td>
<td>Direct reduction work</td>
</tr>
<tr>
<td></td>
<td>Trenton, New Jersey</td>
<td>concentrate</td>
<td></td>
</tr>
<tr>
<td>1/31/57</td>
<td>Mr. J. L. Loring Sinclair Research Lab., Inc.</td>
<td>100# flotation</td>
<td>Research work in connection with oil</td>
</tr>
<tr>
<td></td>
<td>Harvey, Illinois</td>
<td>concentrates</td>
<td>refining processes</td>
</tr>
<tr>
<td>2/8/57</td>
<td>Grellinger &amp; Rose Architects, Milwaukee,</td>
<td>2 small samples of ore</td>
<td>Possible use as concrete aggregate for</td>
</tr>
<tr>
<td></td>
<td>Wisconsin</td>
<td></td>
<td>radiation barrier</td>
</tr>
<tr>
<td>2/21/57</td>
<td>Mr. Jerome A. Schwartz, Chicago 13, Illinois</td>
<td>Approx. 100 lbs., 1 can</td>
<td>Experimental test work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>low grade iron ore</td>
<td></td>
</tr>
<tr>
<td>3/13/57</td>
<td>Mr. A. D. Kennedy, Institute of Mineral</td>
<td>12 - 5 lb. boxes of</td>
<td>For standard MOC test work</td>
</tr>
<tr>
<td></td>
<td>Research, Houghton, Michigan</td>
<td>Richmond Samples RH12A</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>thru L &amp; Sample K-786</td>
<td></td>
</tr>
<tr>
<td>3/15/57</td>
<td>Mr. Al Fry, Pennsylvania Crusher Div.</td>
<td>1 drum, 910 lbs.</td>
<td>To test crushing</td>
</tr>
<tr>
<td></td>
<td>Westchester, Pennsylvania</td>
<td>Republic</td>
<td>Mine MOC concentrates frozen chunks</td>
</tr>
<tr>
<td>3/15/57</td>
<td>Mr. George L. Farnsworth, Chemical Corn</td>
<td>1 iron ore specimen</td>
<td>For display purposes</td>
</tr>
<tr>
<td></td>
<td>Exchange Bank New York, New York</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/15/57</td>
<td>Mr. Julius Kadaras, Meridan, Inc. Longview,</td>
<td>4 drums, 3,750 lbs.</td>
<td>For test work crude Humboldt ore</td>
</tr>
<tr>
<td></td>
<td>Texas</td>
<td>gross</td>
<td></td>
</tr>
<tr>
<td>3/21/57</td>
<td>Blackstone Corporation, Jamestown, New York</td>
<td>2 samples of flotation</td>
<td>For ultrasonic testing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>froth</td>
<td></td>
</tr>
<tr>
<td>3/21/57</td>
<td>Mr. Dale Bergstedt, Elmo Corporation</td>
<td>1-55 gal. drum of arti-</td>
<td>For filtering tests</td>
</tr>
<tr>
<td></td>
<td>Palatine, Illinois</td>
<td>ficial magnetite</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>concentrates</td>
<td></td>
</tr>
<tr>
<td>4/1/57</td>
<td>Dr. C. F. Fuchs Emulsol Chemical Corp.</td>
<td>1 gal. sample of froth</td>
<td>For froth depression studies</td>
</tr>
<tr>
<td></td>
<td>Chicago 3, Illinois</td>
<td>from Pelletizing Plant</td>
<td></td>
</tr>
<tr>
<td>4/1/57</td>
<td>Dearborn Chemical Company Chicago 9, Illinois</td>
<td>1 gal. sample of froth</td>
<td>Settling aids testing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>from Pelletizing Plant</td>
<td></td>
</tr>
<tr>
<td>4/2/57</td>
<td>Denver Equipment Company Denver 17, Colorado</td>
<td>938 lbs. of R-70 arti-</td>
<td>Filtering tests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ficial magnetite</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>concentrate</td>
<td></td>
</tr>
<tr>
<td>4/4/57</td>
<td>Inland Steel, Research Laboratory, Hammond,</td>
<td>115 lbs. Empire</td>
<td>General sample for inspection</td>
</tr>
<tr>
<td></td>
<td>Indiana</td>
<td>magnetic concentrate</td>
<td></td>
</tr>
<tr>
<td>4/9/57</td>
<td>Angel Stone, Ltd., Hamilton, Ont., Canada</td>
<td>29 lbs. Maas Special</td>
<td>Tinting stone</td>
</tr>
<tr>
<td>4/10/57</td>
<td>University of Wisconsin Madison, Wisconsin</td>
<td>10 bags, approx. 1,000</td>
<td>Possible use for radiation barrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>lbs. CS intermediate</td>
<td></td>
</tr>
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<td></td>
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<td>ore</td>
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</tbody>
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<th>Date</th>
<th>Company</th>
<th>Amount &amp; Samples</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/10/57</td>
<td>Denver Equipment Company</td>
<td>12 lbs., R-70 cyclone overflow product</td>
<td>For hydroseparator tests</td>
</tr>
<tr>
<td>4/11/57</td>
<td>Emulsion Corporation</td>
<td>5 lbs., deslimed flotation feed</td>
<td>Flotation test work</td>
</tr>
<tr>
<td>4/26/57</td>
<td>Dorr Oliver, Inc.</td>
<td>5 gals. artificial magnetite conc. pulp</td>
<td>For filter tests</td>
</tr>
<tr>
<td>5/3/57</td>
<td>Carpool Research &amp; Engr.</td>
<td>20# R-70-1, 25# R-70-2, 14# R-68</td>
<td>For testing with high tension separators</td>
</tr>
<tr>
<td>5/3/57</td>
<td>Dings Magnetic Separator Co.</td>
<td>30 lbs., Republic ore</td>
<td>Testing with high intensity magnetic separator equipment</td>
</tr>
<tr>
<td>5/7/57</td>
<td>Mines Experiment Station</td>
<td>50 tons magnetic concentrate</td>
<td>Pelletizing studies</td>
</tr>
<tr>
<td>5/17/57</td>
<td>Dorr-Oliver, Inc.</td>
<td>100 lbs., rougher flotation concentrates</td>
<td>Space rate determination</td>
</tr>
<tr>
<td>5/20/57</td>
<td>Institute of Mineral Research, Houghton, Michigan</td>
<td>4-5# boxes Mn-1641, Mn-1643, Mn-1655</td>
<td>For standard MOC tests</td>
</tr>
<tr>
<td>5/23/57</td>
<td>Sharon Steel Corporation</td>
<td>5 lbs. of pellets</td>
<td>As per request of Mr. H. C. Swanson</td>
</tr>
<tr>
<td>5/24/57</td>
<td>Mr. J.S. Wilbur</td>
<td>3 Specimens</td>
<td>For transmittal to Sharon Steel repres-entatives</td>
</tr>
<tr>
<td>5/28/57</td>
<td>Lurgi, Germany</td>
<td>15 barrels 1/4&quot; ore prepared in Hardinge Cascade Mill 20</td>
<td>For tests in rotary kiln</td>
</tr>
<tr>
<td>6/5/57</td>
<td>Institute of Mineral Research, Houghton, Michigan</td>
<td>28-5# bags Cascade and Tilden samples</td>
<td>For standard MOC test work</td>
</tr>
<tr>
<td>6/6/57</td>
<td>Mines Experiment Station</td>
<td>657# pulverized coal</td>
<td>Shaft furnace pelletizing tests</td>
</tr>
<tr>
<td>6/26/57</td>
<td>Institute of Mineral Research, Houghton, Michigan</td>
<td>41-5# boxes samples-Project 17</td>
<td>For standard Davis magnetic tube tests</td>
</tr>
<tr>
<td>6/28/57</td>
<td>Institute of Mineral Research, Houghton, Michigan</td>
<td>32-5# boxes of Humboldt samples</td>
<td>For standard MOC-concentration tests</td>
</tr>
<tr>
<td>7/3/57</td>
<td>American Colloid Company</td>
<td>130 lbs., Republic concentrate</td>
<td>Test work with bentonite</td>
</tr>
<tr>
<td>7/9/57</td>
<td>Carpool Mfg. Company, Inc.</td>
<td>35 pounds low grade iron ore</td>
<td>High tension separator tests</td>
</tr>
<tr>
<td>7/9/57</td>
<td>Mr. Russell E. Hollis</td>
<td>2 lbs., Republic specular hematite concentrate</td>
<td>Display purposes</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Date</th>
<th>Company</th>
<th>Amount &amp; Samples</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/19/57</td>
<td>National Lead, Research Lab</td>
<td>276# Republic crude No. 1, 263# Republic crude No. 2, 276# Humboldt crude No. 1, 264# Humboldt Rougher Flotation concentrate</td>
<td>For tests with RN Process</td>
</tr>
<tr>
<td>7/23/57</td>
<td>Institute of Mineral Research Houghton, Michigan</td>
<td>100# 1957 Surface samples</td>
<td>For standard MOC tests</td>
</tr>
<tr>
<td>7/24/57</td>
<td>United Abrasive Grain Co. Quinnesec, Michigan</td>
<td>1-1/2# Tilden siliceous ore</td>
<td>To determine possible application in the tumbling of metal</td>
</tr>
<tr>
<td>7/29/57</td>
<td>Dorr-Oliver Westport, Connecticut</td>
<td>1 drum reactor product, 1 drum Republic crude</td>
<td>For fluidizing tests</td>
</tr>
<tr>
<td>8/5/57</td>
<td>Bethlehem Steel Company Lebanon, Pennsylvania</td>
<td>80# reground Republic concentrate</td>
<td>For laboratory balling tests</td>
</tr>
<tr>
<td>8/8/57</td>
<td>J.F. Cullen &amp; Son Janesville, Wisconsin</td>
<td>100# Cliffs Shaft lump</td>
<td>Radioactive shielding</td>
</tr>
<tr>
<td>8/14/57</td>
<td>Ontario Research Foundation Toronto, Ontario, CANADA</td>
<td>5# artificial magnetite concentrate</td>
<td>For demagnetization tests</td>
</tr>
<tr>
<td>8/20/57</td>
<td>Mr. Breg Bjornraa 2926 W. River Rd., Minneapolis, Minnesota</td>
<td>60# pellets, 60# low grade specular hematite ore</td>
<td>Requested by Mr. G. J. Holt</td>
</tr>
<tr>
<td>8/20/57</td>
<td>Institute of Mineral Research Houghton, Michigan</td>
<td>10-5# boxes Tilden &amp; Isabella samples</td>
<td>For standard MOC tests</td>
</tr>
<tr>
<td>8/23/57</td>
<td>Institute of Mineral Research Houghton, Michigan</td>
<td>7-5# boxes Tilden samples</td>
<td>For standard MOC tests</td>
</tr>
<tr>
<td>8/23/57</td>
<td>Dearborn Chemical Company Chicago 9, Illinois</td>
<td>20# Republic reground concentrate</td>
<td>Froth depression</td>
</tr>
<tr>
<td>8/30/57</td>
<td>Institute of Mineral Research Houghton, Michigan</td>
<td>200 gms H6 Kaster dust, 200 gms H6 Kuhler dust</td>
<td>For sizing analyses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total shipment approximately 20 tons</td>
<td></td>
</tr>
<tr>
<td>9/10/57</td>
<td>Institute of Mineral Research Houghton, Michigan</td>
<td>11-5# boxes Empire samples</td>
<td>For MOC test work E-202 to E-205, E-207, -209 and E-210</td>
</tr>
<tr>
<td>9/11/57</td>
<td>MCM&amp;T Bureau of Mines Houghton, Michigan</td>
<td>200# Republic concentrate, 200# artificial magnetite concentrate</td>
<td>For pelletizing tests</td>
</tr>
<tr>
<td>9/17/57</td>
<td>Dr. Roberts Dorr Company Westport, Connecticut</td>
<td>15# R-70 crude</td>
<td>For microscopic tests</td>
</tr>
<tr>
<td>9/18/57</td>
<td>Mr. F. C. Roberts 2636 1/2 W. Main St. Alhambra, California</td>
<td>69 Specimens</td>
<td>For standard size thin sections</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Date</th>
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<th>Amount &amp; Sample</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/20/57</td>
<td>National Lead Research Lab.</td>
<td>3 bags T-185 Tilden</td>
<td>For direct reduction</td>
</tr>
<tr>
<td></td>
<td>Brooklyn, New York</td>
<td>crude ore</td>
<td>RN Process</td>
</tr>
<tr>
<td>10/11/57</td>
<td>Mr. A.C. Behrendsen</td>
<td>100# Republic flotation concentrates</td>
<td>For bentonite studies</td>
</tr>
<tr>
<td></td>
<td>Liberty, Missouri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/15/57</td>
<td>Sharon Steel Corp.</td>
<td>46 long tons Tilden</td>
<td>For direct reduction</td>
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<tr>
<td></td>
<td>Lowellville, Ohio</td>
<td>crude ore</td>
<td>studies</td>
</tr>
<tr>
<td>10/23/57</td>
<td>Mines Experiment Station</td>
<td>2500# Eagle Mills</td>
<td>For test work</td>
</tr>
<tr>
<td></td>
<td>Minneapolis, Minnesota</td>
<td>products</td>
<td></td>
</tr>
<tr>
<td>10/24/57</td>
<td>Bethlehem Steel Company</td>
<td>500# Republic flotation concentrates</td>
<td>For study of various</td>
</tr>
<tr>
<td></td>
<td>Bethlehem, Pennsylvania</td>
<td></td>
<td>concentrates</td>
</tr>
<tr>
<td>10/24/57</td>
<td>Bethlehem Steel Company</td>
<td>1 bag-25# Republic</td>
<td>For study of various</td>
</tr>
<tr>
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<td>Bethlehem, Pennsylvania</td>
<td>flotation concentrate</td>
<td>concentrates</td>
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<tr>
<td>10/25/57</td>
<td>Linde Company</td>
<td>2-100# bags pellets</td>
<td>Use as possible heat</td>
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<tr>
<td></td>
<td>Tonawanda, New York</td>
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<td>barrier</td>
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<tr>
<td>10/25/57</td>
<td>Hercules Powder Company</td>
<td>1-50# bag Republic</td>
<td>Test work relative to</td>
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<tr>
<td></td>
<td>Willmington, Delaware</td>
<td>flotation concentrate</td>
<td>removing reagent film</td>
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<tr>
<td>10/25/57</td>
<td>The Philip Carey Mfg. Co.</td>
<td>10# iron ore fine</td>
<td>For inspection and</td>
</tr>
<tr>
<td></td>
<td>Lockland, Cincinnati,15, Ohio</td>
<td>concentrates</td>
<td>examination</td>
</tr>
<tr>
<td>10/28/57</td>
<td>Fried-Krupp</td>
<td>20# Humboldt rougher</td>
<td>For tests employing</td>
</tr>
<tr>
<td></td>
<td>Essen, Germany</td>
<td>flotation concentrate</td>
<td>Krupp-Renn Process</td>
</tr>
<tr>
<td>10/28/57</td>
<td>Institute of Mineral Research</td>
<td>23-5# boxes I3A-Q,</td>
<td>For standard</td>
</tr>
<tr>
<td></td>
<td>Houghton, Michigan</td>
<td>T-188A-F</td>
<td>MOC tests</td>
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<tr>
<td>11/1/57</td>
<td>Allis-Chalmers Mfg. Co.</td>
<td>8 tons, 20 barrels</td>
<td>For ACL Test Work</td>
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<tr>
<td></td>
<td>Carrollville, Wisconsin</td>
<td>Eagle Mills concentrate</td>
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<tr>
<td>11/8/57</td>
<td>Allis-Chalmers Mfg. Co.</td>
<td>20 barrels, 20,000#</td>
<td>For ACL test work</td>
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<tr>
<td></td>
<td>Carrollville, Wisconsin</td>
<td>Republic MOC concentrated product</td>
<td></td>
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<tr>
<td>11/8/57</td>
<td>Dorr-Oliver Inc.</td>
<td>4 barrels, approx. 4000#</td>
<td>For MOC test work</td>
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<tr>
<td></td>
<td>Westport, Connecticut</td>
<td>Tilden &amp; R-70 crude ore</td>
<td></td>
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<tr>
<td>11/15/57</td>
<td>Allis-Chalmers Mfg. Co.</td>
<td>30 barrels, 27,000#</td>
<td>For ACL test work</td>
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<td></td>
<td>Carrollville, Wisconsin</td>
<td>Group No. 1 1/4&quot; fines from</td>
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<td></td>
<td></td>
<td>Ore Improvement Plant</td>
<td></td>
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<tr>
<td>11/21/57</td>
<td>Jones &amp; Laughlin</td>
<td>50# Republic RM Feed</td>
<td>For examination</td>
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<td>Pittsburgh, Pennsylvania</td>
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<tr>
<td>11/21/57</td>
<td>Ramsey Engr. Co.</td>
<td>41 lbs. R-76B</td>
<td>For determination of</td>
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<td></td>
<td>St. Paul, Minnesota</td>
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<td>magnetite content</td>
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<tr>
<td>11/21/57</td>
<td>Dorr-Oliver, Inc.</td>
<td>92 lbs. R-76B</td>
<td>To determine grind-</td>
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<tr>
<td></td>
<td>Westport, Connecticut</td>
<td></td>
<td>ability in the Fluid bed</td>
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<tr>
<td>11/21/57</td>
<td>Battelle Memorial Institute</td>
<td>50 tons artificial</td>
<td>For experimental</td>
</tr>
<tr>
<td></td>
<td>Columbus, Ohio</td>
<td>magnetite</td>
<td>reduction work</td>
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<tr>
<td>11/22/57</td>
<td>Shell Oil Research Lab.</td>
<td>200# Republic flotation</td>
<td>For agglomeration</td>
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<tr>
<td></td>
<td>Wood River, Illinois</td>
<td>concentrate</td>
<td>testing</td>
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Continued -- -
<table>
<thead>
<tr>
<th>Date</th>
<th>Company</th>
<th>Amount &amp; Samples</th>
<th>Purpose</th>
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<tbody>
<tr>
<td>11/22/57</td>
<td>Battelle Memorial Institute</td>
<td>10# artificial</td>
<td>For experimental reduction work</td>
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<tr>
<td></td>
<td>Columbus, Ohio</td>
<td>magnetite</td>
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<tr>
<td>11/27/57</td>
<td>Institute of Mineral Research</td>
<td>53-5# boxes Empire,</td>
<td>For standard MOC tests</td>
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<tr>
<td></td>
<td>Houghton, Michigan</td>
<td>Ogden, Tilden, Vulcan, and Gwinn</td>
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<tr>
<td>12/3/57</td>
<td>John A. Mercier Brick Co.</td>
<td>1,000# MOC</td>
<td>Preliminary study for blocking process</td>
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<td>Dearborn, Michigan</td>
<td>concentrates</td>
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<tr>
<td>12/3/57</td>
<td>Dow Chemical Company</td>
<td>10# Republic flotation</td>
<td>Studies on removal of fatty acid</td>
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<td>Midland, Michigan</td>
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<td>Hanna Research Lab.</td>
<td>200# -1/4&quot; Group I</td>
<td>Agglomeration studies</td>
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<td>A.G. McKee, Requested by</td>
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<tr>
<td>12/4/57</td>
<td>Institute of Mineral Research</td>
<td>9-5# boxes 43 lbs.</td>
<td>For standard MOC tests</td>
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<td>Houghton, Michigan</td>
<td>Isabella Drill Hole 4</td>
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<td>12/5/57</td>
<td>Armco Steel Corp.</td>
<td>35 lbs. Brazilian ore</td>
<td>For examination of fines</td>
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<td>Middletown, Ohio</td>
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<tr>
<td>12/6/57</td>
<td>Institute of Mineral Research</td>
<td>188# Humboldt and Republic rod mill feed composites</td>
<td>For grindability test correlation study</td>
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<tr>
<td>12/6/57</td>
<td>Dayton Malleable Iron Co.</td>
<td>1,000# concentrates</td>
<td>Examination of material</td>
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<td>Dayton, Ohio</td>
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<tr>
<td>12/10/57</td>
<td>Mr. W.R. VanSlyke, CCI</td>
<td>1,070# artificial</td>
<td>For use as cyclone media</td>
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<tr>
<td></td>
<td>Taconite, Minnesota</td>
<td>magnetite</td>
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<tr>
<td>12/10/57</td>
<td>Allis-Chalmers Mfg. Co.</td>
<td>37,800# Republic</td>
<td>Tests in ACL Process</td>
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<tr>
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<td>Carrollville, Wisconsin</td>
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<tr>
<td>12/11/57</td>
<td>Tamms Industries</td>
<td>Approx. 7# cyclone dust samples from Ore Improvement Plant</td>
<td>To evaluate use as paint pigment</td>
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<td>Chicago, Illinois</td>
<td></td>
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<tr>
<td>12/19/57</td>
<td>Mr. M.E. Volin</td>
<td>50 lbs. Republic high grade crude ore</td>
<td>For test work</td>
</tr>
<tr>
<td></td>
<td>MCM&amp;T</td>
<td></td>
<td></td>
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<tr>
<td>12/20/57</td>
<td>Mr. T.T. Quirke, Jr.</td>
<td>1-3/4&quot;, 21 polished specimens-Albanel &amp; Sandspit</td>
<td>For microscopic work</td>
</tr>
<tr>
<td></td>
<td>Univ. of Minnesota</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minneapolis, Minnesota</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12/23/57</td>
<td>Mr. M. E. Volin</td>
<td>300# pellets</td>
<td>For test work</td>
</tr>
<tr>
<td></td>
<td>MCM&amp;T</td>
<td>150# concentrates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Houghton, Michigan</td>
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<td></td>
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<tr>
<td>12/27/57</td>
<td>Allis-Chalmers Mfg. Co.</td>
<td>40 tons artificial</td>
<td>For 3-day agglomeration test using ACL Process</td>
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<tr>
<td></td>
<td>Carrollville, Wisconsin</td>
<td>magnetite concentrate</td>
<td></td>
</tr>
<tr>
<td>12/27/57</td>
<td>Allis-Chalmers Mfg. Co.</td>
<td>15 tons -1/4&quot; fines from</td>
<td>For agglomeration tests using ACL Process</td>
</tr>
<tr>
<td></td>
<td>Carrollville, Wisconsin</td>
<td>Group I Stockpile</td>
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</table>
PART II
PYROLYSIS & AGGLOMERATION

OPERATION OF THE EAGLE MILLS PELLETIZING PLANT:

During the first part of the year the entire staff of the pyrometallurgical section was at the Eagle Mills Pelletizing Plant helping the operators in the start-up of the plant.

Studies were conducted at the Research Laboratory in an attempt to aid the process and operation of the Pellet Plant. The variables studied are as follows:

1. Effect of de-liming during concentration on the ballability of the concentrate.
2. Effect of reagentizing the crude ore for flotation on the ballability of the concentrate.
3. Effect of the amount of flotation reagent on the strength and plasticity of wet green pellets.
4. Effect of various chemical reagents on the ballability and green strength properties of pellets produced from flotation concentrate.
   (a) settling agents
   (b) reagents used to neutralize the returns
   (c) defoamers and defoathers
5. Effect of the quantity of bentonite in the balling feed on the ballability and green strength properties of pellets.
6. Effect of the flotation reagent-bentonite ratio on the strength, ballability, and plasticity of wet green pellets.
7. Effect of returns on the balling and firing phases of the updraft process.
   (a) with limestone present in the circuit
   (b) without limestone
8. Variables that affect balling at Eagle Mills:
   (a) Bentonite additions - location and method of mixing
   (b) Moisture content of balling feed
   (c) Size consist of the regrind concentrate
9. Quality of the green pellets produced from the discs at Eagle Mills.
10. Grate feeders and their effect on the green pellet bed permeability.
   (a) breakage caused by excessive drops
   (b) deformation of plastic pellets caused by the excessive drop
11. Addition of various amounts of underground fines to reground and/or raw concentrate to increase the ballability and green pellet strength.

(a) size of underground fines
(b) amount of underground fines
(c) varying the reground-raw concentrate ratio

12. Factors affecting production at Eagle Mills:

(a) size consist of reground concentrate
(b) amount of returns in balling feed
(c) amount of reagent in concentrate

13. Study the corrosion problem in the RotoClones.

(a) determine cause of corrosion
(b) investigate possible methods of preventing corrosion

PRELIMINARY LABORATORY MOG PELLETIZING TESTS:

Tests were conducted during the year using a high grade artificial magnetite concentrate produced from Republic crude in the FluoSolids reactor and laboratory pilot plant concentrating circuit. Balling characteristics were investigated in the laboratory's 16" diameter x 6" batch balling drum while drying and firing characteristics were investigated in the Burrell tube furnace. The variables investigated are as follows:

1. The ballability of the concentrate.
2. Effect of the size consist of the concentrate on the wet and dry strength properties of green pellets.
3. Effect of the quantity of bentonite on the green strength properties of the pellets.
4. Effect of the addition of various chemical reagents to the balling feed:
   (a) reagents to increase the pH and as such the swelling properties of bentonite
   (b) reagents to retard drying rates
5. Effect of the pellet diameter on drying rates.
6. Quality control tests on the green and fired pellets.
7. Reducibility tests on the finished products.

AGGLOMERATION TESTS CONDUCTED AT THE UNIVERSITY OF MINNESOTA, MINES EXPERIMENT STATION:

Shaft Furnace Pelletizing Tests:

A series of four shaft furnace pelletizing tests were conducted at the Mines Experiment Station using artificial magnetite concentrate. Difficulties were en-
countered in discharging the fired pellets evenly from the furnace and maintaining the desired inuring temperature in the furnace. These difficulties caused a poorly fired product to be produced and unfavorable results were obtained. The following investigations were conducted during and after these tests:

1. Effect of palletizing without solid fuel
2. Effect of palletizing with solid fuel
   (a) Internal coal
   (b) Surface coal
   (c) Partially internal and partially surface coal
3. Effect of adding bentonite to the surface fuel.
4. Quality control tests on fired products from the tests.

Updraft Sintering:
A series of six tests were conducted on the traveling grate at the Mines Experiment Station using underground ore. The first two tests were practice tests to determine operating conditions and obtain returns for future tests. Complete sets of data were obtained on the four remaining tests. Variables studied during these tests were as follows:

1. Size of the underground ore
2. Effect of the Fe:SiO2 ratio on sinter strength
3. Effect of the amount of fuel on the sinter strength

Quality control tests on the various size sinter products revealed a very brittle product. This type of sinter could not be sold as open hearth sinter.

AGGLOMERATION BY THE ACL GRATE-KILN SYSTEM:
During the year specular hematite flotation concentrate, artificial magnetite concentrate, and underground fines were subjected to a new and novel method of agglomerating iron ore. These materials were tested on a pilot plant unit of the Allis-Chalmers grate-kiln system, commonly known as the ACL Process. Following is a brief description of the test procedures and results for each type ore.

Specular Hematite:
Pilot plant tests were conducted on October 31st and November 7th, 1957. The concentrate used during these tests was obtained from the filter circuit at Eagle Mills. The investigations conducted before and after the tests are as follows:
1. Determine if it was feasible to agglomerate this material by this method.
2. Determine the capacity of the process.
3. Determine if pre-heated pellets would withstand drop from grate to kiln.
4. Determine the preheat and drying temperatures required.
5. Quality control tests on the grate, kiln, and cooler products.

**Artificial Magnetite Concentrate:**

A pilot plant test was conducted on October 29th, 1957. The concentrate used during these tests was obtained from the laboratory pilot plant concentrating circuit. The investigations conducted before and after the test are as follows:

1. Determine if it is feasible to agglomerate this material by this method.
2. Determine the capacity of the process.
3. Determine the preheat and drying temperatures required.
4. Determine the extent of oxidation of the pellets on the grate.
5. Investigate the effect of pellet diameter.
6. Quality control tests on the grate, kiln, and cooler products.

**Underground Ore Fines:**

Pilot plant tests were conducted on November 26th and December 5th, 1957. The tests failed because the green pellets were more tightly compacted than previous pellets and spalled or explosively disintegrated when dried at the standard drying time and temperature for the ACL Process. Because of this failure, basic studies were undertaken at the Research Laboratory. The variables studied were as follows:

1. Determine maximum drying temperature attainable without spalling or explosive disintegration.
2. Determine maximum indurating temperature to produce a hard pellet that shows no signs of thermal decomposition.
3. Determine the time required to dry pellets at the various drying temperatures.
4. Investigate the ballability of this material and the shape disc required.
   a) Effect of moisture
   b) Effect of rerolling the green pellets.
QUALITY CONTROL TESTS OF VARIOUS FIRED PELLETS:

During the year samples of concentrates and fired pellets were received from pelletizing plants throughout the world. These samples were subjected to quality control tests.

These samples were received from the following sources:

1. Shaft Furnace:
   (a) Malmberget - Sweden
   (b) Erie Mining Company - Aurora, Minnesota
   (c) Bethlehem Steel - Lebanon, Pennsylvania
   (d) Marmora

2. Grate Machine:
   (a) Eagle Hills Pelletizing Plant's first shipment to International Harvester - Wisconsin Steel Division (Updraft)
   (b) Reserve Mining Company - Silver Bay, Minnesota (Downdraft)
   (c) Lurgi - flotation concentrate pellets - (Lurgi system - pilot plant, Frankurt, Germany)

3. ACL System:
   (a) Benson magnetite, Jones & Laughlin Steel Corporation.

STANDARD LABORATORY BALLING STUDIES:

Standard laboratory balling tests conducted during the year included the following investigations:

1. Binder study.
2. Chemical reagents to remove the flotation reagent from the concentrate.
3. Addition of Ore Improvement Plant fines to the flotation concentrate to increase the wet strength of green pellets.
4. Standard laboratory balling tests to determine the quality of the bentonite received at Eagle Hills.

MISCELLANEOUS TEST PROGRAM:

The following test programs were also conducted during the year:

1. Evaluate the possibility of replacing anthracite coal at Eagle Mills with coke from Island Creek Coal.
2. Determine moisture segregation of artificial magnetite concentrate stored 100 hours in a 25 foot bin.
3. Test a method of screening green pellets from the discs at Eagle Hills.

   (a) Vibrating screen
   (b) Stationary trommel
   (c) Moving trommel

   (1) 1/8" - openings (Eagle Hills)
   (2) 1/4" - openings (Research Laboratory)

4. Compute chemical analysis of pellets which will be produced from different properties in the future.

5. Conduct MOC tests at the University of Minnesota, Mines Experiment Station, on a traveling grate.
PART III
RESEARCH AND DEVELOPMENT WORK AND FLOTATION PROJECTS

PILOT PLANT MILLING:

FluoSolids MOC Calcine:

During the first eight months of the year, FluoSolids MOC calcine of Humboldt and Republic crude ores was treated in the magnetic separation pilot mill. The flowsheet consisted of a two or three stage cobbing of a minus 28 mesh rod mill discharge, closed circuit grinding of the cobber concentrate, and a three drum magnetic finisher separation on the cyclone classifier overflow.

Starting in September, Humboldt and Republic duplex MOC calcine was milled in the pilot mill. The circuit consisted of a one or two stage cobbing of the as is calcine, dewatering the cobber concentrate with a cyclone or a spiral classifier, grinding the dewatered sands in a ball mill in open circuit, and finishing magnetic separation on the ball mill discharge using one, two, or three drums of the Jeffrey three drum unit.

About 100 tons of high grade duplex MOC magnetic concentrates have been prepared with the pilot mill and have been shipped to Allis-Chalmers and the Mines Experiment Station for agglomeration tests.

Traveling Grate MOC Calcine:

A small tonnage of MOC calcine was made from Republic crude ore on a traveling grate machine at the Mines Experiment Station. The calcine was milled in a magnetic separation pilot mill circuit at the Station. A report on the results of this test was issued by the Station.

Hardinge Cascade Mill:

A six foot Hardinge Cascade mill was tested at the Republic Mill to get an indication of the applicability of that unit and also to determine energy requirements which could be compared with conventional crushing and grinding. A report on this test was issued by Hardinge.

A small tonnage of minus 1/8" product was made from Republic crude. Some of this was sent to Lurgi for MOC in the pilot plant kiln test and the balance was stockpiled at the Laboratory.
Empire:

Because of the immediate need for the development of the Humboldt and Republic
MOC-magnetic separation flowsheets first for crude ore calcine and then for pre-
concentrate calcine, only a limited amount of pilot plant milling was done on Empire
crude ore.

DRILL CORE TESTING:

Core material from the following named drill holes in the several districts was
subjected to concentration tests, the results of which have been presented in
metallurgical reports or memoranda. Because of the work load at the Laboratory, drill
core composites and field samples were sent to the Institute of Mineral Research.
This testing involved MOC-magnetic concentration as for Richmond and Tilden or grind-
ing and magnetic separation as for Albanel.

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<td>Cascade</td>
<td>47, 48, 59</td>
<td>Section 27, T47N-R26W</td>
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<td>Empire</td>
<td>20 through 34</td>
<td>Section 19, T47N-R26W</td>
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<td>Humboldt</td>
<td>8</td>
<td>Section 2, T47N-R29W</td>
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<td>Isabella</td>
<td>1, 2, 3</td>
<td>Section 32, T47N-R26W</td>
</tr>
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<td>Osier</td>
<td>1, 2</td>
<td>Section 18, T43N-R21W</td>
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<td>Richmond</td>
<td>45, 46, 49</td>
<td>Section 27, T47N-R26W</td>
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<td>Rock</td>
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<td>Section 31, T43N-R22W</td>
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<td>Tilden</td>
<td>59, 60</td>
<td>Section 28, T47N-R27W</td>
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<td>45, 5, 6, 7</td>
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<td>1, 2, 3</td>
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<tr>
<td>Tilden</td>
<td>25, 26, 27</td>
<td>Section 27, T47N-R27W</td>
</tr>
</tbody>
</table>

Composites have been made and metallurgical testing is underway but not completed
for the following drill holes:

Empire         36  
Isabella       5   
Ogden          3   

Section 19, T47N-R26W
Section 32, T47N-R26W
Section 24, T47N-R27W

The composites for Bellevue area DDH Nos. 33 and 34, Section 18, T47N-R26W
were retested to determine if a finer grind would make possible the separation of
concentrates of acceptable grade. The initial test results on these composites were
reported in Metallurgical Report No. 186.

Field Samples:

Field samples from the following named areas were processed. The testing involved
either grinding and magnetic separation or MOC-magnetic separation.

Empire, Section 19  
Ogden, Section 13  
Tilden, Section 34  
Vulcan, Section 9  
Gwinn, Sections 17, 18, 20, 28, 35
Project 17 - Albanel Area:

Albanel Area drill core composites were tested by grinding and magnetic separation with the Davis tube. Field samples were tested in the same way. The bulk of the work was conducted at the Institute of Mineral Research.

Natashquan River Sands Testing:

A rather comprehensive group of auger drill samples of Natashquan River sands were composited by the Department of Mines, Province of Quebec. These composites were subjected to concentration at the School of Mines, Laval University in Quebec. The concentration scheme which previously had been outlined by laboratory personnel consisted of (1) separation of a crude magnetics from the "as is" sand sample, (2) screening the crude magnetics on 65 mesh rejecting the plus 65 mesh as a lower grade middling product, (3) grinding the minus 65 mesh fraction to minus 200 mesh, and (4) final magnetic separation on the minus 200 mesh material.

These composites were shipped to the Laboratory for cross checking. It was established that overall recovery could be increased with no lowering of final concentrate grade by grinding and finishing magnetic separation on the total crude magnetics.

O'Keefe Lake Claim:

A sample of crude ore from the O'Keefe Lake Claim Group was subjected to a comminution test by Aerofall Mills Limited, Toronto, Canada. Samples of the Aerofall Mill products were submitted to the Research Laboratory for testing.

High Tension Separation:

Both Humboldt and Republic crude ore samples were sent to Carpcro Research and Engineering for high tension separation and high intensity magnetic separation. Of the two methods a quick study showed the former superior to the latter method and thus all of the effort was devoted to high tension.

The results of the earliest work on Humboldt ore ground to 65 mesh and deslimed showed that high tension could isolate a high grade concentrate with high iron unit recovery. However, as Carpcro gained experience with Humboldt and Republic crudes and with other iron ores such as very coarse martites and specular hematites, it developed that the Republic ores liberated at too fine a size to get high grade concentrates at economically feasible feed rates in the high tension.
Republic rougher concentrate did not respond favorably to high tension nor did
a sample of Tilden ore which was ground to minus 65 mesh and deslimed.

**LURGI MOC PRODUCTS:**

Samples of MOC calcines of Republic crude ores and Humboldt rougher concentrates
from Lurgi kiln pilot plant tests were submitted to the Laboratory for concentration
tests. The tests involved grinding and magnetic separation with the Davis tube.

**DUPLEX MOC:**

Both Humboldt and Republic crude ore samples were subjected to duplex concen-
tration scheme which involves separation of a rougher concentrate with high iron unit
recovery by fatty acid flotation and then MOC-magnetic concentration of the rougher
concentrate. The duplex MOC process was compared with standard MOC on monthly rod mill
feed composites and on special pit samples.

The advantages of duplex MOC are: (1) to reduce the feed to MOC by about 40 per-
cent, (2) greater ease of separation of a high grade concentrate at coarser grinds
than with MOC on crude ore, and (3) a somewhat greater consistency in producing high
grade concentrates.

Both Humboldt and Republic rougher concentrates have been sent to Lurgi and to
the Laboratory for pilot plant reduction tests.

**CONCENTRATION OF MAGNETITE FROM HUMBOLDT ORES:**

The possibility of magnetic separation to recover magnetite from Humboldt ores
before or after flotation was investigated using monthly rod mill feed composites,
mill flotation circuit samples, pit samples, and some high magnetite drill core.
Magnetics could be recovered either from the hydrosizer overflow or the flotation
tailings. In the duplex MOC scheme, magnetite could be recovered before MOC to still
further reduce the feed to MOC.

**FLOCULATING AGENTS FOR FLOTATION TAILINGS:**

Eighteen flocculants of the inorganic type or commercially synthesized products
were tested individually or in combination as flocculants for Republic plant tailings.
Fresh samples of as is tailings were used with the respective flocculating agents
following a standardized settling procedure. Several of the inorganic salts were
effective as were combinations of inorganic salts and commercial products.
DEFOAMING AGENTS FOR FATTY ACID FLOTATION CONCENTRATES:

About 35 commercial defoaming agents were tested in a qualitative study to determine their relative effectiveness to breakdown froth from the thickener at the Pellet Plant. They were also tested to indicate any ability to prevent the formation or destroy froth formed when Republic reground concentrate was aerated in the flotation cell. Some of the most promising defoaming additives were tested in the Agglomeration Section to determine their effect, if any, on balling.

FILTER AIDS FOR REPUBLIC FLOTATION CONCENTRATES:

In the testing of the commercial defoamers it was observed that a few functioned by a pronounced floculating action. Batch tests were run with a leaf filter on repulped Pellet Plant filter cake using a few of these additives. A Hercules experimental product HXV-100 used in amounts as little as 0.02 lb. per ton increased filter capacity by 50 per cent and gave a somewhat drier cake.

FILTER TESTS ON MIXTURES OF REGROUND REPUBLIC CONCENTRATE AND IMPROVEMENT PLANT FINES:

Tests have been conducted in the Agglomeration Section on balling of reground Republic concentrate with admixtures of cyclone dust and fines from the Improvement Plant. Batch leaf filter tests were run on these mixed pulps to get an indication of the effect of these fines on filtration.

FATTY ACID FILM REMOVAL STUDY:

Laboratory balling studies and plant operating data indicated that the fatty acid that adheres to the concentrate is detrimental to good pelleting. A study was initiated to try to find a method to remove the fatty acid after concentration. Several schemes used in the phosphate field to remove fatty acids from concentrates failed to work on Republic concentrate. Quebracho and ferric chloride both appeared to be effective in rendering the concentrate wetable but no improvement was noted in balling so removal of the fatty acid by these treatments was questionable.

FLOTATION STUDIES:

Undeslimed Flotation Tests at Republic:

During January and February, tests were made at Republic with an undeslimed flotation system which had been previously outlined by laboratory batch tests. Principally, the scheme involved conditioning of the ore in the grinding mills with fatty acid and caustic soda. The aim was better metallurgy plus recovery of more fine material to aid the pelleting.
The system as tested at Republic failed to show the improvements which were indicated by batch test results. Generally, the new system was not as good as was the existing mill practice. It was concluded that insufficient reagentizing in the continuous closed circuit grinding was the result of a differential in grinding rates versus conditioning rates for the complete size range of the flotation feed.

**Fatty Acid Reagent Testing:**

Several fatty acid reagents were tested as possible substitutes for the present mill reagents. The distilled tall oil types appear to be the most effective and economical. Both Humboldt and Republic are scheduled to use in the summer months a tall oil fatty acid which is slightly lower in grade and has a higher titer but which cost $1.25 less per pound than the first grade reagents.

**Effect of Calcium Chloride on Flotation:**

To inhibit freezing of the fine ore in the silos at Humboldt it was proposed that calcium chloride be added to the fine ore being charged into the silos. A batch test investigation showed that calcium chloride added to the ground and deslimed flotation feed definitely reduced recovery.

**Flotation with Mill Reuse and Humboldt Pit Water:**

A drought during the later part of summer reduced the level of Lake Lory which is the source of mill fresh water for Humboldt. A batch test investigation showed that mill re-use water gave practically the same results in flotation as the Lake Lory water. Test results with Humboldt pit water showed a definitely lower recovery than with Lake Lory water. The greater suitability of Lake Lory or mill re-use water for flotation as compared to pit water was related to the relatively high hardness of the pit water.

**Preparation of Reagent 899 Concentrates for Balling Studies:**

Some difficulty has been experienced in the pelletizing of fatty acid flotation concentrates. The question was raised as to whether an 899 concentrate may be more suitable for pelletizing. Using an aggregate sample of Republic rod mill feed composites it was demonstrated with closely controlled batch tests that the 899 system gave superior metallurgy but at higher reagent cost per ton of concentrate. This study is being extended to balling studies on concentrates produced on a batch scale with each flotation system.
Batch Flotation Tests on Republic Crude Ore Types:

The crude ore that has been thus far treated in the Republic Mill has been classified into three basic types according to mineral grain size and texture. A laboratory batch study was initiated to get some indication of the response to these ore types to flotation with respect to liberation size, grade and recovery, reagent addition, and concentrate structure. This study is being tied in with an overall study on the concentrateability and pelleting of various types of Republic crudes.

Amine Flotation Upgrading of Tilden MDC Concentrates:

Amine flotation studies were done on MDC magnetic concentrates from a pit sample of Tilden crude ore with satisfactory upgrading with good mineral recovery. About 1500 pounds of Tilden Fire Tower drill core rejects were aggregated into a sample for testing. In addition to amine flotation upgrading of MDC-magnetic concentrates, consideration will be given to preconcentration of the crude for MDC by gravity separation such as heavy media at a relatively coarse size.
PART IV
MICROSCOPY SECTION

AGGLOMERATION:

Agglomeration study has been one of the major projects for the Microscopy Section during the year.

The materials investigated were pellets produced by the shaft furnace method from Bethlehem Steel and the Nalymberget operation, Sweden; by the Allis-Chalmers process (traveling grate and kiln); by the Lurgi process (traveling grate), Germany; by the downdraft traveling grate method from the Reserve Mining Company; and by a laboratory unknown pelletizing technique employed by the Pickands Mather's Laboratory.

A number of briquettes from Klockner-Humboldt-Deutz were also studied. The main purpose was to study the micro-structure of the pellets and briquettes, and their mineralogic and textural transformation during the processes.

DIRECT REDUCTION:

Five products related to direct reduction of the Republic NiC concentrate by the direct reduction fluidizing method at Battelle Memorial Institute were microscopically studied. The purpose was to determine the relationship between quartz and metallic iron, to examine the progression of reduction from the iron ore concentrate to the metallic state, and to study the texture and structure of the products.

NiC-Concentration:

The main project was to study the NiC product samples of the Republic ore produced by The Cleveland-Cliffs Iron Company's Research Pilot Plant, Lurgi kiln process, and the Mines Experiment Station, Minneapolis. The purpose was to determine the degree of reduction, reoxidation and textural changes of the ore and gangue particles in the samples and their effect on magnetic concentration.

REPUBLIC TAILINGS:

This study was to determine the mineralogic characteristic and its effect to flotation concentration. The results revealed that the iron in the samples examined is chiefly in the form of specular hematite occurring as specular hematite-chert, specular hematite, and fine inclusions in chert.

The statistic study showed that the efficiency of flotation selectivity reduces with the decrease of particle size.
EAGLE MILLS FILTER CAKE SAMPLES:

The purpose of this study was an attempt to determine whether there are relationships between the mineral composition and particle texture of the filter cake samples and the rate of production at the plant. It was suggested that the ratio between water-repellent and water-wettable particles might be related to the production rate. The samples with higher percentages of water-repellent particles usually give rise to lower production rates.

OGDEN SCHOOLHOUSE PROJECT:

The study of a few core specimens from D.D. Hole No. 1, Section 13, Ogden Schoolhouse, revealed that the core specimens are a magnetite-bearing cherty carbonate resembling most of the Empire magnetite-bearing rocks. However, the average grain size of magnetite is much finer than that from the Empire Area.

PROJECT 17, ALBANEL LAKE AREA:

This project covers the microscopic investigation of both the iron formation and the titaniferous magnetite-bearing rocks. The investigation was to study the concentrating characteristics of the iron formation rocks and to determine the relationships between the magnetite and the titanium-bearing minerals.

LAND OFFERS & OUTSIDE EXPLORATIONS:

During the year, specimens and samples from six land offers and three outside explorations were examined. The objectives were to study the composition, texture, and association of minerals in the samples and specimens and their effects on ore beneficiation.
FLUOSOLIDS REACTOR PILOT PLANT

MOC pilot plant testing throughout this year had three objectives: (1) to so alter and change the reactor that the calcine produced would yield a high grade magnetic concentrate containing under 3% silica from amenable concentrates and crudes; (2) to test various materials in the reactor, and (3) to produce sufficient calcine to meet the requirements of concentration and pelletizing research.

During the year some 1,800 tons of miscellaneous ore materials were processed as part of this research effort and sampling shifts account for about 41% of the gross shifts in the year. This figure (41%) makes no allowance for planned shut-downs or operating shifts during which no samples were taken, but does allow 14 days out of the year for legal holidays plus vacation time.

Major changes made in the reactor this year were: (1) replacement of the two main fluoseals by gravity flow, plug-valve controlled transfers. These control valves are operated by positioners tied in with instruments measuring bed depths and have operated satisfactorily; and while it is likely that fluoseal transfers would perform satisfactorily on a larger unit, they were not dependable nor positive in their action on this small pilot plant unit; (2) installation of a secondary cyclone dust collector and of a wet scrubber to reclaim as much solids as possible from the stack gas and at the same time minimize the nuisance value of the plant effluent; (3) installation of an internal cyclone and baffle in the reduction compartment to minimize short circuiting of the fine particles and prevent their leaving the chamber before being completely reduced; (4) relocation of both the fine and the coarse discharge lines leading into the reduction bed from the preheat section as a further means of minimizing short circuiting; (5) replacement of metal tuyeres by ceramic ones to minimize enlargement of the tuyere holes by sand blasting, successful except for the fact that the tuyeres kept cracking off, forcing a return to the original metal ones; and (6) the application of "upflow operation" to the treatment of fine concentrates at a potential capacity approaching that attainable with crude ore.

In all, twelve test periods were designated during the year, seven of these being ones treating Republic or Humboldt crude ore while the balance treated rougher flotation concentrates from Republic and Humboldt. It was not until rougher concentrates were treated that calcines were obtained which would magnetically concentrate
to less than 2% silica. Testing of various Republic rougher and cleaner concentrates have yielded calcines which can be ground and concentrated magnetically to recover 95% of the iron present in a product analyzing 69-70% iron, 1.00-3.00% silica. Reactor results indicate that it may be possible to make a calcine from which as much as 97% of the iron can be recovered. Material progress has been made in capturing the dust from the plant and either returning it hot to the MOC bed or collecting it for return with new feed. Dust losses from the plant have been reduced from about 10% or more of the feed weight to a low of 3% on the average. Installation of an internal cyclone and baffle was made after the plant started to treat rougher concentrates and served to improve the degree of reduction and hence the iron recovery. Material is on hand crushed to minus 1/8" so that tests can be made, if desired, of both Republic and Tilden crudes now that the reactor is operating in a much more successful fashion than was the case at the beginning of this year.
PART VI
CHECK SAMPLING PROGRAM

A visit was made in October, 1957 to the McLouth Steel Corporation's plant in Trenton, Michigan at the request of the Ore Sales Department. The purpose of the visit was to obtain general information on McLouth's ore requirements as related to Cliffs Group Ores. Ore samples were collected from mine pocket and stockpile shipments during the 1957 Season for general sampling correlation data, structure and concentration tests.

A number of samples were collected during the season from the Ore Improvement Plant for testing at the Research Laboratory.

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