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FLOTATION AND HIGH-INTENSITY MAGNETIC SEPARATION, TESTS ON A SAMPLE OF IRON-BEARING CARBONATE ROCK FROM THE ZEP PROPERTY IN SOUTHWESTERN ALBERTA, SUBMITTED BY MR. G. C. McCARTNEY, CONSULTING GEOLOGIST, TORONTO, ONTARIO

by

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MINERAL DRESSING AND PROCESS METALLURGY DIVISION

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SUMMARY OF RESULTS

The sample, which was somewhat lower in iron content than had originally been anticipated, assayed 19.2% soluble iron, and contained 1.36% phosphorus. Attempts to lower the phosphorus content by means of flotation concentration were unsuccessful. Further attempts to concentrate the iron-carbonate minerals by high intensity magnetic separation, and thereby obtain a product sufficiently high in iron and low in phosphorus to be economically attractive, had only limited success.

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INTRODUCTION

Location of Property

The location of the Zep property, from which this sample was said to be obtained, is in southwestern Alberta, township 16, range 5, west of the fifth meridian, about 70 miles north of Coleman, Alberta.

Shipment

The shipment, which was received at the Mines Branch on November 13, 1957, consisted of 6 bags of ore weighing 295 lb. The material, as received, was broken rock ranging in size up to about 8 in.

Nature of Investigation Requested

In correspondence from Mr. G. C. McCartney, Consulting Geologist, [redacted] Toronto, Ontario, it was stated that the iron-bearing zone, from which the sample was taken, had been traced for a distance of 2000 ft in a width of 10 to 15 ft, and that the property was held in his name, on behalf of clients, in the form of a reservation from the Alberta government.

Mr. McCartney requested that tests be conducted on the sample to determine if the apatite could be removed, thereby lowering the phosphorus content, which then might possibly make this material

a relatively attractive source of iron.

Sampling and Analysis

The sample was crushed to minus ½ in. and cut into four parts. One quarter of the sample was screened and crushed to -10 mesh and a head sample was riffled out. The rejects from the head sample were set aside for investigative tests.

The head sample was analysed as follows:

Iron (total Fe)	-	19.20%
Iron (soluble Fe)	-	19.20%
Silica (SiO_2)	-	14.60%
Titanium dioxide (TiO_2)	-	0.26%
Phosphorus (P)	-	1.36%
Sulphur (S)	-	0.94%
Manganese (Mn)	-	0.10%
Magnesium (Mg)	-	1.87%
Insoluble	-	15.07%
Loss on Ignition	-	23.76%

MINERALOGICAL EXAMINATION[A]

Results of Mineralogical Examination

Microscopic examination of thin sections prepared from portions of the head sample reveals that the rock is an impure granular carbonate rock, consisting of rounded grains of carbonate minerals, quartz, and apatite in a fine-grained carbonate matrix. The larger

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A From Mineragraphic Report M-1550-E, by E. H. Nickel, December 3, 1957.

rounded grains, which comprise about 50% of the rock, average about 0.1 to 0.4 mm (35 to 150 mesh) in diameter, (Figure 1). The carbonate matrix is very much finer grained (-325 mesh) and contains abundant limonitic stain (Figure 2).

The apatite grains are unusually dark in colour, probably due to impurities, and frequently show concentric banding, suggestive of sedimentary nodules.

The following procedure was employed in determining the different carbonate minerals present: A representative sample of the crushed rock, weighing 50 g, was pulverized to pass a 65 mesh screen. The +325 mesh particles, comprising 78.2% of the sample, were then separated by a series of heavy liquids with specific gravities of 2.96, 3.33, and 3.62. This was done in two batches: -65+100 mesh, and -150+325 mesh. The results are shown in Table 1.

TABLE 1

Results of Heavy Liquid Separation

	-65+100 mesh	-150+325 mesh
Weight (% of total)	57.1%	21.1%
Specific Gravity		
Most of the apatite: less than 2.96	33.7 %	36.6 % (calcite)
2.96 to 3.33	50.7	33.1 (calcite + brown spar)
3.33 to 3.62	15.0	27.1
greater than 3.62	0.6	3.2
	100.0	100.0

It is immediately evident from Table 1 that there is very little true siderite in the ore, since the heaviest fraction, which should contain any siderite present, constitutes only a very small percentage

of the total sample weight (pure $FeCO_3$ has a specific gravity of 3.96).

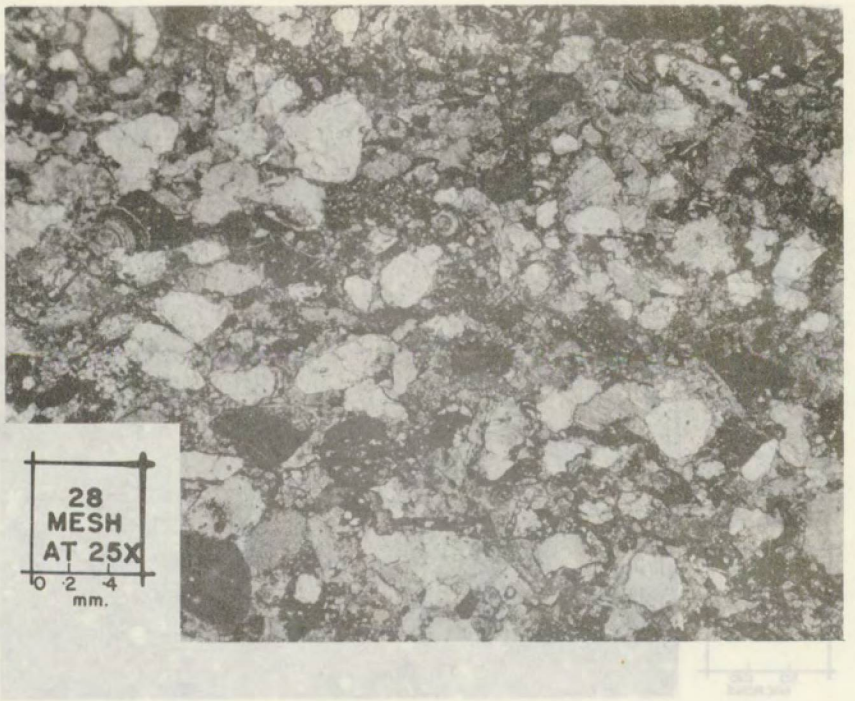
Refractive index measurements made on the carbonate grains in the different fractions reveal that the principal carbonate minerals present are calcite and a brownspar ($(Mg, Fe)CO_3$) containing an estimated 32% iron. The specific gravity of a brownspar of this composition is 3.5, so this mineral would be expected to report in the 3.33-3.62 specific gravity fraction. This was found to be the case, which substantiates the estimated iron content of the brownspar. The calcite, as would be expected, is in the fraction with a specific gravity less than 2.96. The fraction with a specific gravity between 2.96 and 3.33 is a middling product consisting of combined calcite and brownspar; the percentage of material in this fraction gives some indication as to the liberation of the two carbonates, which was far from complete at this grain size. The -65+150 mesh portion has a middling fraction of about 50%, while in the -150+325 mesh portion it is 33%. These fractions also contain most of the apatite in the sample; so the percentage of combined calcite-brownspar grains is somewhat less than the values of 50% and 33%.

Conclusions

The carbonate rock is composed largely of calcite and a brownspar estimated to contain 32% iron. About one-half of the carbonates occurs as rounded grains from 35 to 150 mesh in size; the

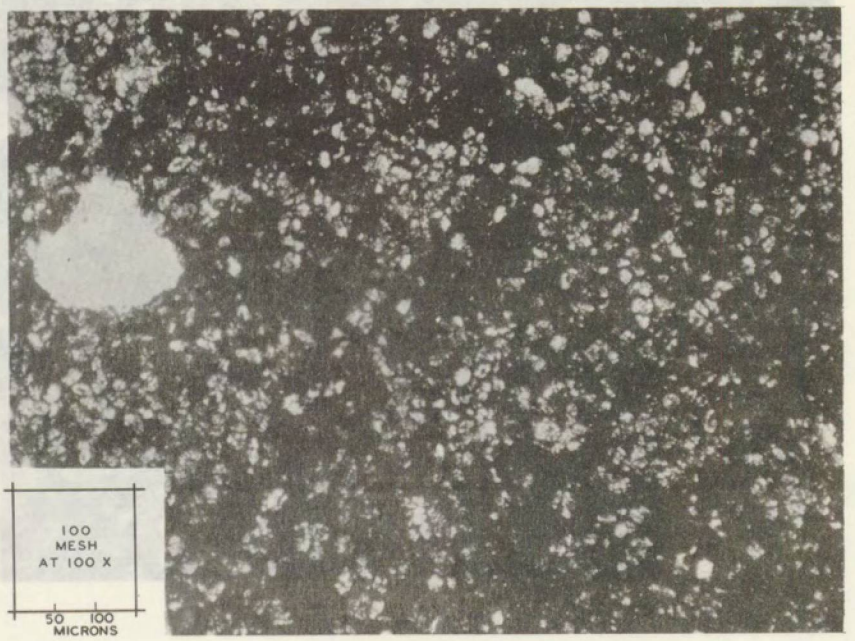
remainder, which constitute the matrix or cement, are much finer grained (-325 mesh). Other minerals present include quartz and apatite, and the rock is rather heavily stained by limonite.

FIGURE 1



Thin section in plane polarized light, showing relatively large grains of carbonate minerals (white, light grey) and apatite (dark grey to black) in a fine-grained carbonate matrix.

FIGURE 2



Thin section in plane polarized light, showing fine-grained carbonate matrix (tiny white grains) heavily stained by limonite (black). The large white grain at the extreme left is quartz.

DETAILS OF INVESTIGATION

Test No. 1

One thousand grams of ore, crushed to -10 mesh, was ground 15 min to 60% -200 mesh and transferred to a flotation cell. The pulp was diluted with water to 25% solids and conditioned for 10 min with the following reagents:-

Sodium hydroxide	-	2.0 lb/ton
Emulsol X-1	-	0.1 "
Crude oil	-	0.1 "
Oleic acid	-	0.15 "
pH	-	10.8

A dark, graphitic-looking concentrate was then skimmed off for 7 min. A few more drops of oleic acid were then added, which produced a heavy froth, and a second concentrate was skimmed off for 7 min.

Results of Test No. 1

Product	Weight, %	Assays, %		Distribution, %	
		Fe	P	Fe	P
Conc. No. 1	2.7	19.9	1.58	2.8	3.2
Conc. No. 2	18.1	19.3	1.23	18.4	16.5
Flot. tailing	79.2	18.9	1.37	78.8	80.3
Feed (calc.)	100.0	19.0	1.35	100.0	100.0

Test No. 2

One thousand grams of ore, crushed to -10 mesh, was ground 20 min to 74.4% -200 mesh, transferred to a flotation cell, and conditioned with the following reagents:-

Sodium hydroxide - 2.0 lb/ton

Neofat 42-12 - 0.1 lb/ton

pH - 11.4

A dark brown concentrate, with only a small amount of froth (similar to Test No. 1), was then skimmed off for 7 min.

Two more drops of Neofat 42-14 were then added, which created a large amount of froth, and a second concentrate was skimmed off for 7 min.

Results of Test No. 2

Product	Weight, %	Assays, %		Distribution, %	
		Fe	P	Fe	P
Conc. No. 1	2.3	19.6	1.33	2.4	2.3
Conc. No. 2	18.7	20.8	1.27	20.6	17.5
Flot. tailing	79.0	18.4	1.38	77.0	80.2
Feed (calc.)	100.0	18.9	1.36	100.0	100.0

Test No. 3

One thousand grams of ore was crushed to -28 mesh and then screened on 65, 100, 150 and 200 mesh. The screened fractions were fed separately to a high-intensity dry magnetic separator in which the amperage setting was 1.0 amp. The tailing from each pass was refed to the separator with amperage raised to 3.0 amp. The

concentrate from the second pass was called a middling. The products obtained from the -65+100 mesh and -100+150 mesh were combined for assay.

Results of Test No. 3

Product	Weight, %	Assays, %		Distribution, %	
		Fe	P	Fe	P
Magnetic concentrate					
-28+65 mesh	18.1	23.6	1.15	21.8	14.0
-65+150 "	7.0	26.2	0.81	9.4	3.8
-150+200 "	3.2	28.2	0.63	4.6	1.4
-200 "	11.8	21.1	1.23	12.7	9.8
Composite conc. (calc.)	40.1	23.7	1.07	48.5	29.0
Magnetic middling					
-28+65 mesh	27.5	19.9	1.40	27.9	26.0
-65+150 "	4.4	19.7	1.47	4.4	4.4
-150+200 "	1.2	23.8	1.17	1.5	0.9
-200 "	8.2	20.4	1.21	8.5	6.7
Composite mids. (calc.)	41.3	20.0	1.36	42.3	38.0
Magnetic tailing					
-28+65 mesh	7.5	7.6	3.02	2.9	15.3
-65+150 "	5.0	7.4	2.92	1.9	9.8
-150+200 "	3.1	8.6	2.46	1.4	5.1
-200 "	3.0	19.4	1.36	3.0	2.8
Composite tailing (calc.)	18.6	9.6	2.63	9.2	33.0
Feed (calc.)	100.0	19.6	1.48	100.0	100.0

CONCLUSIONS

The principal iron-bearing mineral in this sample was brownspar, an iron magnesium carbonate, estimated to contain 32% iron. Approximately half of this mineral occurs in grain sizes coarser than 150 mesh; the remainer is extremely fine grained, requiring grinding to 325 mesh for its liberation.

The mineral, apatite, which accounts for the phosphorus in the ore, occurs for the most part in grains coarser than 150 mesh. This mineral should be liberated at medium fine grinding.

Apatite is not readily amenable to concentration. With certain apatite ores, some success has been obtained using flotation with the reagent combination tried in tests Nos. 1 and 2. However, in this sample the apatite did not respond to this treatment.

Testing the sample on a high-intensity magnetic separator did produce a concentrate somewhat lower in phosphorus content. The difficulty with this treatment is that -200 mesh material is not amenable to this type of dry separation. A wet separator in which washing action takes place might be more suitable but, unfortunately, a high-intensity magnetic separator of this type was not available.

The mineral characteristics of the sample precluded the use of other means of separating the minerals, such as gravity concentration or magnetic roasting.

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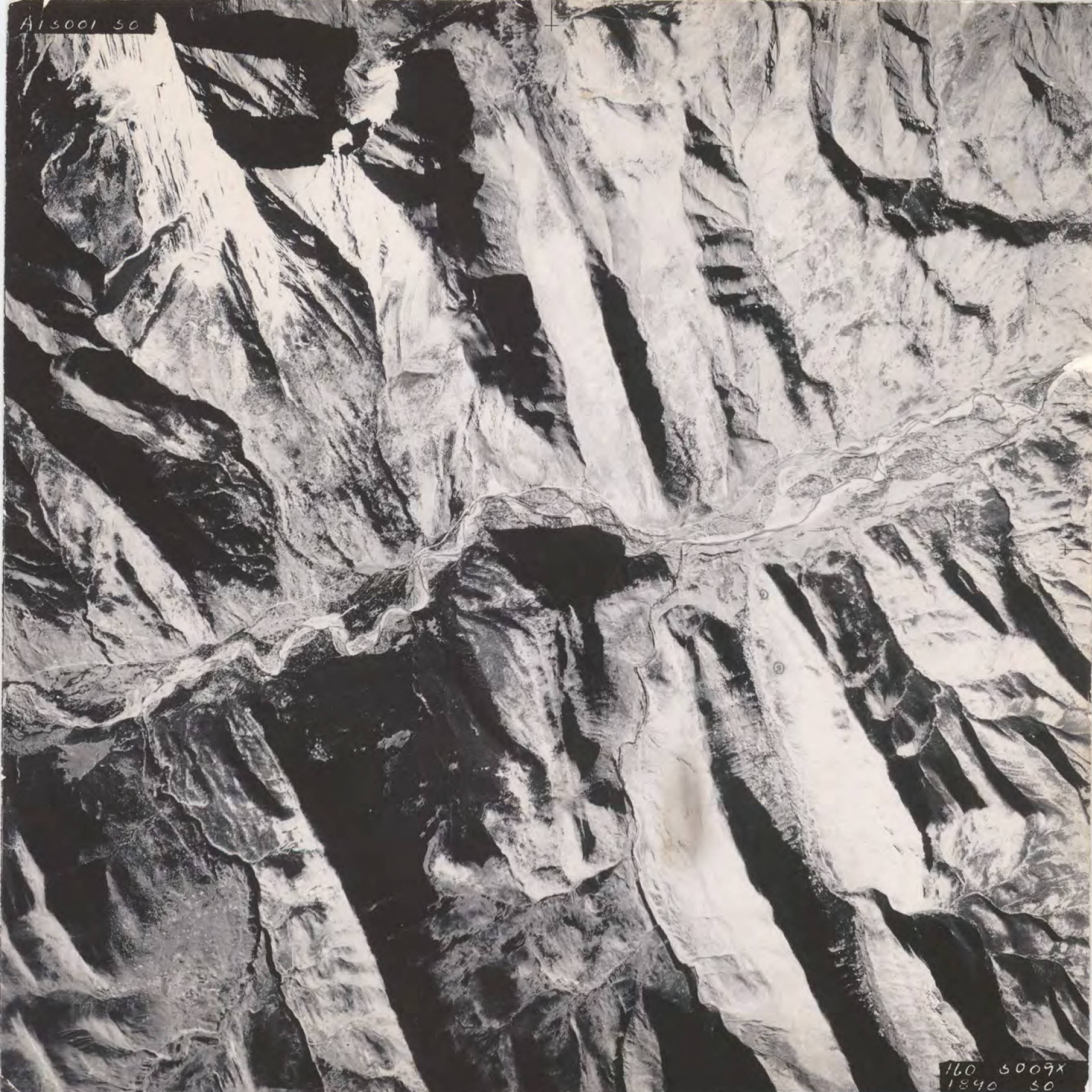
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