CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 61-85

# PILOT PLANT INVESTIGATION OF IRON ORE SAMPLE "F" FROM KUKATUSH MINING CORPORATION, 1960, LTD., KUKATUSH, ONTARIO

by

P. D. R. MALTBY & L. L. SIROIS

MINERAL PROCESSING DIVISION

NOTE: THIS REPORT RELATES ESSENTIALLY TO THE SAMPLES AS RECEIVED. THE REPORT AND ANY CORRESPONDENCE CONNECTED THEREWITH SHALL NOT BE USED IN FULL OR IN PART AS PUBLICITY OR ADVERTISING MATTER.



COPY NO. 7

AUGUST 4, 1961

Industrial Confidential

Mines Branch Investigation Report IR 61-85

# PILOT PLANT INVESTIGATION OF IRON ORE SAMPLE "F" FROM KUKATUSH MINING CORPORATION, 1960, LTD., KUKATUSH, ONTARIO

by

P. D. R. Maltby* and L. L. Sirois*

## SUMMARY OF RESULTS

Preliminary cobbing tests on the crude feed showed that the best overall results were obtained at 10 or 20 M. In a series of pilot plant tests a concentrate was produced assaying 54.55% Fe and containing 65.8% of the iron in the original head sample. This concentrate was 62.3% minus 325 M and acceptable feed for the Strategic-Udy direct reduction process. Silica content was 17.8% and the ratio of concentration 3.10:1.

In tests where the first stage concentrate was reground and recleaned, a final concentrate of 62.2% Fe containing 48.4% of the iron in the original head sample was produced. This concentrate was 95.5% minus 325 M, and contained 10.40% silica. Filter cake moisture was 14.7% and the final ratio of concentration 5.05:1.

In the laboratory tests the highest grade concentrate made was 64.39% Fe at 98.2% minus 325 M. Flotation tests were made for silica removal but are inconclusive at present, and did not produce a grade higher than 63.7% Fe.

*Scientific Officers, Mineral Processing Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

CONTENTS

TABLES

Page

## INTRODUCTION

The purposes of the investigation were: (1) to discover if premium grade iron ore pellets could be produced from the sample; (2) to determine the recovery of iron that could be made in the production of acceptable feed for the Strategic-Udy direct reduction process.

### Shipment

A carload of 67 tons was received from Kukatush, Ontario, at the Mines Branch on June 10, 1961, shipped by Mr. Gerson of Kukatush Mining Corporation, 1960, Ltd. The material received consisted of rock in all sizes from 12 in. diameter to 100 M, taken from the Company's property at Kukatush, near Capreol, Ontario. The sample was said to be representative of the 'F' orebody.

### Sample Analysis

All analyses in connection with this investigation were done by the Analytical Chemistry Subdivision, Mineral Sciences Division, Mines Branch, Ottawa. Credit is given to Mr. D. J. Charette of the Subdivision for devising the method used for soluble iron analysis which presented special problems due to the unusual gangue minerals.

## Outline of Investigation

The methods for investigating the beneficiation of the sample were decided on with Mr. T. B. Counselman of Behre, Dolbear and Company, New York, consultants to Kukatush Mining Corporation. Mr. Counselman was present at the Mines Branch during most of the pilot plant tests.

Preliminary cobbing tests were done at sizes from 3/4 in. to 20 M to determine the optimum size for tailing rejection. The results from these tests showed that the ore could be cobbed best at 10 or 20 M, and cobbing at these sizes was done in subsequent tests. All tests were performed using the Mines Branch Pilot Mill.

Tests 1 and 2 used the standard flowsheet for taconites to discover the grade and recovery of iron at a grind of approximately 80% minus 325 M. Test 1 used a cyclone in closed circuit with the ball mill, while Test 2 used open circuit grinding.

Tests 3, 4 and 5 were done to determine the degree of grinding necessary to produce a better than 51% iron concentrate at maximum recovery. This minimum grade was specified for Strategic-Udy feed. In these tests the grinding was done in open circuit, the only variable being the quantity of balls used in the ball mill.

In Test 6 the concentrate produced from the first two tests was reground and retreated in an effort to produce a concentrate of approximately 65% iron, suitable for making premium grade iron pellets.

Tests 7 and 8 were similar to Tests 3, 4 and 5 except that a coarser grind was obtained by increasing the feed size to the rod mill to ½ in. and decreasing the amount of balls in the ball mill. The ball load was altered for each test. Acceptable concentrates were produced for the Strategic-Udy process.

In Tests 9, 10 and 11, the crude ore was treated using a standard flowsheet with the ball mill in closed circuit with a cyclone. The object was to produce a concentrate assaying about 57% iron which could be later upgraded to pelletizing grade by retreatment. These tests were run until all of the original carload of ore was used up.

In Tests 12, 13 and 14, previous concentrate was upgraded by various means in order to get final information on maximum Fe grade, grind and Fe recovery. Laboratory tests were also done in an effort to improve grade, main attention being given to upgrading samples of concentrate by silica flotation using cationic collectors.

# MINERALOGY*

## Results of Investigation

The iron ore samples consist of magnetite-rich and chert-rich layers (see Figure 1). In order to determine the composition of this ore two magnetite-rich layers and three chert-rich layers were studied in detail. One of the magnetite-rich layers consists of magnetite in a chert-minnesotaite matrix and the other consists of magnetite in a chert-stilpnomelane matrix. The magnetite grains present in each layer range between 5 microns and 50 microns in diameter and are disseminated in the matrix (see Figure 2). These grains coalesce into larger masses in a few richer sections (see Figure 3). The chert-minnesotaite matrix is composed of chert, minnesotaite, and lesser quantities of dolomite and siderite. The minnesotaite occurs as very fine blades in the chert. The chert-stilpnomelane matrix is composed of chert, stilpnomelane, and also contains quantities of dolomite and siderite.

The three chert layers studied differ from each other and are described as chert-minnesotaite, chert-stilpnomelane, and chert-sericite-chlorite. The chert-minnesotaite layer consists of chert, minnesotaite, and small amounts of magnetite, siderite, and dolomite. The

*From Internal Report MS-61-66 of the Mineralogy Section, Mineral Sciences Division, by W. Petruk.

minnesotaite occurs as very fine blades in the chert and these form radial patterns (see Figure 4). The magnetite, siderite, and dolomite occur as isolated grains in the chert-sericite matrix and constitute less than 5% of this layer of the ore.

The chert-stilpnomelane layer consists of chert, stilpnomelane and magnetite. The chert occurs as nodules surrounded by stilpnomelane, and as interstitual material between stilpnomelane and magnetite. The magnetite grains range between 5 and 50 microns in diameter and are disseminated in the chert and stilpnomelane (see Figures 5 and 6).

The chert-sericite-chlorite layer consists of chert, sericite, chlorite, and small amounts of magnetite and calcite. Some of the sericite occurs as tiny blades in the chert and these form a radial pattern. Most of it however, has no definite orientation and is finely intergrown with the chlorite. The magnetite and calcite occur as isolated grains and constitute less than 5% of this layer.

The mineral content of each of the above layers was determined by means of the X-ray diffractometer and the results are tabulated in Table 1.

TABLE 1

Mineral Content of the Magnetite-Rich and Chert-Rich Layers in the Iron Ore

| Mineral | Magnetite-rich layers | | Chert-rich layers | | |
|---|---|---|---|---|---|
| | chert-stilpnomelane matrix | chert-minnesotaite matrix | chert-minnesotaite layer | chert-stilpnomelane layer | chert-sericite-chlorite layer |
| Magnetite | 60 | 50 | 2 | 20 | 4 |
| Chert | 10 | 4 | 65 | 65 | 30 |
| Minnesotaite | -- | 38 | 30 | -- | -- |
| Stilpnomelane | 26 | -- | -- | 13 | -- |
| Chlorite | -- | -- | -- | -- | 45 |
| Siderite | 3 | 3 | 1 | 2 | -- |
| Dolomite | 1 | 5 | 2 | -- | -- |
| Calcite | -- | -- | -- | -- | 1 |
| Sericite | -- | -- | -- | -- | 20 |
| Total | 100 | 100 | 100 | 100 | 100 |

## Discussion

During the course of mineral processing it was found that the tailings contain 11.45% Fe in Test No. 1, and 11.90% Fe in Test No. 2. These tailings were analyzed by X-ray diffraction and it was found that the sample of Test No. 1 consists of chert, siderite, and stilpnomelane, and the sample of Test No. 2 consists of chert, stilpnomelane, chlorite, and a trace of magnetite. It is concluded from this that most of the iron in the tailings is chemically combined in the gangue minerals.

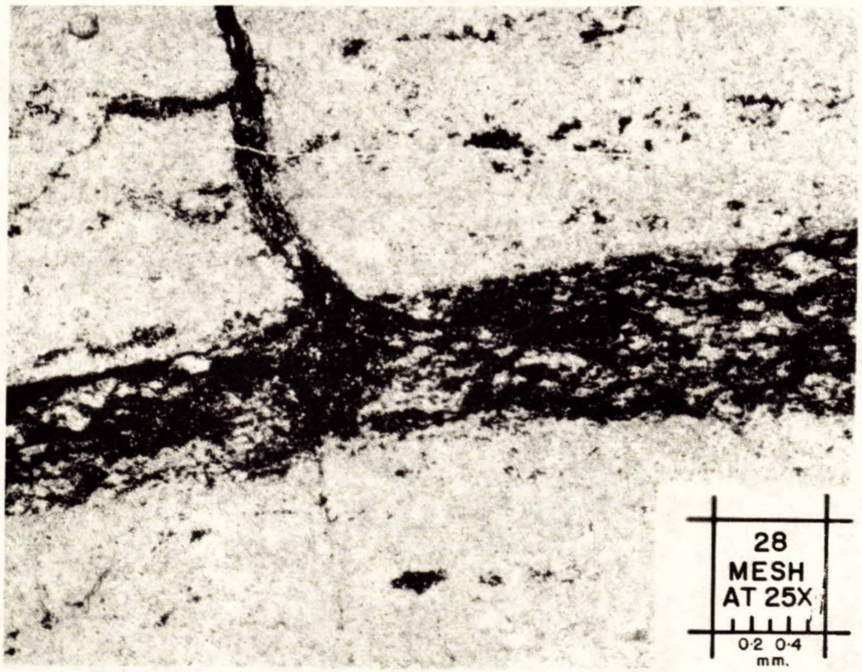


Figure 1. - Photomicrograph of a thin section in ordinary light, showing one magnetite-rich layer (black) and two chert-rich layers (grey).

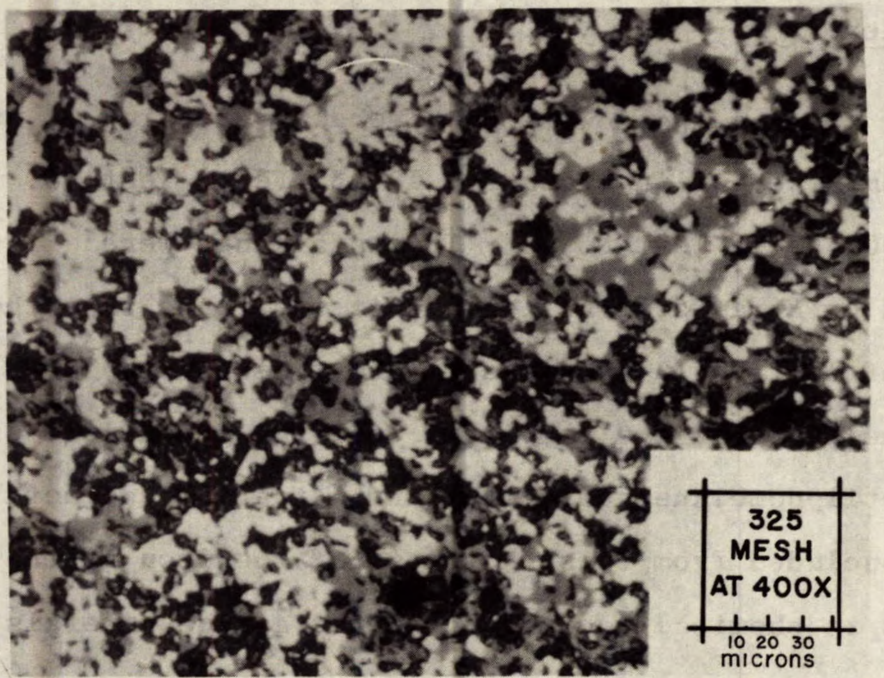


Figure 2. - Photomicrograph of a polished section of the magnetite-rich layer showing magnetite grains (white) disseminated in gangue. The grey gangue is chert and the dark grey gangue material with an uneven surface is stilpnomelane.

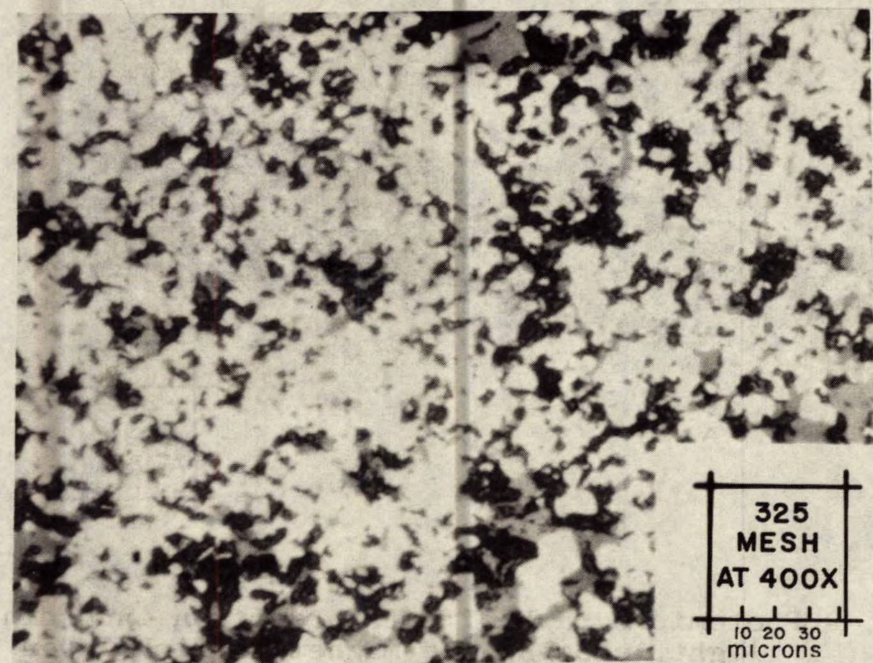


Figure 3. - Photomicrograph of a polished section showing an area where the magnetite grains (white) have coalesced into larger masses.

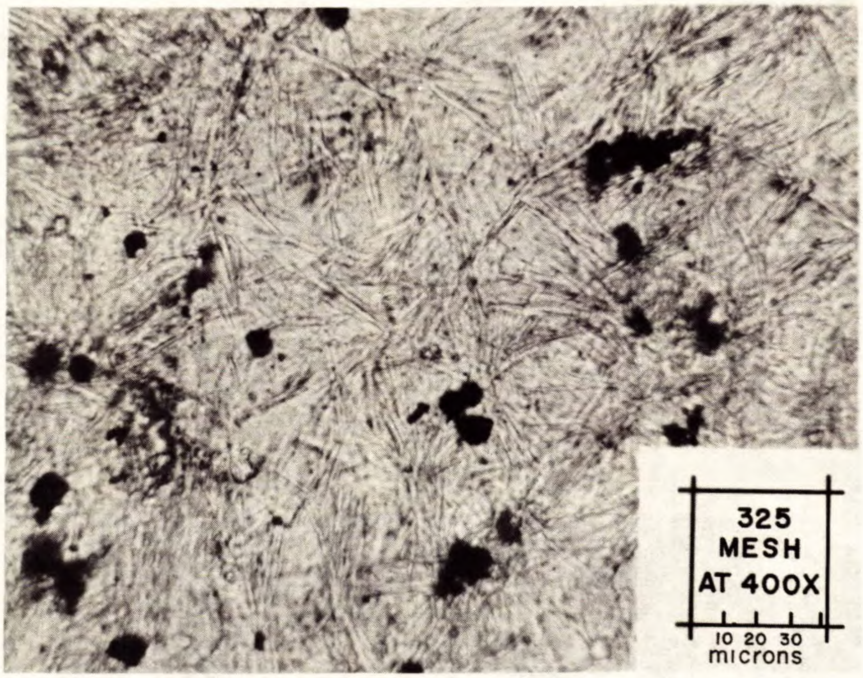


Figure 4. - Photomicrograph of a thin section in ordinary light showing minnesotaite blades in chert. The black spots are magnetite.

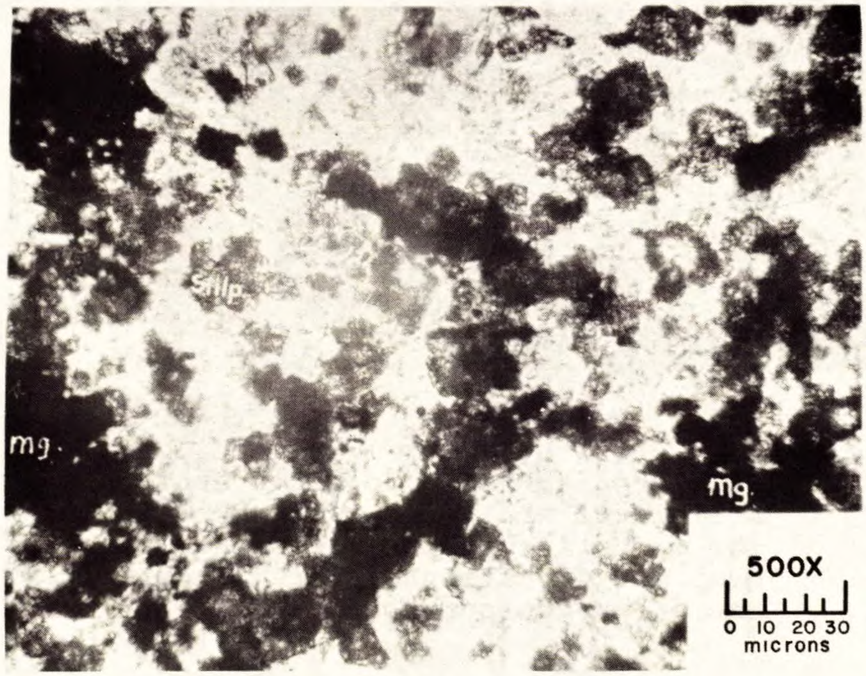


Figure 5. - Photomicrograph of a thin section in ordinary light showing a field of the chert-stilpnomelane layer. The white areas are chert. The stilpnomelane and magnetite are indicated.

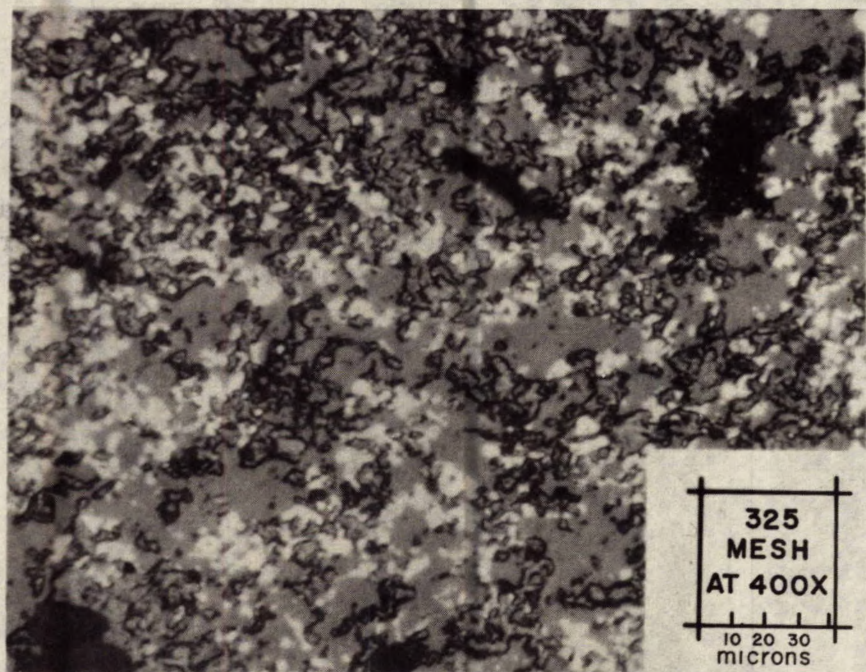


Figure 6. - Photomicrograph of a polished section showing a field of the chert-stilpnomelane layer. The magnetite grains are white, the chert is grey and the stilpnomelane is dark grey and has an uneven surface.

# TEST PROCEDURE AND RESULTS

## Cobbing Tests

### Preliminary Cobbing

Preliminary tests were done on June 15, 1961, on three sizes of crushed ore using the dry belt magnetic head pulley. The separator was run at maximum amperage of approximately 17 amp, the only variable on the separator being the distance of the splitter plate from the head pulley. Three series of tests were run on ore crushed to 3/4 in., 1/2 in., and 3/8 in. In each series the splitter was set at openings of 2 in., 1 3/4 in., and 1 in. Concentrate and tailing products were all weighed, analyzed and screened. Davis tube tests were done for magnetic iron.

The results of cobbing crushed ore at 3/4 in. are shown in Tables 2 and 3. Approximately 250 lb of ore was used for each cobbing test.

TABLE 2

Results of Cobbing at 3/4 in.

| Plate Opening | Product | Weight, % | Analysis, % | | Distn, % | |
|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| 2 in. | Conc | 78.8 | 28.6 | 22.0 | 90.6 | 99.2 |
| | Tail | 21.2 | 11.1 | 0.68 | 9.4 | 0.8 |
| | Feed* | 100.0 | 24.9 | 17.5 | 100.0 | 100.0 |
| 1 3/4 in. | Conc | 72.2 | 29.0 | 21.3 | 87.3 | 97.9 |
| | Tail | 27.8 | 11.0 | 1.18 | 12.7 | 2.1 |
| | Feed* | 100.0 | 24.0 | 15.7 | 100.0 | 100.0 |
| 1 in. | Conc | 55.5 | 33.7 | 25.4 | 76.9 | 93.4 |
| | Tail | 44.5 | 12.4 | 2.23 | 23.1 | 6.6 |
| | Feed* | 100.0 | 24.3 | 15.1 | 100.0 | 100.0 |

*calculated

TABLE 3

Screen Tests on 3/4 in. Cobbing Products

| Mesh | 2 in. opening | | 1 3/4 in. opening | | 1 in. opening | |
|---|---|---|---|---|---|---|
| | Conc | Tail | Conc | Tail | Conc | Tail |
| +5/8 in. | 1.5 | 2.4 | 1.8 | 2.2 | 2.6 | 3.6 |
| +1/2 in. | 17.7 | 21.8 | 10.8 | 1.6 | 11.9 | 14.0 |
| +3/8 in. | 31.6 | 48.1 | 31.8 | 44.6 | 38.6 | 39.6 |
| +3 M | 18.1 | 14.5 | 13.4 | 20.7 | 13.6 | 13.2 |
| +4 | 9.6 | 6.2 | 10.1 | 11.7 | 8.0 | 8.7 |
| +6 | 6.9 | 3.4 | 7.6 | 8.4 | 7.1 | 6.4 |
| +8 | 2.6 | 1.0 | 4.1 | 3.6 | 2.8 | 3.9 |
| +10 | 2.5 | 0.6 | 3.7 | 2.7 | 2.6 | 2.8 |
| +14 | 1.9 | 0.4 | 3.2 | 1.5 | 2.2 | 2.2 |
| +20 | 1.6 | 0.2 | 2.7 | 0.8 | 1.9 | 1.7 |
| +28 | 1.0 | 0.2 | 1.9 | 0.4 | 1.4 | 1.1 |
| +35 | 1.0 | 0.1 | 1.6 | 0.3 | 1.2 | 0.7 |
| -35 | 4.0 | 0.9 | 7.3 | 1.5 | 6.3 | 2.1 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Cobbing tests were next done on ore crushed to 1/2 in. The results are shown in Tables 4 and 5.

TABLE 4

Results of Cobbing at 1/2 in.

| Plate Opening | Product | Weight, % | Analysis, % | | Distn, % | |
|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| 2 in. | Conc | 79.5 | 29.3 | 20.7 | 90.5 | 98.7 |
| | Tail | 20.5 | 11.9 | 1.02 | 9.5 | 1.3 |
| | Feed* | 100.0 | 25.7 | 16.7 | 100.0 | 100.0 |
| 1 3/4 in. | Conc | 73.8 | 29.3 | 21.8 | 87.2 | 97.6 |
| | Tail | 26.2 | 12.1 | 1.50 | 12.8 | 2.4 |
| | Feed* | 100.0 | 24.8 | 16.5 | 100.0 | 100.0 |
| 2 in. | Conc | 57.8 | 33.1 | 24.7 | 77.6 | 89.0 |
| | Tail | 42.2 | 13.1 | 4.2 | 22.4 | 11.0 |
| | Feed* | 100.0 | 24.7 | 16.1 | 100.0 | 100.0 |

*calculated

TABLE 5

Screen Tests on 1/2 in. Cobbing Products

| Mesh | 2 in. opening | | 1 3/4 in. opening | | 1 in. opening | |
|---|---|---|---|---|---|---|
| | Conc | Tail | Conc | Tail | Conc | Tail |
| +3/8 in. | 30.9 | 49.9 | 24.2 | 35.7 | 19.0 | 25.4 |
| + 3 M | 18.9 | 24.3 | 21.2 | 27.4 | 23.3 | 27.8 |
| + 4 | 12.2 | 11.8 | 11.9 | 13.9 | 13.9 | 14.8 |
| + 6 | 10.6 | 8.1 | 10.6 | 11.7 | 10.1 | 12.7 |
| + 8 | 4.6 | 2.0 | 4.9 | 3.6 | 5.6 | 4.9 |
| +10 | 3.9 | 1.3 | 4.2 | 2.6 | 4.5 | 3.8 |
| +14 | 3.4 | 0.7 | 4.0 | 1.7 | 3.9 | 3.2 |
| +20 | 3.0 | 0.5 | 3.7 | 1.0 | 3.6 | 2.3 |
| +28 | 2.1 | 0.3 | 2.8 | 0.5 | 2.7 | 1.3 |
| +35 | 1.7 | 0.2 | 2.4 | 0.4 | 2.4 | 0.8 |
| -35 | 8.7 | 0.9 | 10.1 | 1.5 | 11.0 | 3.0 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Cobbing tests were finally run using the magnetic head pulley on ore crushed to 3/8 in. The results of these tests are shown in Tables 6 and 7.

TABLE 6

Results of Cobbing at 3/8 in.

| Plate Opening | Product | Weight, % | Analysis, % | | Distn, % | |
|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| 2 in. | Conc | 82.7 | 28.3 | 18.9 | 91.8 | 98.7 |
| | Tail | 17.3 | 12.1 | 1.14 | 8.2 | 1.3 |
| | Feed* | 100.0 | 25.5 | 15.8 | 100.0 | 100.0 |
| 1 3/4 in. | Conc | 77.2 | 30.5 | 22.0 | 90.3 | 99.4 |
| | Tail | 22.8 | 11.1 | 0.47 | 9.7 | 0.6 |
| | Feed* | 100.0 | 26.1 | 17.1 | 100.0 | 100.0 |
| 1 in. | Conc | 63.1 | 34.2 | 25.4 | 82.5 | 97.9 |
| | Tail | 36.9 | 12.4 | 0.91 | 17.5 | 2.1 |
| | Feed* | 100.0 | 26.2 | 16.4 | 100.0 | 100.0 |

*calculated

TABLE 7

Screen Tests on 3/8 in. Cobbing Products

| Mesh | 2 in. opening | | | | 1 3/4 in. opening | | 1 in. opening | |
|---|---|---|---|---|---|---|---|---|
| | Conc | % Fe | Tail | % Fe | Conc | Tail | Conc | Tail |
| + 3 | 28.9 | 30.4 | 54.0 | 11.3 | 23.2 | 43.8 | 28.4 | 40.5 |
| + 4 | 15.2 | 30.0 | 20.2 | 11.6 | 16.9 | 20.7 | 14.3 | 16.6 |
| + 6 | 14.7 | 29.5 | 12.9 | 12.0 | 12.2 | 17.2 | 11.9 | 14.3 |
| + 8 | 6.8 | 27.3 | 4.5 | 11.4 | 9.2 | 6.6 | 5.4 | 7.4 |
| +10 | 5.8 | 27.1 | 2.9 | 12.3 | 6.9 | 4.2 | 5.0 | 5.9 |
| +14 | 5.0 | 26.5 | 1.4 | 12.6 | 5.8 | 2.5 | 5.0 | 4.4 |
| +20 | 4.5 | 25.8 | 1.0 | 12.3 | 5.1 | 1.4 | 4.9 | 3.3 |
| +28 | 3.2 | 25.2 | 0.5 | 13.2 | 3.8 | 0.7 | 4.0 | 1.8 |
| +35 | 2.6 | 24.6 | 0.4 | 14.0 | 3.0 | 0.5 | 3.5 | 1.2 |
| -35 | 13.3 | 23.0 | 2.2 | 18.8 | 13.9 | 2.4 | 17.6 | 4.6 |
| Total | 100.0 | 28.11 | 100.0 | 11.7 | 100.0 | 100.0 | 100.0 | 100.0 |

From the 1/2 in. cobbing at 1 in. opening, 1000 g of cobbed concentrate was taken and pulverized to 20 M. The sample was treated by a Crockett wet belt separator.

The concentrate was ground for 40 min and treated on a Jeffrey-Steffensen separator followed by cleaning on a Wade hydroseparator. The Jeffrey-Steffensen separator magnetic intensities were: No. 1 drum 2.2 amp (max), No. 2 drum 1.5 amp, No. 3 drum 0.7 amp. An upflow of 40 ft/hr was used on the hydroseparator.

The complete results of this test, including the 1/2 in. cobbing, are shown in Table 8. A screen test on the Jeffrey concentrate showed 91.2% minus 325 M with 2.2% plus 200 M.

TABLE 8

Results of Cobbing and Jeffrey-Steffensen Test from 1/2 in. Feed

| Product | Weight, % | Analysis, % | | Distn, % | |
|---|---|---|---|---|---|
| | Crude Feed | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| Crude ore* | 100.0 | 24.7 | 16.1 | 100.0 | 100.0 |
| Cobber conc | 57.8 | 33.1 | 24.7 | 77.6 | 89.0 |
| Cobber tail | 42.2 | 13.1 | 4.2 | 22.4 | 11.0 |
| Crockett conc | 38.4 | 42.8 | 36.2 | 67.0 | 86.7 |
| Crockett tail | 19.4 | 13.53 | 1.9 | 10.6 | 2.3 |
| Jeffrey conc* | 15.1 | 60.8 | 60.0 | 37.3 | 56.6 |
| Jeffrey midd | 7.7 | 50.0** | 48.5** | 15.6 | 23.2 |
| Jeffrey tail | 15.6 | 22.31 | 7.2 | 14.1 | 6.9 |
| Wade spigot | 14.9 | 61.07 | 60.5 | 37.0 | 56.3 |
| Wade o'flow | 0.2 | 56.8 | -- | 0.3 | 0.3 |

*calculated **adjusted assays

Ratio of concentration = 6.70:1

Cobbing at 10 and 20 M

Two laboratory tests were run on crude ore, 2500 g being taken in each case. In the first test the rock was crushed to 10 M and treated on a Crockett separator. The results are shown in Table 9.

TABLE 9

Results of Cobbing at 10 M

| Product | Weight, % | Analysis, % | | Distn, % | |
|---|---|---|---|---|---|
| | | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| Crockett conc | 50.6 | 39.8 | 32.9 | 77.6 | 96.0 |
| Crockett tail | 49.4 | 11.8 | 1.4 | 22.4 | 4.0 |
| Feed* | 100.0 | 26.0 | 17.3 | 100.0 | 100.0 |

*calculated

In the second test the rock was crushed to 20 M and treated on the Crockett separator. The concentrate was then ground for 20 min and treated on the Jeffrey-Steffensen separator using the same settings as before. Results are shown in Table 10.

TABLE 10

Results of Cobbing at 20 M Followed by Regrinding

| Product | Weight, % | Analysis, % | | Distn, % | |
|---|---|---|---|---|---|
| | | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| Crockett conc | 50.1 | 41.0 | 35.6 | 78.0 | 97.3 |
| Crockett tail | 49.9 | 11.6 | 1.00 | 22.0 | 2.7 |
| Jeffrey midd | 8.2 | 45.0 | 43.3 | 14.0 | 19.4 |
| Jeffrey tail | 18.2 | 18.6 | 5.2 | 12.9 | 5.2 |
| Wade o'flow | 0.2 | 25.6 | -- | 0.2 | -- |
| Wade spigot | 23.5 | 57.0 | 56.7 | 50.9 | 72.7 |
| Feed* | 100.0 | 26.3 | 18.3 | 100.0 | 100.0 |

*calculated

Ratio of concentration = 4.26:1

The silica content of the Wade spigot = 14.5%.

The Crockett concentrate was 14.5% plus 14 M with 10% minus 200 M. The final concentrate after regrinding (Wade spigot) was 0.8% plus 65 M and 77.8% minus 325 M.

## Pilot Plant Tests

### Tests 1 and 2

From the preliminary test results it was apparent that an extremely fine grind was required to produce a concentrate containing over 62% Fe. It was therefore decided to start the first pilot plant tests with the object of producing a concentrate assaying about 55% Fe at a grind of 80% minus 325 M. The flowsheet used is shown in Fig. 7. Both tests were identical with two exceptions. First, the ball mill in Test 1 was operated in closed circuit with a cyclone, whereas in Test 2 an open circuit grind was used without a cyclone. Second, another Denver cone was added in Test 2 to obtain additional washing for slime removal.

The ore was crushed to 3/8 in. and fed at 2 ton/hr to the rod mill. The discharge was fed to a 20 M Sweco screen by bucket elevator and the screen undersize was cobbed on one drum of the 2 drum Dings separator. Screen oversize was returned to the rod mill. The cobbed concentrate was reground in the ball mill and, after two more stages of magnetic separation and various desliming stages, a filter cake was made containing about 56% Fe. Test 1 was run for 5½ hr and Test 2 for 4½ hr. Magnetic separator intensities were set at 500 gauss. The rate of upflow on the Siphon Sizer was kept at 14 ft/hr. The results of Tests 1 and 2 are shown in Tables 11 and 12.

A Jeffrey-Steffensen separator test, followed by cleaning the concentrate produced with a Wade hydroseparator, was done on the filter cake from Test 1, and the results are shown in Table 11. A sample of 1620 g was taken. An upflow of 40 ft/hr was kept on the hydroseparator. Amperage settings on the Jeffrey-Steffensen separator were: No. 1 drum 2.2 amp, No. 2 drum 1.0 amp, and No. 3 drum 0.7 amp. In test 2 the Siphon Sizer spigot produced was passed over the Wilfley table and the products were sampled and assayed before being recombined. The results of this test are included in Table 12.

TABLE 11

Balanced Results of Test 1

| Product | Weight, % | Solids, % | Analysis, % Sol Fe | Analysis, % Mag Fe | Distn, % Sol Fe | Distn, % Mag Fe |
|---|---|---|---|---|---|---|
| R.M. discharge | | 67.2 | 25.86 | 17.05 | | |
| 20 M Screen u'size | 100.0 | | 25.64 | | 100.0 | 100.0 |
| Dings R conc | 48.6 | 42.0 | 40.62 | | 75.8 | |
| Dings R tail | 51.4 | 30.7 | 11.45 | 0.1 | 24.2 | 0.3 |
| Dorr class o'flow | 2.1 | | 13.25 | 0.2 | 2.3 | 0.1 |
| B.M. discharge | 99.3 | 75.0 | 47.41 | | 184.0 | |
| Dings Cl conc | 91.2 | 46.8 | 49.74 | | 178.2 | |
| Dings Cl tail | 8.1 | 0.4 | 20.92 | 6.3 | 5.8 | 3.0 |
| Denver cone o'flow | 8.7 | 0.2 | 15.00 | 11.3* | 4.9 | 5.6 |
| Denver cone spigot | 82.5 | 52.8 | 53.52 | | 173.3 | |
| Coll cone o'flow | 0.3 | | 14.0 | | 0.1 | |
| Coll cone spigot | 82.2 | 32.7 | 54.0 | | 173.2 | |
| Cyclone o'flow | 29.4 | 20.6 | 54.34 | | 62.7 | |
| Cyclone spigot | 52.8 | 60.8 | 52.09 | | 110.4 | |
| No. 2 drum Dings conc | 27.7 | | 56.23 | | 61.3 | |
| No. 2 drum Dings tail | 1.7 | 0.1 | 21.45 | 20.0* | 1.4 | 2.0 |
| Siphon Sizer o'flow | 4.9 | 3.9 | 50.62 | 46.6 | 9.6 | 13.4 |
| Siphon Sizer spigot | 22.8 | 29.0 | 56.77 | 56.4* | 51.7 | 75.6 |
| Filter cone o'flow | 0.2 | | 20.0 | | 0.2 | 0.1 |
| Filter cone spigot | 22.6 | 52.0 | 57.73 | | 51.5 | 75.5 |
| Filter cake | | 14.2% Moisture | 58.06 | | | |
| *adjusted assays<br>Ratio of concentration = 4.43:1 | | | | | | |
| Jeffrey midd | 3.2 | | 52.43 | 50.6 | 6.3 | 9.4 |
| Jeffrey tail | 1.0 | | 30.22 | 11.35 | 1.2 | 0.6 |
| Wade o'flow | 0.1 | | 37.37 | -- | 0.2 | -- |
| Wade spigot | 18.3 | | 61.74 | 61.74 | 43.8 | 65.5 |
| Final ratio of concentration = 5.46:1 | | | | | | |

TABLE 12

Balanced Results of Test 2

| Product | Weight, % | Solids, % | Analysis, % | | Distn, % | |
|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| R.M. discharge | | 65.2 | 27.01) 25.56 | | | |
| 20 M Screen u'size | 100.0 | | 24.12) | 17.80 | 100.0 | 100.0 |
| Dings R conc | 42.0 | | 44.16 | | 72.8 | |
| Dings R tail | 58.0 | | 11.90 | | 27.2 | |
| Dorr class o'flow | 1.8 | | 13.99 | | 1.0 | |
| B.M. discharge | 40.2 | 72.0 | 45.66 | | 71.8 | |
| No. 1 Denver cone o'flow | 5.6 | | 31.40 | 20.45 | 6.8 | 6.2 |
| No. 1 Denver cone spigot | 34.6 | | 48.16 | | 65.0 | |
| Dings Cl conc | 26.3 | | 55.36 | | 56.7 | |
| Dings Cl tail | 8.3 | | 25.50 | 13.20 | 8.3 | 6.1 |
| No. 2 Denver cone o'flow | 0.4 | | 17.93 | | 0.3 | |
| No. 2 Denver cone spigot | 25.9 | | 55.81 | | 56.4 | |
| Coll cone o'flow | 0.2 | | 29.83 | | 0.2 | |
| Coll cone spigot | 25.7 | | 55.91 | | 56.2 | |
| No. 2 drum Dings conc | 25.3 | | 56.40 | | 55.8 | |
| No. 2 drum Dings tail | 0.4 | | 23.73 | | 10.4 | |
| Siphon Sizer o'flow | -- | | 17.75 | | -- | |
| Siphon Sizer spigot | 25.3 | | 56.41 | 55.1 | 55.8 | 78.1 |
| Filter cone o'flow | | | 18.64 | | | |
| Filter cake | | | 56.50 | | | |
| Ratio of concentration = 3.96:1 | | | | | | |
| Table conc | 24.0 | | 56.76 | 56.4 | 53.3 | 74.8 |
| Table midd | 0.5 | | 53.43 | 51.8 | 1.0 | 1.5 |
| Table tail | 0.8 | | 45.46 | 41.8 | 1.5 | 1.8 |

TABLE 13

Results of Screen Tests in Test 1

| Mesh | Cyclone o'flow Weight, % | Siphon Sizer o'flow Weight, % | Filter Cake Weight, % |
|---|---|---|---|
| +200 | 0.5 | 0.4 | 0.8 |
| +325 | 9.2 | 6.4 | 6.8 |
| -325 | 90.3 | 93.2 | 92.4 |
| Total | 100.0 | 100.0 | 100.0 |

Three Jeffrey-Steffensen tests combined with the Wade hydroseparator were run on the filter cake sample of Test 2. Before treatment, 1600 g were taken each time and ground for 10, 20 and 30 min. The results are shown in Table 14.

Jeffrey-Steffensen settings were: No. 1 drum 2.2 amp, No. 2 drum 1.0 amp, and No. 3 drum 0.7 amp. Upflow rate on the Wade hydroseparator was 40 ft/hr.

TABLE 14

## Regrinding and Retreatment of Filter Cake

| Grind | Mesh Size | Product | Weight, % Crude Feed | Analysis, % Sol Fe | Distn, % Sol Fe | Crude Feed Distn, % Sol Fe |
|---|---|---|---|---|---|---|
| | % minus 325 M | Jeff midd | 2.4 | 50.44 | 9.5 | 5.3 |
| 10 min | 95.2 | Jeff tail | 1.6 | 28.89 | 6.2 | 3.5 |
| | | Wade o'flow | 0.1 | 46.46 | 0.3 | 0.1 |
| | | Wade spigot | 21.2 | 62.69 | 84.0 | 46.9 |
| | | Feed* | 25.3 | 61.1 | 100.0 | 55.8 |
| | | Jeff midd | 2.4 | 50.29 | 9.6 | 5.4 |
| 20 min | 97.2 | Jeff tail | 2.2 | 26.80 | 8.6 | 4.8 |
| | | Wade o'flow | 0.1 | 44.33 | 0.3 | 0.1 |
| | | Wade spigot | 20.6 | 63.79 | 81.5 | 45.5 |
| | | Feed* | 25.3 | 60.6 | 100.0 | 55.8 |
| | | Jeff midd | 2.5 | 54.90 | 11.0 | 6.1 |
| 30 min | 98.2 | Jeff tail | 2.4 | 30.46 | 9.4 | 5.2 |
| | | Wade o'flow | 0.1 | 51.14 | 0.4 | 0.3 |
| | | Wade spigot | 20.3 | 64.39 | 79.2 | 44.2 |
| | | Feed* | 25.3 | 60.2 | 100.0 | 55.8 |

*calculated

Tests 3, 4 and 5

These tests were run using the same flowsheet for each test, the only variable being the weight of balls in the ball mill. The purpose of the test was to produce a suitable concentrate for feed to the Strategic-Udy process, and to determine the effect of the size distribution on the Fe grade and recovery.

Rock at 3/8 in. was fed to the rod mill and the discharge was cobbed at 20 M with one drum of the Dings separator. The ball mill, in open circuit, ground the cobber concentrate, which was then upgraded by additional stages of magnetic separation and washing. The concentrate was filtered and stored in drums. For Test 3, the ball charge in the mill was 2200 lb, for Test 4 500 lb of balls was added, and for Test 5 a further 500 lb of balls was added. Feed rate in all the tests was 2 ton/hr, each test being run approximately 2 hr to allow sufficient time for the circuit to be stabilized after each change before sampling. The results of the tests are shown in Tables 15, 16 and 17.

TABLE 15

Balanced Results for Test 3

| Product | Weight, % | Solids, % | Analysis, % | | | Distn, % Sol Fe |
|---|---|---|---|---|---|---|
| | | | Sol Fe | P | $SiO_2$ | |
| R.M. discharge | 100.0 | 66.7 | 25.3 | | | |
| 20 M Screen u'size | 100.0 | | 25.1 | | | 100.0 |
| Dings R conc | 40.8 | | 44.12 | | | 71.7 |
| Dings R tail | 59.2 | | 12.2 | | | 28.3 |
| Dorr o'flow | 1.7 | | 14.55 | | | 1.0 |
| B.M. feed ) | 39.1 | | 46.0 | | | |
| B.M. discharge) | - - | 73.1 | 45.5 | | 27.52 | 70.7 |
| Dings Cl conc | 26.4 | 8.8 | 55.09 | | 17.8 | 58.0 |
| Dings Cl tail | 12.7 | | 25.2 | | - - | 12.7 |
| Denver cone spigot | 26.2 | | 55.54 | 0.04 | 16.48 | 57.8 |
| Denver cone o'flow | 0.2 | | 19.13 | | | 0.2 |
| Filter cone o'flow | | | 28.37 | | | |
| Ratio of concentration = 3.82:1 | | | | | | |

TABLE 16

Balanced Results for Test 4

| Product | Weight, % | Solids, % | Analysis, % | | Distn, % Sol Fe |
|---|---|---|---|---|---|
| | | | Sol Fe | P | |
| R.M. discharge | 100.0 | 64.1 | 26.0) 25.4 | | |
| 20 M Screen u'size | 100.0 | | 24.8) | | 100.0 |
| Dings R conc | 38.6 | | 44.2 | | 68.8 |
| Dings R tail | 61.4 | | 12.58 | | 31.2 |
| Dorr o'flow | -- | | 14.63 | | -- |
| B.M. feed ) | 38.6 | | 43.2 | | |
| B.M. discharge) | | 74.0 | 43.6 | | 68.8 |
| Dings Cl conc | 27.5 | 49.4 | 53.7 | | 59.5 |
| Dings Cl tail | 11.1 | | 20.88 | | 9.3 |
| Denver cone o'flow | 0.9 | | 18.69 | | 0.7 |
| Denver cone spigot | 26.6 | | 54.7 | 0.051 | 58.8 |
| Filter cone o'flow | | | 23.42 | | |
| Ratio of concentration = 3.76:1 | | | | | |

TABLE 17

Balanced Results for Test 5

| Product | Weight, % | Solids, % | Analysis, % | | | Distn, % | |
|---|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | P | Sol Fe | Mag Fe |
| R.M. discharge | | 65.9 | 25.9 | 17.6 | | | |
| 20 M Screen u'size | 100.0 | | 25.4 | 17.2 | | 100.0 | 100.0 |
| Dings R conc | 48.0 | 38.0 | 40.8 | | | 77.0 | |
| Dings R tail | 52.0 | | 11.2 | 4.0 | | 23.0 | 12.2 |
| Dorr o'flow | 6.1 | | 14.8 | 1.2 | | 3.6 | 0.4 |
| B.M. feed | -- | | 45.2 | | | -- | |
| B.M. discharge | 41.9 | 72.2 | 44.2 | | | 73.4 | |
| Dings Cl conc | 30.7 | | 53.3 | | | 64.2 | |
| Dings Cl tail | 11.2 | | 20.9 | 7.6 | | 9.2 | 4.9 |
| Denver cone o'flow | 1.5 | | 18.5 | 1.4 | | 1.1 | 0.1 |
| Denver cone spigot | 29.2 | | 54.99 | 48.6* | 0.025 | 63.1 | 82.4 |
| Filter cone o'flow | | | 41.25 | | | | |
| Ratio of concentration = 3.42:1 | | | | | | | |

*adjusted assay

The results of screen tests on the products from Test 3, 4 and 5 are shown in Table 18.

TABLE 18

Results of Screen Tests on Tests 3, 4 and 5

| | R.M. Discharge Weight, % | | | Dings Rougher conc Weight, % | | | B.M. Feed Weight, % | | | B.M. Discharge Weight, % | | | Dings Cl conc Weight, % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mesh | Test 3 | Test 4 | Test 5 | Test 3 | Test 4 | Test 5 | Test 3 | Test 4 | Test 5 | Test 3 | Test 4 | Test 5 | Test 3 | Test 4 |
| + 14 | 0.6 | 0.8 | 0.8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| + 20 | 1.2 | 2.6 | 1.8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| + 28 | 3.3 | 4.3 | 4.6 | 2.3 | 2.4 | 2.6 | 2.4 | 2.3 | 3.8 | -- | -- | -- | -- | -- |
| + 35 | 9.0 | 8.8 | 10.4 | 7.2 | 7.4 | 8.4 | 7.3 | 8.6 | 11.8 | -- | -- | -- | -- | -- |
| + 48 | 11.4 | 11.0 | 12.3 | 11.4 | 10.6 | 10.7 | 11.0 | 12.5 | 14.4 | -- | -- | -- | -- | -- |
| + 65 | 12.4 | 12.0 | 12.4 | 13.8 | 12.0 | 11.4 | 13.5 | 14.0 | 14.3 | 1.4 | 2.2 | 1.8 | 1.5 | 2.6 |
| +100 | 11.6 | 10.0 | 10.4 | 12.7 | 11.0 | 10.0 | 13.3 | 13.2 | 11.5 | 2.6 | 3.7 | 3.9 | 3.6 | 4.2 |
| +150 | 7.6 | 6.8 | 7.0 | 9.4 | 8.3 | 7.0 | 10.0 | 9.2 | 7.8 | 5.4 | 5.0 | 5.3 | 6.3 | 6.3 |
| +200 | 6.0 | 5.6 | 5.2 | 7.5 | 7.2 | 7.1 | 7.8 | 7.5 | 6.8 | 7.4 | 7.8 | 7.8 | 8.3 | 8.9 |
| +325 | 5.6 | 5.2 | 5.6 | 7.2 | 8.0 | 7.1 | 7.9 | 7.0 | 6.8 | 11.8 | 12.8 | 12.2 | 13.4 | 13.4 |
| -325 | 31.3 | 32.9 | 29.5 | 28.5 | 33.1 | 35.7 | 26.8 | 25.7 | 22.8 | 71.4 | 68.5 | 69.0 | 66.9 | 64.6 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Test 6

The purpose of Test 6 was to regrind and reclean the concentrate made from Tests 1 and 2. After repulping and washing in the Dorr classifier, the concentrate was fed to the ball mill operated in closed circuit with the cyclone. The ball mill discharge was fed to the Dings 3-drum separator at an intensity of 500 gauss. The Dings concentrate was washed by a Denver cone and a collecting cone, and pumped to a cyclone. The cyclone spigot was returned to the ball mill and the overflow was washed in a second collecting cone, remagnetized in the second drum of the Dings 2-drum separator at 500 gauss and cleaned again in the Siphon Sizer with an upflow of 14 ft/hr. The Siphon Sizer spigot was filtered and the cake put in drums. A feed rate of 1200 lb/hr was used and the results are shown in Table 19. The drop in grade between the Siphon Sizer spigot and the filter cake is due to contamination from the concentrate of Test 5 which remained in the filter cone and filter boot.

TABLE 19

Balanced Results of Test 6

| Product | Weight, % | Weight, % Crude Feed | Analysis, % | | | Distn, % | | Crude Feed Distn, % | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | $SiO_2$ | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| Feed | 100.0 | 25.0 | 56.83 | 55.0 | | 100.0 | 100.0 | 55.0 | 77.8 |
| Dorr o'flow | 0.2 | 0.1 | 14.22 | | | 0.1 | 0.1 | 0.1 | 0.1 |
| B.M. feed | 142.1 | 35.5 | 57.35 | | | 144.1 | | 79.3 | |
| B.M. discharge | 141.9 | 35.4 | 57.57 | | | 144.0 | | 79.2 | |
| Dings Cl conc | 129.1 | 32.2 | 59.76 | | | 136.0 | | 74.8 | |
| Dings Cl tail | 12.8 | 3.2 | 35.20 | 23.4 | | 8.0 | 5.4 | 4.4 | 4.2 |
| Denver cone o'flow | 0.5 | 0.1 | 25.30 | 10.0 | | 0.2 | 0.1 | 0.1 | 0.1 |
| Denver cone spigot | 128.6 | 32.1 | 60.00 | | | 135.8 | | 74.7 | |
| No. 1 coll cone o'flow | 0.2 | -- | -- | | | 0.1 | | 0.1 | |
| No. 1 coll cone spigot | 128.4 | 32.1 | 60.10 | | | 135.7 | | 74.6 | |
| Cyclone spigot | 42.1 | 10.5 | 58.58 | | | 44.1 | | 24.2 | |
| Cyclone o'flow | 86.3 | 21.6 | 60.38 | 53.1 | | 91.6 | | 50.4 | |
| No. 2 coll cone o'flow | 0.5 | 0.1 | 21.77 | | | 0.2 | 0.2 | 0.1 | 0.2 |
| No. 2 coll cone spigot | 85.8 | 21.5 | 60.56 | | | 91.4 | | 50.3 | |
| Dings No. 2 conc | 83.6 | 20.9 | 61.15 | | | 90.2 | | 49.6 | |
| Dings No. 2 tail | 2.2 | 0.6 | 34.60 | 18.0 | | 1.2 | 0.7 | 0.7 | 0.5 |
| Siphon Sizer o'flow | 0.9 | 0.2 | 37.11 | 23.4 | | 0.5 | 0.4 | 0.3 | 0.3 |
| Siphon Sizer spigot | 82.7 | 20.7 | 61.61 | 60.1 | 10.91 | 89.7 | 93.1 | 49.3 | 72.4 |
| Filter cone o'flow | -- | | 21.25 | | | | | | |
| Filter cone spigot | -- | | 60.18 | | | | | | |
| Filter cake | -- | | 60.72 | 58.6 | 11.88 | | | | |
| Ratio of concentration from crude feed = 4.83:1 | | | | | | | | | |

Results of screen tests are shown in Table 20.

TABLE 20

Results of Screen Tests of Test 6

| Mesh | B.M. Feed Weight, % | B.M. Discharge Weight, % | Cyclone Spigot Weight, % | S.S. Spigot Weight, % |
|---|---|---|---|---|
| + 65 | 1.2 | 0.8 | | |
| +100 | 2.0 | 1.0 | 2.6 | |
| +150 | 3.3 | 1.0 | 3.2 | |
| +200 | 4.8 | 2.4 | 5.7 | |
| +325 | 15.1 | 9.3 | 25.2 | 1.0 |
| -325 | 73.6 | 85.5 | 63.3 | 99.0 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

Tests 6A and 6B

Two laboratory tests using the Wade hydro-separator and the Jeffrey Steffensen magnetic separator were done on concentrate from Test 6. The feed in each test was the same, approximately 92% minus 325 M. In Test 6A the Wade upflow was 40 ft/hr and the drum intensities were No. 1 drum 2.2 amp, No. 2 drum 1.5 amp and No. 3 drum 1.0 amp. In Test 6B the Wade upflow was 70 ft/hr, and the drum intensities were No. 1 drum 2.2 amp, No. 2 drum 1.0 amp and No. 3 drum 0.4 amp. The results of the tests are shown in Tables 21 and 22. In each test the feed went to the Jeffrey Steffensen separator and the concentrate was pumped to the Wade hydroseparator.

## TABLE 21

**Balanced Results of Test 6A**

| Product | Weight, % | Weight, % Crude Feed | Analysis, % Sol Fe | Distn, % Sol Fe | Crude Feed Distn, % Sol Fe |
|---|---|---|---|---|---|
| Jeff feed | 100.0 | 21.5 | 60.60 | 100.0 | 50.3 |
| Jeff conc | 90.1 | 19.4 | 62.54 | 92.8 | 46.7 |
| Jeff midd | 6.2 | 1.3 | 50.76 | 5.2 | 2.6 |
| Jeff tail | 3.7 | 0.8 | 32.51 | 2.0 | 1.0 |
| Wade o'flow | 0.2 | 0.1 | 39.26 | 0.1 | 0.1 |
| Wade spigot | 89.9 | 19.3 | 62.53 | 92.7 | 46.6 |
| Ratio of concentration from crude feed = 5.18:1 | | | | | |

## TABLE 22

**Balanced Results of Test 6B**

| Product | Weight, % | Weight, % Crude Feed | Analysis, % | | | Distn, % Sol Fe | Crude Feed Distn, % Sol Fe |
|---|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | $SiO_2$ | | |
| Jeff feed | 100.0 | 21.5 | 60.24 | | | 100.0 | 50.3 |
| Jeff conc | 42.6 | 9.2 | 63.30 | | | 44.5 | 22.4 |
| Jeff midd | 53.2 | 11.4 | 60.80 | 60.30 | | 53.0 | 26.6 |
| Jeff tail | 4.2 | 0.9 | 36.22 | 22.4 | | 2.5 | 1.3 |
| Wade o'flow | 1.7 | 0.4 | 59.52 | 59.1 | | 1.6 | 0.8 |
| Wade spigot | 40.9 | 8.8 | 63.34 | | 9.09 | 42.9 | 21.6 |

Tests 7 and 8

The purpose of these tests was to get more information on the procedure necessary to produce a first stage concentrate suitable for Strategic-Udy feed. Open circuit grinding was used for both mills, the flowsheet being identical to that used in Tests 3, 4 and 5. Two changes were made in order to get a coarser grind. Crude feed was fed to the rod mill at 1/2 in. instead of 3/8 in., and a 10 M screen replaced the 20 M screen ahead of the Dings magnetic cobber.

For Test 7, 2000 lb of balls was taken out of the mill leaving a ball load of about 2000 lb. After feeding at 2 ton/hr for 2½ hr, 1000 lb of balls was added for Test 8. This test was run at the same feed rate for 2 hr before sampling. All other conditions remained constant, the intensities on the Dings separators being set at 500 gauss. The results of the two tests are shown in Tables 23 and 24.

TABLE 23

Balanced Results of Test 7

| Product | Weight, % | Solids, % | Analysis, % Sol Fe | Distn, % Sol Fe |
|---|---|---|---|---|
| R.M. discharge | | 64.2 | 26.91 | |
| 10 M Screen u'size | 100.0 | | 26.49 | 100.0 |
| Dings R conc | 50.4 | | 41.23 | 78.3 |
| Dings R tail | 49.6 | | 11.56 | 21.7 |
| Dorr o'flow | 5.1 | | 14.85 | 2.9 |
| B.M. feed | -- | 76.0 | 46.45 | -- |
| B.M. discharge | 45.3 | 69.6 | 44.12 | 75.4 |
| Dings Cl conc | 32.7 | | 53.60 | 66.2 |
| Dings Cl tail | 12.6 | | 19.42 | 9.2 |
| Denver cone o'flow | 0.7 | 19.0 | 27.36 | 0.7 |
| Denver cone spigot | 32.0 | | 54.20 | 65.5 |
| Filter cone o'flow | 0.2 | | 18.91 | 0.2 |
| Filter cone spigot | 31.8 | | 54.39 | 65.3 |
| Filter cake | | (12.2% Moisture) | 55.82 | |
| Ratio of concentration = 3.16:1 | | | | |

TABLE 24

Balanced Results of Test 8

| Product | Weight, % | Solids, % | Analysis, % | | Distn, % | |
|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| R.M. discharge | | 64.8 | 26.14 | 17.8 | | |
| 10 M in size | 100.0 | | 26.89 | | 100.0 | 100.0 |
| Dings R conc | 49.2 | | 41.75 | 34.5* | 78.7 | 98.8 |
| Dings R tail | 50.8 | | 11.63 | 0.43 | 21.3 | 1.2 |
| Dorr o'flow | 3.6 | | 14.13 | 0.70 | 1.9 | 0.2 |
| B.M. feed | -- | 75.0 | 45.05 | | -- | -- |
| B.M. discharge | 45.6 | 74.8 | 44.89 | | 76.8 | 98.6 |
| Dings Cl conc | 32.6 | | 54.40 | 50.0* | 66.0 | 91.5 |
| Dings Cl tail | 13.0 | | 22.31 | 9.68 | 10.8 | 7.1 |
| Denver cone o'flow | -- | | 17.72 | | -- | |
| Denver cone spigot | 32.6 | 16.0 | 54.28 | | -- | |
| Filter cone o'flow | 0.2 | | 18.81 | | 0.2 | |
| Filter cone spigot | 32.4 | | 54.55 | | 65.8 | |
| Filter cake | | ** | 57.46 | 57.0 | | |
| Ratio of concentration = 3.10:1 | | | | | | |

* estimated assays

**13.2% Moisture

The results of screen tests of Test 7 and 8 are shown in Tables 25 and 26.

Tests 9, 10 and 11

The purpose of these tests was to treat the balance of the crude feed and produce a concentrate assaying about 58% Fe at a grind of 90% minus 325 M. The flowsheet was similar to that used in Test 1. The ball mill was run in closed circuit with the cyclone and a feed rate of 2 ton/hr was maintained. Magnetic intensities were kept at 500 gauss. In Test 11 the upflow in the Siphon Sizer was raised from 14 ft/hr to 30 ft/hr. Results of the tests are shown in Tables 27, 28 and 29.

TABLE 25

Results of Screen Tests of Test 7

| Mesh | R.M. Discharge Weight, % | B.M. Feed Weight, % | B.M. Discharge Weight, % | Dings Cl conc | | Filter Cake Weight, % |
|---|---|---|---|---|---|---|
| | | | | Weight, % | % Sol Fe | |
| + 14 | 0.6 | -- | -- | -- | | -- |
| + 20 | 1.6 | 1.7 | -- | -- | | -- |
| + 28 | 3.6 | 4.4 | -- | -- | | -- |
| + 35 | 9.0 | 11.0 | -- | -- | | -- |
| + 48 | 11.0 | 13.8 | 1.8 | 1.4 | 42.24 | -- |
| + 65 | 11.6 | 14.4 | 3.8 | 3.1 | 44.83 | 1.2 |
| +100 | 11.0 | 13.2 | 7.1 | 7.9 | 46.03 | 3.2 |
| +150 | 7.5 | 8.7 | 8.3 | 9.6 | 45.21 | 5.8 |
| +200 | 5.7 | 5.8 | 9.9 | 11.0 | 46.44 | 7.3 |
| +325 | 6.0 | 6.3 | 12.4 | 13.6 | 48.68 | 11.5 |
| -325 | 32.4 | 20.7 | 56.7 | 53.4 | 57.76 | 71.0 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 52.5 | 100.0 |

TABLE 26

Results of Screen Tests of Test 8

| Mesh | R.M. Discharge Weight, % | B.M. Feed Weight, % | B.M. Discharge Weight, % | Dings Cl conc Weight, % |
|---|---|---|---|---|
| + 14 | 0.6 | -- | -- | -- |
| + 20 | 0.9 | 1.4 | -- | -- |
| + 28 | 3.0 | 3.7 | -- | -- |
| + 35 | 8.3 | 10.0 | -- | -- |
| + 48 | 10.7 | 12.8 | 1.0 | 1.2 |
| + 65 | 12.4 | 14.2 | 2.3 | 2.2 |
| +100 | 11.5 | 13.2 | 4.4 | 4.4 |
| +150 | 7.8 | 8.9 | 6.1 | 7.0 |
| +200 | 6.1 | 6.2 | 7.2 | 9.1 |
| +325 | 6.6 | 6.8 | 12.6 | 13.8 |
| -325 | 32.1 | 22.8 | 66.4 | 62.3 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

TABLE 27

Balanced Results of Test 9

| Product | Weight, % | Solids, % | Analysis, % | | | Distn, % | |
|---|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | $SiO_2$ | Sol. Fe | Mag Fe |
| R.M. discharge | 100.0 | 65.5 | 25.30 | | | | |
| 10 M Screen u'size | 100.0 | | 27.60 | 18.8 | | 100.0 | 100.0 |
| Dings R conc | 53.4 | | 41.10 | | | 79.5 | |
| Dings R tail | 46.6 | | 12.10 | 0.4 | | 20.5 | 1.0 |
| Dorr o'flow | 1.4 | | 13.80 | 0.3 | | 0.7 | 0.1 |
| Dorr sands | 52.0 | | 41.80 | | | 78.8 | |
| B.M. feed | -- | | 47.10 | | | -- | |
| B.M. discharge | 99.8 | 75.9 | 46.80 | | | 169.2 | |
| Dings Cl conc | 78.9 | 35.5 | 53.60 | | | 153.2 | |
| Dings Cl tail | 20.9 | | 21.20 | 8.9 | | 16.0 | 9.9 |
| Denver cone o'flow | 1.3 | | 17.70 | 1.4 | | 0.8 | 0.1 |
| Denver cone spigot | 77.6 | 54.1 | 54.20 | | | 152.4 | |
| No. 1 coll cone o'flow | -- | | 16.60 | | | -- | |
| No. 1 coll cone spigot | 77.6 | | 54.20 | | | 152.4 | |
| Cyclone o'flow | 29.8 | | 57.30 | | | 62.0 | |
| Cyclone spigot | 47.8 | | 52.20 | | | 90.4 | |
| No. 2 coll cone o'flow | 0.1 | | 21.0 | | | 0.1 | 0.1 |
| No. 2 coll cone spigot | 29.7 | | 57.40 | | | 61.9 | |
| No. 2 Dings conc | 29.6 | | 57.60 | | | 61.8 | |
| No. 2 Dings tail | 0.1 | | 22.20 | | | 0.1 | 0.1 |
| Siphon Sizer o'flow | 0.6 | | 17.80 | | | 0.4 | 0.5 |
| Siphon Sizer spigot | 29.0 | 29.3 | 58.40 | | 14.04 | 61.4 | 88.2 |
| Filter cone o'flow | | | -- | | | -- | -- |
| Filter cone spigot | | | 56.30 | | | -- | -- |
| Filter cake | | | 58.90 | 57.20 | 13.96 | 61.4 | 88.2 |

Ratio of concentration = 3.45:1

TABLE 28

Balanced Results of Test 10

| Product | Weight, % | Solids, % | Analysis, % Sol Fe | Mag Fe | $SiO_2$ | Distn, % Sol Fe | Mag Fe |
|---|---|---|---|---|---|---|---|
| R.M. discharge | | 67.7 | 24.90 | | | | |
| 10 M Screen u'size | 100.0 | | 25.40 | 15.90 | | 100.0 | 100.0 |
| Dings R conc | 47.6 | | 40.90 | | | 76.7 | |
| Dings R tail | 52.4 | | 11.30 | 1.6 | | 23.3 | |
| Dorr o'flow | 0.5 | | 14.70 | 1.1 | | 0.3 | 0.4 |
| Dorr sands | 47.1 | | 41.20 | | | 76.4 | |
| B.M. feed | -- | | 47.70 | | | | |
| B.M. discharge | 101.0 | 80.1 | 47.56 | | | 189.1 | |
| Dings Cl conc | 82.1 | 52.4 | 52.80 | | | 170.6 | |
| Dings Cl tail | 18.9 | | 24.80 | 13.2 | | 18.5 | 15.7 |
| Denver cone o'flow | 1.1 | | 16.60 | 0.4 | | 0.6 | 0.1 |
| Denver cone spigot | 81.0 | | 53.30 | | | 170.0 | |
| No. 1 coll cone o'flow | 1.1 | | 15.50 | 0.1 | | 0.7 | -- |
| No. 1 coll cone spigot | 79.9 | | 53.80 | | | 169.3 | |
| Cyclone o'flow | 26.0 | | 55.2* | | | 56.6 | |
| Cyclone spigot | 53.9 | | 53.1* | | | 112.7 | |
| No. 2 coll cone o'flow | 1.0 | | 17.40 | | | 0.7 | |
| No. 2 coll cone spigot | 25.0 | | 56.70 | | | 55.9 | |
| No. 2 Dings conc | 24.3 | | 57.60 | | | 55.1 | |
| No. 2 Dings tail | 0.7 | | 28.0 | | | 0.8 | |
| Siphon Sizer o'flow | 0.3 | | 20.80 | | | 0.2 | |
| Siphon Sizer spigot | 24.0 | | 58.00 | 55.9 | 14.44 | 54.9 | 83.8 |
| Filter cone o'flow | 0.1 | | 17.80 | | | 0.1 | |
| Filter cone spigot | -- | | 57.80 | | | -- | |
| Filter cake | 23.9 | (13.4% Moisture) | 58.20 | 55.4 | 14.08 | 54.8 | |

Ratio of concentration = 4.16:1

*estimated assays

TABLE 29

Balanced Results of Test 11

| Product | Weight, % | Solids, % | Analysis, % | | | Distn, % | |
|---|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | $SiO_2$ | Sol Fe | Mag Fe |
| R.M. discharge | | 63.9 | 24.70 | | | | |
| 10 M Screen u'size | 100.0 | | 25.20 | 15.9* | | 100.0 | 100.0 |
| Dings R conc | 45.5 | | 41.00 | | | 74.0 | |
| Dings R tail | 54.5 | | 12.00 | 0.7 | | 26.0 | 2.4 |
| Dorr o'flow | 2.9 | | 14.80 | 1.8 | | 1.7 | 0.4 |
| Dorr sands | 42.6 | | 42.80 | | | 72.3 | |
| B.M. feed | -- | | 47.40 | | | -- | |
| B.M. discharge | 82.7 | 73.2 | 47.40 | | | 155.5 | |
| Dings Cl conc | 67.5 | | 52.80 | | | 141.4 | |
| Dings Cl tail | 15.2 | | 23.50 | 11.7 | | 14.1 | 11.1 |
| Denver cone o'flow | 1.3 | | 16.80 | 0.4 | | 0.9 | 0.1 |
| Denver cone spigot | 66.2 | | 53.50 | | | 140.5 | |
| No. 1 coll cone o'flow | 0.2 | | 18.60 | | | 0.1 | |
| No. 1 coll cone spigot | 66.0 | | 53.60 | | | 140.4 | |
| Cyclone o'flow | 25.9 | | 55.60* | | | 57.2 | |
| Cyclone spigot | 40.1 | | 52.30 | | | 83.2 | |
| No. 2 coll cone o'flow | 0.8 | | 19.00 | | | 0.6 | |
| No. 2 coll cone spigot | 25.1 | | 56.80 | | | 56.6 | |
| No. 2 Dings conc | 24.6 | | 57.50 | | | 56.1 | |
| No. 2 Dings tail | 0.5 | | 25.60 | | | 0.5 | |
| Siphon Sizer o'flow | 1.2 | | 34.60 | 21.9 | | 1.7 | 1.6 |
| Siphon Sizer spigot | 23.4 | 18.8 | 58.60 | 57.4 | | 54.4 | 84.4 |
| Filter cone o'flow | -- | | 17.90 | | | 54.4 | |
| Filter cone spigot | 23.4 | | 58.60 | | | -- | |
| Filter cake | 23.4 | (12.8% Moisture) | 58.60 | 56.4 | 13.60 | 54.4 | |
| Ratio of concentration = 4.27:1 | | | | | | | |

*estimated assays

TABLE 30

Results of Screen Tests of Tests 9, 10, and 11

| Mesh | R.M. Discharge Weight, % | | | B.M. Feed Weight, % | | | B.M. Discharge Weight, % | | |
|---|---|---|---|---|---|---|---|---|---|
| | Test 9 | Test 10 | Test 11 | Test 9 | Test 10 | Test 11 | Test 9 | Test 10 | Test 11 |
| + 14 | 1.0 | 1.1 | 0.9 | -- | -- | -- | -- | -- | -- |
| + 20 | 2.0 | 2.0 | 1.8 | 1.2 | 1.2 | 1.3 | -- | -- | -- |
| + 28 | 4.4 | 4.8 | 4.5 | 2.7 | 3.1 | 2.9 | -- | -- | -- |
| + 35 | 10.0 | 10.6 | 10.5 | 7.0 | 7.2 | 7.5 | -- | -- | -- |
| + 48 | 11.7 | 11.8 | 11.6 | 9.4 | 8.5 | 8.8 | 1.6 | 1.0 | 1.8 |
| + 65 | 12.3 | 11.8 | 11.6 | 9.9 | 8.2 | 8.2 | 3.9 | 2.1 | 2.8 |
| +100 | 10.3 | 10.0 | 10.2 | 11.2 | 9.2 | 8.8 | 5.7 | 4.2 | 4.9 |
| +150 | 6.8 | 6.6 | 6.7 | 10.4 | 8.2 | 8.6 | 6.8 | 7.0 | 6.8 |
| +200 | 5.4 | 5.2 | 5.1 | 11.3 | 11.0 | 10.8 | 10.7 | 10.0 | 11.2 |
| +325 | 5.7 | 5.5 | 5.6 | 13.3 | 16.9 | 16.8 | 16.2 | 18.1 | 19.0 |
| -325 | 30.4 | 30.6 | 31.5 | 23.6 | 26.5 | 26.3 | 55.1 | 57.6 | 53.5 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

| Mesh | Dings Cl conc Weight, % | | | Siphon Sizer Spigot Weight, % | | |
|---|---|---|---|---|---|---|
| | Test 9 | Test 10 | Test 11 | Test 9 | Test 10 | Test 11 |
| + 14 | -- | -- | -- | -- | -- | -- |
| + 20 | -- | -- | -- | -- | -- | -- |
| + 28 | -- | -- | -- | -- | -- | -- |
| + 35 | -- | -- | -- | -- | -- | -- |
| + 48 | 1.6 | 2.0 | 1.8 | -- | -- | -- |
| + 65 | 3.3 | 2.6 | 2.8 | -- | -- | -- |
| +100 | 6.4 | 5.2 | 5.6 | 0.2 | -- | 0.4 |
| +150 | 9.1 | 8.0 | 7.6 | 0.4 | 0.4 | 0.4 |
| +200 | 11.5 | 12.2 | 11.7 | 1.2 | 1.2 | 0.9 |
| +325 | 17.8 | 20.6 | 21.0 | 7.3 | 6.9 | 4.7 |
| -325 | 50.3 | 49.4 | 49.5 | 90.9 | 91.5 | 93.6 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Tests 12, 13 and 14

As it had not yet been possible to get a concentrate grade of better than 60.1% Fe in the pilot plant, or 64% Fe in the laboratory tests with very fine grinding, some more test work was done before the first stage concentrate was upgraded in Tests 12, 13 and 14. The methods considered for upgrading were further magnetic separation, tabling and flotation. Accordingly a representative 40 lb sample of Siphon Sizer spigot from Tests 9, 10 and 11 was taken and kept moist. A table test was carried out on 2500 g of this sample which was about 93% minus 325 M. The results of tabling are shown in Table 31.

TABLE 31

Results of Tabling First Stage Concentrate

| Product | Weight, % | Analysis, % Sol Fe | Distn, % Sol Fe |
|---|---|---|---|
| Table conc | 45.8 | 60.40 | 47.2 |
| Table midd | 30.9 | 61.24 | 32.3 |
| Table tail | 23.3 | 51.66 | 20.5 |
| Feed* | 100.0 | 58.6 | 100.0 |

*calculated

Three samples of 2000 g each were taken for upgrading by the Jeffrey-Steffensen separator followed by the Wade hydroseparator. The samples were ground 10, 20 and 30 minutes before treatment. The magnetic drums were set at: No. 1 drum 2.2 amp, No. 2 drum 1.0 amp, No. 3 drum 0.4 amp for the first 2 tests. The last test had settings of: No. 1 drum 2.2 amp, No. 2 drum 1.2 amp, No. 3 drum 0.7 amp, to prevent the loss of too much fine magnetite in the middling. Water upflow on the hydro-separator was kept at 70 ft/hr. The results of the three tests are shown in Tables 32, 33 and 34.

TABLE 32

Results of Concentrate Upgrading After 10 min Grind

| Product | Weight, % | Analysis, % Sol Fe | Distn, % Sol Fe |
|---|---|---|---|
| Feed* | 100.0 | 59.1 | 100.0 |
| Jeff midd | 40.8 | 58.64 | 40.5 |
| Jeff tail | 5.5 | 29.26 | 2.7 |
| Wade o'flow | 1.9 | 56.04 | 1.8 |
| Wade spigot | 51.8 | 62.82 | 55.0 |

*calculated

The Wade spigot product was 94% minus 325 M.

TABLE 33

Results of Concentrate Upgrading After 20 min Grind

| Product | Weight, % | Analysis, % Sol Fe | Distn, % Sol Fe |
|---|---|---|---|
| Feed* | 100.0 | 59.4 | 100.0 |
| Jeff midd | 68.4 | 61.0 | 70.2 |
| Jeff tail | 7.0 | 30.24 | 3.6 |
| Wade o'flow | 3.3 | 61.64 | 3.4 |
| Wade spigot | 21.3 | 63.60 | 22.8 |

*calculated

The Wade spigot product was 95.6% minus 325 M.

TABLE 34

Results of Concentrate Upgrading After 30 min Grind

| Product | Weight, % | Analysis, % Sol Fe | Distn, % Sol Fe |
|---|---|---|---|
| Feed* | 100.0 | 59.2 | 100.0 |
| Jeff midd | 17.8 | 56.5 | 17.0 |
| Jeff tail | 9.1 | 28.44 | 4.4 |
| Wade o'flow | 0.8 | 56.44 | 0.7 |
| Wade spigot | 72.3 | 63.80 | 77.9 |

*calculated

The Wade spigot product was 98.2% minus 325 M.

In order to find out the grade and recovery obtainable with no regrinding, a sample was treated using the same procedure and settings as in Table 34. The results are shown in Table 35.

TABLE 35

Results of Concentrate Upgrading With No Regrind

| Product | Weight, % | Analysis, % | | Distn, % Sol Fe |
|---|---|---|---|---|
| | | Sol Fe | $SiO_2$ | |
| Jeff feed | 100.0 | 58.4 | 14.24 | 100.0 |
| Jeff midd | 16.4 | 53.2 | | 14.6 |
| Jeff tail | 4.7 | 30.0 | | 2.4 |
| Jeff conc | 78.9 | 61.7 | 10.64 | 83.0 |
| Wade o'flow | 1.0 | 51.3 | | 0.9 |
| Wade spigot | 77.9 | 62.5 | 10.32 | 82.1 |

Some flotation tests were made and more work is planned to try to upgrade the concentrate by floating the silica with amines. Results indicate that it is desirable to remove as much silica as possible before flotation by means of the Jeffrey-Steffensen separator, so that the feed for flotation would be about 62.5% Fe with 10.3% silica. Preliminary results are fairly encouraging. At a pH of 10.9 using 2.5 lb/ton yellow dextrine and 0.7 lb/ton Armac C, a concentrate assaying 63.7% Fe with 8.68% $SiO_2$ was made from a feed containing 61.8% Fe. It is possible that better results will be obtained with a less alkaline or acid pH in the pulp.

Due to the failure in the laboratory tests to produce a concentrate over 64% Fe, it was decided to upgrade the first stage concentrate to the best possible grade by further grinding and washing with magnetic separators.

Test 12 was run at 1000 lb/hr using the ball mill in open circuit with various stages of magnetic separation and washing. A cyclone was used in an effort to upgrade the spigot product, both fractions being recombined after the sampling points. Magnet intensities were 500 gauss. The upflow on the 2 ft dia hydro-separator, that replaced the Siphon Sizer for this test only, was about 40 ft/hr. The results of Test 12 are shown in Table 36.

In Test 13 similar conditions were used as in Test 12, the Siphon Sizer upflow being about 28 ft/hr. The results of Test 13 are shown in Table 37.

In Test 14, no regrinding was done; the feed was upgraded by using a flowsheet as in Test 13 but without the ball mill. Results of Test 14 are shown in Table 38.

Two laboratory tests were carried out to find the grindability of the sample compared with ore from Lake Shore Mines, Ontario, of known grindability. In two grinding tests of 21 min and 35 min the Bond work indices were 15.0 and 13.4 kwh/ton. Details of these tests are described in Mineral Processing Division Test Report MPT No. 61-79 by R. Ratzlaff, August 4, 1961.

TABLE 36

Balanced Results of Test 12

| Product | Weight, % | Weight, % Crude Feed | Solids, % | Analysis, % | | | Distn, % | | Crude Feed Distn, % | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sol Fe | Mag Fe | $SiO_2$ | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| B.M. feed | 100.0 | 24.0 | | 57.9 | 56.8 | 15.0 | 100.0 | 100.0 | 54.9 | 83.8 |
| Dorr o'flow | -- | -- | | 56.4 | 55.0 | | 0.9 | | 0.5 | |
| Dorr sands | -- | -- | | 58.0 | | | -- | | -- | |
| B.M. discharge | 97.5 | 23.4 | | 59.0 | | | 99.1 | | 54.4 | |
| Dings Cl conc | 87.3 | 21.0 | | 61.4 | | 11.36 | 92.6 | | 50.8 | |
| Dings Cl tail | 10.2 | 2.4 | | 37.2 | 14.2 | | 6.5 | 2.6 | 3.6 | 2.2 |
| Denver cone o'flow | -- | -- | | 25.5 | | 11.28 | 92.6 | | 50.8 | |
| Denver cone spigot | 87.3 | 21.0 | | 61.4 | | | -- | | -- | |
| Cyclone feed | -- | -- | 68.8 | 59.2 | 58.8 | 13.28 | -- | | -- | |
| Cyclone spigot | -- | -- | 52.3 | 61.6 | 61.6 | 10.68 | -- | | -- | |
| Cyclone o'flow | -- | -- | | 60.8 | 58.4 | | -- | | -- | |
| Coll cone o'flow | -- | -- | | 21.8 | | | -- | | -- | |
| Coll cone spigot | -- | -- | | 61.2 | | | -- | | -- | |
| Dings No. 2 conc | 86.8 | 20.8 | | 61.6 | | 11.00 | 92.3 | | 50.7 | |
| Dings No. 2 tail | 0.5 | 0.2 | | 29.4 | | | 0.3 | | 0.1 | |
| Hydrosep. o'flow | 7.6 | 1.8 | | 59.4 | 58.2 | | 7.8 | 7.8 | 4.3 | 6.5 |
| Hydrosep. spigot | 79.2 | 19.0 | | 61.8 | 61.8 | 10.72 | 84.5 | | 46.4 | |
| Filter cone o'flow | 0.6 | 0.1 | | 36.7 | | | 0.3 | | 0.2 | |
| Filter cone spigot | 78.6 | 18.9 | | 62.0 | | 10.52 | 84.2 | | 46.2 | |
| Filter cake | 78.3 | 18.9 | (17.8% Moisture) | 62.2 | 62.0 | 10.32 | 84.2 | 86.6 | 46.2 | 72.6 |
| Ratio of concentration from crude feed = 5.29:1 | | | | | | | | | | |

Taking 2000 g of hydroseparator spigot and treating by Jeffrey-Steffensen separator and Wade hydroseparator at standard settings gave the results shown in Table 37.

TABLE 37

Results of Upgrading Test 12 Concentrate

| Product | Weight, % | Weight, % Crude Feed | Analysis, % | | Distn, % Sol Fe | Crude Feed Distn, % Sol Fe |
|---|---|---|---|---|---|---|
| | | | Sol Fe | $SiO_2$ | | |
| Jeff feed | 100.0 | 19.0 | 61.5 | | 100.0 | 46.4 |
| Jeff tail | 3.7 | 0.7 | 40.2 | | 2.5 | 1.2 |
| Jeff midd | 14.5 | 2.7 | 57.4 | | 13.3 | 6.2 |
| Wade o'flow | 1.9 | 0.4 | 57.0 | | 1.8 | 0.8 |
| Wade spigot | 79.9 | 15.2 | 63.8 | 8.84 | 82.4 | 38.2 |
| Ratio of concentration from crude feed = 6.58:1 | | | | | | |

TABLE 38

Balanced Results of Test 13

| Product | Weight, % | Weight, % Crude Feed | Analysis, % Sol Fe | Analysis, % Mag Fe | Analysis, % $SiO_2$ | Distn, % Sol Fe | Distn, % Mag Fe | Crude Feed Distn, % Sol Fe | Crude Feed Distn, % Mag Fe |
|---|---|---|---|---|---|---|---|---|---|
| B.M. feed | 100.0 | 23.4 | 59.2 | 58.6 | 13.68 | 100.0 | 100.0 | 54.4 | 84.4 |
| Dorr o'flow | 2.5 | 0.6 | 27.8 | | | 1.2 | | 0.7 | |
| Dorr sands | 97.5 | 22.8 | 60.0 | | | 98.8 | | 53.7 | |
| B.M. discharge | 97.5 | -- | 59.0 | | | -- | | -- | |
| Dings Cl conc | 90.2 | 21.1 | 61.2 | | 11.68 | 93.3 | | 50.8 | |
| Dings Cl tail | 7.3 | 1.7 | 45.1 | 37.7 | | 5.5 | 4.7 | 2.9 | 4.0 |
| Denver cone o'flow | -- | -- | 24.8 | | | -- | | -- | |
| Denver cone spigot | -- | -- | 61.0 | | 11.60 | -- | | -- | |
| Coll cone o'flow | -- | -- | -- | | | -- | | -- | |
| Coll cone spigot | -- | -- | 60.4 | | | -- | | -- | |
| Dings No. 2 conc | 90.2 | 21.1 | 61.2 | | 11.40 | 93.3 | | 50.8 | |
| Dings No. 2 tail | -- | | 30.6 | | | -- | | -- | |
| Siphon Sizer o'flow | 4.0 | 0.9 | 50.6 | 30.0 | | 3.5 | 2.0 | 1.9 | 1.7 |
| Siphon Sizer spigot | 86.2 | 20.2 | 61.7 | | 10.90 | 89.8 | | 48.9 | |
| Filter cone o'flow | 1.5 | 0.4 | 33.23 | | | 0.8 | | 0.5 | |
| Filter cone spigot | 84.7 | 19.8 | 62.2 | | 10.52 | 89.0 | | 48.4 | |
| Filter cake | 84.7 | 19.8 (14.7% Moisture) | 62.2 | | 10.40 | 89.0 | 89.7 | 48.4 | 75.7 |
| Ratio of concentration from crude feed = 5.05:1 | | | | | | | | | |

TABLE 39

Balanced Results of Test 14

| Product | Weight, % | Weight, % Crude Feed | Analysis, % | | | Distn, % | | Crude Feed Distn, % | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Sol Fe | Mag Fe | $SiO_2$ | Sol Fe | Mag Fe | Sol Fe | Mag Fe |
| Feed | 100.0 | 23.9 | 58.2 | 57.1 | 14.00 | 100.0 | 100.0 | 54.8 | 83.8 |
| Dorr o'flow | 1.0 | 0.2 | 54.8 | | | 0.9 | | 0.5 | |
| Dings Cl conc | 87.1 | 20.9 | 59.6 | | 12.80 | 89.2 | | 48.9 | |
| Dings Cl tail | 11.9 | 2.8 | 48.2 | 38.6 | | 9.9 | 8.1 | 5.4 | 6.8 |
| Denver cone o'flow | -- | -- | 20.4 | | | -- | | -- | |
| Denver cone spigot | 87.1 | 20.8 | 59.6 | | 12.32 | 89.2 | | 48.9 | |
| Coll cone o'flow | -- | -- | -- | | | -- | | -- | |
| Coll cone spigot | -- | -- | 60.0 | | | -- | | -- | |
| Dings No. 2 conc | 86.0 | 20.6 | 60.0 | | 12.52 | 88.7 | | 48.6 | |
| Dings No. 2 tail | 1.1 | 0.2 | 29.3 | | | 0.5 | | 0.3 | |
| Siphon Sizer o'flow | 7.4 | 1.8 | 53.6 | 53.1 | | 6.8 | 6.9 | 3.7 | 5.8 |
| Siphon Sizer spigot | 78.6 | 18.8 | 60.6 | 59.1 | 12.04 | 81.9 | | 44.9 | |
| Filter cone o'flow | 0.8 | 0.2 | 21.5 | | | 0.3 | | 0.2 | |
| Filter cone spigot | 77.8 | 18.6 | 61.0 | | 11.40 | 81.6 | 83.1 | 44.7 | 69.6 |
| Filter cake | (14.4% Moisture) | | 61.0 | 61.0 | 11.82 | | | | |
| Ratio of concentration from crude feed = 5.38:1 | | | | | | | | | |

Screen tests were done on Tests 12, 13 and 14 and the results are shown in Table 40.

TABLE 40

Results of Screen Tests on Tests 12, 13 and 14

| Mesh | Feed Weight, % | | | Ball Mill Weight, % Feed | | Ball Mill Weight, % Discharge | | Dings Cl Conc Weight, % | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Test 12 | Test 13 | Test 14 | Test 12 | Test 13 | Test 12 | Test 13 | Test 12 | Test 13 | Test 14 |
| +100 | 2.3 | -- | 0.8 | 0.3 | -- | 0.3 | -- | 0.4 | -- | 0.5 |
| +150 | 2.0 | 0.3 | 0.3 | 0.5 | 0.4 | 0.2 | 0.6 | 0.3 | 0.8 | 0.4 |
| +200 | 3.2 | 0.9 | 0.6 | 1.4 | 0.9 | 0.4 | 0.6 | 0.7 | 0.9 | 0.7 |
| +325 | 7.0 | 4.4 | 3.2 | 6.0 | 4.2 | 3.0 | 3.0 | 3.7 | 3.6 | 4.0 |
| -325 | 85.5 | 94.4 | 95.1 | 91.8 | 94.5 | 96.4 | 95.8 | 94.9 | 94.7 | 94.4 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

| Mesh | Hydroseparator Spigot Weight, % | | | Filter Cake Weight, % | | |
|---|---|---|---|---|---|---|
| | Test 12 | Test 13 | Test 14 | Test 12 | Test 13 | Test 14 |
| +100 | 0.3 | -- | 0.3 | -- | -- | -- |
| +150 | 0.4 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 |
| +200 | 1.1 | 0.7 | 0.8 | 0.8 | 0.9 | 0.8 |
| +325 | 3.8 | 3.4 | 3.7 | 4.5 | 3.3 | 4.1 |
| -325 | 94.4 | 95.7 | 94.9 | 94.4 | 95.5 | 94.8 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

## CONCLUSIONS

From the results of the test work carried out on this carload of Kukatush 'F' ore, it was not possible to make a suitable iron concentrate for pellets. With extremely fine grinding to 98% minus 325 M it was only possible to make a concentrate of about 64% Fe, and with this size distribution the concentrate contained over 14% moisture in the filter cake. Laboratory flotation tests are continuing in the hope that a better method for silica flotation may be devised, sufficient to lower the silica content in the final concentrate to below 6%. The presence of other elements, such as phosphorus, were within required limits.

By grinding to about 60% minus 325 M, and treating by the standard flowsheet, a concentrate assaying about 56% Fe could be produced containing 65% of the iron in the original head sample. This concentrate would be acceptable as feed for the Strategic-Udy direct reduction process. On grinding finer to produce a 58% iron concentrate, iron recovery dropped sharply to about 55%. This is attributed to the liberation of fine gangue inclusions of stilpnomelane (hydrated iron silicate) from the concentrate by finer grinding, which were rejected as non-magnetic.

- - -

PDRM:LLS:CL

FIGURE 7

Test 1 Flowsheet