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Central Mineral Dressing

Laboratory

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REPORT NO. 24

Nov. 1959

ANALYSES OF SAMPLES  
FROM THE  
SAVAGE RIVER IRON ORE DEPOSIT  
TASMANIA

By

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WHYALLA S.A.

November, 1959.

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1. SUMMARY

The Gossan of the Savage River ore deposit consisted of high grade direct shipping ore.

A sample from an adit showed that 2% Sulphur, as pyrite, could be expected in the underlying ore after removal of the Gossan.

TiO<sub>2</sub> averaged approximately 0.5%, without beneficiation.

Mineragraphic examination showed small amounts of native copper in the surface samples. Spectrographic analyses showed less than 0.01% Cu.

Vanadium, was present in all samples to a maximum of 0.09%.

With the exception of Samples Nos. 1 and 2 which contain appreciable amounts of pyrite and non-opaque minerals, all other samples represent high grade iron ore grading from magnetite rich to hematite rich ore, with very minor impurities such as silicate minerals and traces of native copper and ilmenite. Limonite is always a minor constituent.

The hematite rich ores are the result of martitization of magnetite as indicated by shape of grains and replacement structures.

2. SAMPLES

Thirteen bulk samples, from the Savage River iron ore deposit in Tasmania, were received from Rio Tinto Australian Exploration Pty Ltd.

The samples were contained in thirteen 12 gallon oil drums. The lids had been tacked down in several places but not sealed.

The samples as received were contaminated with oil, as the drums had not been cleaned out before the samples were placed in them.

A description of the samples in each drum may be seen in Table. 2.1.

TABLE 2.1DESCRIPTION OF SAMPLES

<u>SAMPLE NO.</u>	<u>LENGTH FT.</u>	<u>DESCRIPTION</u>
1	76'	Channel sample S. wall adit "C" from portal to face. Medium grained granular magnetite with granular pyrite throughout.
2	25'	Outcrop 40' W of access road and 76' N of line A00.
3	31'	Surface outcrop.
4	51'	Surface outcrop.
5	62'	Surface outcrop.
6		No details available at Whyalla.
7	10'	Surface outcrop.

<u>SAMPLE NO.</u>	<u>LENGTH FT.</u>	<u>DESCRIPTION</u>
8	12'	Surface outcrop
9	40'	Surface outcrop
10	12'	Surface outcrop
11	45'	Surface outcrop
12	34'	Surface outcrop
13	6'	Surface outcrop

### 3. EXPERIMENTAL

The drums of samples were tipped into a tared tub for weighing. Before the wet weight was taken, samples were picked out for petrological examination.

The samples were weighed wet, oven dried and reweighed.

Each sample was crushed, cut down, pulverised and prepared for analyses.

Analyses for Fe, MnO, P, S, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, CaO MgO, and ignition loss were performed at Whyalla. The trace elements, Cr, V, Ni, Cu and Co were determined spectrographically at Port Kembla.

### 4. RESULTS

#### 4.1 MOISTURE TEST

The results of the oven drying for moisture determination, and preparation of the sample, may be seen in Table 4.1.

TABLE 4.1

#### MOISTURE DETERMINATION

<u>SAMPLE NO.</u>	<u>WET WEIGHT (LBS)</u>	<u>DRY WEIGHT (LBS)</u>	<u>LOSS OF WEIGHT (LBS)</u>	<u>% MOISTURE</u>
1	225.5	206.5	19.0	9.2
2	120	113.5	6.5	5.7
3	114	108.5	5.5	5.1
4	112.5	107	5.5	5.1
5	114	109.5	4.5	4.1
6	113.5	108.5	5.0	4.6
7	119	103	6.0	5.8
8	115.5	109.5	6.0	5.5
9	122	115	7.0	6.1
10	111.5	107	4.5	4.2
11	126	121	5.0	4.1
12	116.5	111	5.5	4.9
13	102.5	98	4.5	4.6

#### 4.2 MINERAGRAPHIC EXAMINATION

The results of the mineragraphic examination, of specimens taken from each of the thirteen drums, may be seen in "Petrological Report No. 70/59, which has been attached to this report as Appendix 1.

4.3 ANALYSES

The analyses carried out at Whyalla may be seen in Table 4.2. The analyses, for trace elements, carried out at Port Kembla may be seen in Table 4.3.

TABLE 4.2  
SAVAGE RIVER SAMPLES  
ANALYSES (WHYALLA)

SAMPLE NO.	% Fe	% MnO	% P	% S	% SiO <sub>2</sub>	% Al <sub>2</sub> O <sub>3</sub>	% TiO <sub>2</sub>	% CaO	% MgO	% Ign. Loss
1	63.0	0.1	0.085	2.0	2.8	1.5	0.35	0.6	0.45	1.6
2	67.7	0.05	0.12	0.03	1.4	0.5	0.37	0.4	0.4	0.7
3	67.4	0.1	0.05	0.04	0.45	0.6	0.50	0.4	1.0	1.2
4	68.5	0.15	0.12	0.02	0.15	0.2	0.45	0.4	0.7	0.3
5	66.8	0.05	0.08	0.03	0.25	0.3	0.55	0.35	0.35	2.2
6	65.8	0.10	0.10	0.05	0.3	0.5	0.90	0.35	0.45	3.5
7	68.1	0.05	0.03	0.04	0.5	0.8	0.55	0.35	0.2	0.3
8	66.2	0.05	0.21	0.09	1.1	0.5	0.35	0.25	0.4	2.4
9	67.2	0.05	0.04	0.03	0.6	0.7	0.45	0.25	0.2	1.8
10	67.7	0.1	0.025	0.03	0.5	0.5	0.40	0.35	0.3	0.9
11	67.0	0.1	0.045	0.03	0.6	0.5	0.45	0.35	0.4	1.3
12	66.6	0.1	0.095	0.03	0.5	0.6	0.65	0.3	0.1	2.3
13	67.7	0.1	0.05	0.03	0.2	0.3	0.90	0.3	0.7	0.6

TABLE 4.3

SAVAGE RIVER SAMPLES

ANALYSES (PORT KEMBLA)

SAMPLE NO.	% Cr	% V	% Ni	% Cu	% Co
1	0.003	0.050	0.030	less than 0.01	Nil
2	0.005	0.090	0.030	less than 0.01	Nil
3	0.005	0.090	0.025	less than 0.01	Nil
4	0.005	0.080	0.030	less than 0.01	Nil
5	0.005	0.070	0.045	less than 0.01	Nil
6	0.005	0.070	0.055	less than 0.01	Nil
7	0.005	0.090	0.040	less than 0.01	Nil
8	0.005	0.090	0.045	less than 0.01	Nil
9	0.005	0.070	0.045	less than 0.01	Nil
10	0.005	0.070	0.045	less than 0.01	Nil
11	0.005	0.080	0.045	less than 0.01	Nil
12	0.005	0.090	0.055	less than 0.01	Nil
13	0.005	0.090	0.045	less than 0.01	Nil

5. DISCUSSION OF RESULTS

Chemical analyses showed that samples Nos. 2 to 13 represent high grade direct shipping iron ore. These samples, which were surface samples, constituted the gossan of the orebody and were low in Sulphur.

Sample No. 1, which was an adit sample, contained 2.0% S. The probability that this sample could represent the underlying ore must not be overlooked. It may be expected that this will be the material to be mined after removal of the gossan.

TiO<sub>2</sub> content, which averaged approximately 0.5%, was not excessive. In consequence no beneficiation testing was carried out.

Mineragraphic examination showed that native copper was present in small amounts, in some surface samples; but spectrographic analyses showed the copper to be less than 0.01%.

There was no Cobalt in the samples.

6. CONCLUSIONS

The surface material of the Savage River ore deposit consisted of high grade direct shipping ore.

The sample of ore, beneath the gossan, contained 2.0% Sulphur. It could be that this slightly pyritic ore would constitute the underlying ore after removal of the gossan.

Native Copper was seen in some of the gossan samples.

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but spectrographic analyses showed less than 0.01% Cu in all samples.

Vandium was present in all samples to a maximum of 0.09%.

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THE BROKEN HILL PROPRIETARY COMPANY LIMITED; WHYALLA S.A.MEMO. FROM D. Burger  
TO Senior GeologistPETROLOGICAL REPORT NO. 70/59 - Iron Ore from Savage River  
TasmaniaIntroduction

The Ore Dressing Laboratory at Whyalla recently received a series of thirteen bulk samples Nos. 1 - 13 from the Savage River Iron Ore prospect, Tasmania. The Petrological laboratory at Whyalla was required to carry out a microscopic examination, for which purpose thin sections and polished sections were prepared from representative specimens from the thirteen samples.

Where possible micro-metric analyses have been carried out.

SUMMARYSample No. 1 - 1 Pyritic magnetite ore

<u>Mineral Percentages by volume</u>		<u>Grainsize m.m.</u>
Magnetite	81	0.08 - 0.30
Pyrite	6	
Non-opaque minerals ) )		
talc, gypsum, chrysotile )	13	
Choloopyrite	Trace	0.016 - 0.060

Sample No. 2 - Impure Limonitic magnetite - hematite ore

Magnetite	56	0.08 - 0.24
Hematite	23	
Limonite	6	
Non-opaque minerals )		
quartz, talc, dahlite)	15	

Sample No. 3 - Limonitic magnetite - hematite ore

Magnetite	bulk	0.16 - 0.44
Hematite	minor	
Limonite	minor	

Sample No. 4 - Magnetite - hematite ore

Magnetite	87	0.08 - 0.32
Hematite	13	
Limonite	Trace	

Sample No. 5 - Limonitic hematite - magnetite ore

Magnetite	11 )	0.16 - 0.50
Hematite	78 )	
Limonite	11	

Sample No. 6 - Limonitic hematite - ore

Magnetite	minor )	0.24	0.56
Hematite	bulk )		
Limonite	minor		
Native copper	2 grains	0.016	0.080
Non-opaque minerals )	traces		
(halloysite))			

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Sample No. 7- Limonitic - Magnetite - hematite ore

Magnetite plus hematite	74 (minor hematite)	0.08	0.40
limonite	26		

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Sample No. 8 - Limonitic hematite ore

Magnetite	Traces )	0.080	0.50
Hematite	92 )		
Limonite	6		
Native Copper	Trace (4 grains)	0.008	0.030
Non-opaque (talc)	2		

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Sample No. 9 - Limonitic hematite ore

Magnetite	Trace )	0.16	0.60
Hematite	bulk )		
Limonite	Very minor		
Native Copper	Trace (1 grain)	0.024	

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Sample No. 10 - Limonitic hematite ore

Magnetite	trace )		
Hematite	92 )	0.12	0.60
Limonite	8		
Ilmenite	trace	0.08	0.30
Talc	trace		

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Sample No. 11 - Limonitic Hematite - magnetite - ore

Magnetite	trace )	0.04	0.40
Hematite	89 )		
Limonite	11		
Ilmenite	trace	0.06	0.40

Other specimen from same sample

Magnetite	80
Hematite	trace
Limonite	17
Quartz	3

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Mineral Percentages by volume

Grain size m.m.

Sample No. 12 - Limonite Hematite - ore

Magnetite	trace )		
Hematite	96 )	0.08	0.40
Limonite	3.8		
Ilmenite	0.2	0.16 -	0.060

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Sample No. 13 - Limonitic Magnetite - hematite ore

Magnetite	79 )	0.16	0.60
Hematite	6 )		
Limonite	15		
Ilmenite	trace	0.016	0.060

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General Conclusions

(1) With the exception of Samples Nos. 1 and 2 which contain

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appreciable amounts of pyrite and non-opaque minerals, all other samples represent high grade iron ore grading from magnetite rich to hematite rich ore, with very minor impurities such as silicate minerals and traces of native copper and ilmenite. Limonite is always a minor constituent.

(2) The hematite rich ores are the result of martitization of magnetite as indicated by shape of grains and replacement structures.

DESCRIPTION OF SAMPLES

Sample No. 1 (thin section No. 1,344, polished section No. 1,344)

Location Channel sample, south wall Adit C, taken from portal to face, 76 ft.

Macroscopic Two types of materials can be distinguished.

(a) chiefly made up of fine grained magnetite, minor pyrite and silicate minerals. Limonite occurs only as stains.

(b) Consists of magnetite, minor silicates. Limonite although a minor component, is more prominent in this type.

Both types are strongly magnetic. Type (b) evidently is the more hydrated form of (a).

Pyrite occurs as irregular veinlets and elongated blebs white silicate minerals form a minor but conspicuous constituent occurring in thin irregular veinlets. Both types of ore are rather soft and easily break up into small fragments and grains.

Microscopic Polished section No. 1,344, prepared from type

(a) reveals that the bulk of the specimen consists of an aggregate of closely packed magnetite grains, with occasional cavities and minor silicate minerals.

In places the magnetite grains which have a pitted surface reveal cleavage lines in a triangular pattern, characteristic of the octahedral crystal - structure. Grains range in size from 0.08 mm. to 0.30 mm. Their colour in reflected light is brownish-grey.

Pyrite is creamy-yellow and occurs in highly irregular veinlets up to 2 mm. wide. Blebs range in size from 0.016 mm. to 0.20 mm. The majority are of irregular shape, but there are rare grains showing the characteristic rectangular shape of pyrite crystals. Cracks are common, generally without any regular pattern but occasionally there are cracks in two directions of right angle. Individual pyrite grains range in size from 0.016 mm. to 0.20 m.m.

Chalcopyrite Traces only, occurring as minute yellow blebs (0.016 - 0.06 mm.) inside creamy-yellow pyrite grains. One bleb was observed occurring on the contact between pyrite and magnetite.

Relationship between Magnetite and pyrite

The irregular blebs and veinlets of pyrite suggest that this mineral has been introduced into the bulk of magnetite.

Non-opaque minerals

The binocular magnifier reveals (1) thin veinlets of a soft pale green mineral with flakey habit (2) small aggregates (3 mm.) of a clear colourless mineral with prismatic habit.

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1. Pale Green mineral: it is very soft. A small sample was removed from the hand specimen, and mounted in oil. The flakes are nearly dark between crossed nicols and display an optically negative biaxial interference figure with a small axial angle of approximately  $15^\circ$ . R.I. (highest) between 1.57 and 1.58.

These properties suggest talc.

2. Colourless mineral: The crystals which can easily be scratched by the fingernail are well formed slender prisms display excellent cleavage, moderate birefringence and an optically positive biaxial interference Figure.

R.I. (lowest) between 1.51 and 1.52  
 R.I. (highest) " 1.52 and 1.53  
 Largest extinction angle observed  $36^\circ$ .  
 The mineral is gypsum.

3. Minute amounts of a mineral with fibrous habit

The fibres show weak birefringence, length slow orientation and R.I. between 1.502 and 1.515. The mineral is chrysotile.

Mineral Percentages by volume.

Magnetite	81
Pyrite	6 (including traces of chalcopyrite)
Non-opaque minerals: ) talc, gypsum, chrysotile. )	13

Conclusion: Essentially pyritic magnetite ore with talc and gypsum as minor impurities.

Sample No. 2 (Polished section No. 1345)

Location: Outcrop 40 ft. west of Access Road and 76 ft. north of line A00. Length 25 ft.

Macroscopic: The material is somewhat porous and from moderately to strongly magnetic. Constituents are magnetite, limonite and limonite-stained silicate minerals.

Microscopic: Chiefly composed of closely packed, partly oxidized, often enohedral magnetite grains and minor limonite.

Magnetite: The grains ranging in size from (0.08 mm. to 0.24 mm. clearly show martitization along the rims. Hematite commenced replacing the magnetite along crystallographic lines, often revealed by three sets of lamellae crossing at an angle of approximately  $60^\circ$ . The hematite lamellae are pale grey and strongly anisotropic; magnetite is brownish grey in reflected light.

Limonite is grey, with yellow brown internal reflection. The bulk is structure-less. It occurs (1) interstitially, in cracks along the grain boundaries (2) in wider veinlets and blebs. Relics of magnetite grains can be sometimes recognized, forming a kind of box work. (3) as a thin crust of fibrous goethite on the wall of some of the cavities. This mineral is bluish grey and strongly anisotropic in reflected light and when viewed between crossed nicols.

Non-opaque minerals: The following minerals have been identified, using small samples removed from the hand specimens, mounted in oil.

- (1) Quartz: occurs as a fine powdery material.
- (2) Talc.
- (3) A mineral occurring as minute fragments with low birefringence

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length, fast orientation, R.I. between 1.63 and 1.64. This mineral is probably dahlite, one of the phosphate minerals.

Mineral Percentages by Volume

Magnetite	56
Hematite	23
Limonite	6
Non-opaque minerals	15

Conclusion: an impure and slightly hydrated magnetite-hematite ore.

Sample No. 3 (Polished section No. 1346)

Length 31 ft.

Location from surface outcrop

Macroscopic: A strongly to moderately magnetic iron ore, in parts limonitic and with fine granular texture.

Microscopic: A polished section prepared from a strongly magnetic specimen reveals an apparently massive type of ore. Outlines of grains are generally not clearly visible probably on account of more closely packed and recrystallized magnetite grains. Where grain boundaries are visible, the grains range in size from 0.16 mm. to 0.44 mm. or somewhat coarser than in previous specimens.

The magnetite grains are hardly effected by martitization and the thin lines of hematite along the outlines of the grains form only a trace compared with the bulk of the section. Limonite also forms only a trace in this section.

Conclusions: Chiefly a magnetite ore with limonite and hematite as a minor constituent.

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Sample No. 4 (Polished section No. 1,347)

Length: 51 feet

Location: from surface outcrop

Macroscopic: Strongly magnetic material with minor limonite.

Microscopic: A fine granular texture. The chief constituents are grains of magnetite, ranging in size from 0.08 mm. to 0.32 mm. partly martitized along crystallographic lines. This section is composed of 87% magnetite and 13% hematite (by volume).

Ilmenite: One small bleb occurs (0.05 mm). The colour is grey-brown).

Conclusion: A high grade magnetite ore, partly martitized. Limonite forms only a very minor constituent.

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Sample No. 5 (Polished section No. 1348)

Length: 62 feet

Location: From surface outcrop

Macroscopic: Limonite forms only a relatively minor constituent in this sample. The ore has a granular texture, but some specimens are prous in parts. The majority of the specimens are only moderately magnetic.

Microscopic: the polished section reveals that a considerable portion consists of hematite in which the triangular pattern of lamellae indicate that magnetite was the original mineral.

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This is further confirmed by grains of magnetite only partly converted to hematite. They have a brownish grey core of unaltered magnetite with characteristic pitted surface. The grains range in size from 0.16 mm. to 0.5 mm, generally larger than in previous specimens.

Noticeable is the great number of well formed crystals in this section.

Limonite: Occurs (1) Interstitially (2) In cleavage traces of magnetite grains (3) in cavities, as a thin crust on the wall, and as skeletons of completely altered magnetite crystals.

Mineral Percentages (by volume)

Magnetite	11
Hematite	78
Limonite	11

Conclusion: A limonitic hematite ore. It is derived from magnetite ore considerably affected by martitization.

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Sample No. 6 (Polished section No. 1349)

Location: not stated

Macroscopic: The specimens are somewhat porous. Limonite forms only a thin superficial coating and when scratched the specimen yields a red brown powder indicating the presence of hematite. The specimen is non-magnetic.

Microscopic: In parts of the section the granular texture can still be observed. The specimen consists chiefly of hematite and very minor limonite.

Hematite: The lamellar texture is clearly visible and the pattern suggests crystallographic lines and cleavage of the original magnetite.

Magnetite: No trace could be found in this section. The mineral has been completely converted either to hematite or to limonite. There are skeletal structures, which originally were magnetite crystals. The martitization of the magnetite commenced along the grain boundaries. The centre of the magnetite grains was apparently directly converted to limonite which in turn was leached out, leaving a shell of hematite with a regular box work texture, indicating original crystallographic lines.

The texture of this box work is extremely fine and this type has not been noticed in the specimens described above. Grains range in size from 0.24 mm. to 0.56 mm.

Native copper: Only two minute grains (0.016 mm. - 0.080 mm) occur. The grains have a high, distinctly pink luster and occur in contact with hematite on the wall of a cavity.

Limonite: is a very minor constituent. It occurs  
(1) as a thin crust in some of the cavities  
(2) in cracks  
(3) as interstitial material along grain boundaries and cleavage traces.

Silicate mineral

Traces of a white mineral occur on some of the fracture faces. It is of extremely fine grain, isotrope and has a R.I. between 1.54 and 1.55. The mineral is probably halloysite, one of the clay minerals.

Conclusion: a slightly limonitic hematite ore, derived from granular magnetite ore.

Sample No. 7 (polished section No. 1350)

Location: from surface outcrop

Length: 10 feet

Macroscopic: A somewhat porous ore with cavities up to 2 cm. long. It is moderately to strongly magnetic. Limonite forms a relatively small proportion.

Microscopic In parts of the section the granular texture is apparent and clearly indicate the outlines of original magnetite grains. A fault crosses the section, marked by a 0.6 mm. wide zone of angular hematite fragments set in a matrix of limonite. The bulk consists of martitized magnetite as shown by the texture of hematite. Occasional patches of unaltered magnetite form the core of some of the otherwise completely martitized magnetite grains. They range in size from 0.08 mm. to 0.4 mm.

Limonite forms a minor but appreciable constituent. It occurs (1) as a thin crust on the wall of cavities (2) as a cement in micro-faults (3) as interstitial material along grain boundaries and in cracks.

Mineral Percentages (by volume)

Hematite plus magnetite	74 (Hematite very minor)
Limonite	26

The pitted surface on the greater portion of this section does not permit determining magnetite and hematite separately. Evidently the polished section represents the oxidised portion of the hand specimen. A scratch made on the freshly sectioned surface of the hand specimen reveals limonite and hematite (as red-brown powder) in the soft oxidized part, but moving inward the material becomes considerably harder on account of unaltered magnetite.

Conclusions: A limonitic hematite-magnetite ore, derived from magnetite as a result of martitization and hydration.

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Sample No. 8 (Polished section No. 1351)

Length: 12 ft.

Location: from surface outcrop

Macroscopic: Composed partly of strongly magnetic, partly of non-magnetic ore. The specimens show a coarse porosity; cavities up to 2 cm. long occur. Some of the specimens are partly covered by a crust of pale coloured silicate minerals.

Microscopic the polished section has been prepared of the non-magnetic material. The bulk of the material consist of hematite. The pattern of the lamallae suggests martitization of the original magnetite-grains which range in size from 0.08 mm. to 0.5 mm. Limonite is a minor constituent occurring in cracks and in cavities.

Native copper: Only four minute grains occur, ranging in size from 0.008 mm. to 0.03 mm. All grains are located on the wall of a cavity in contact with hematite. As in polished section No. 1,349 ( sample No. 6) the grains have a distinctly pink metallic lustre.

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Silicate mineral: A micaceous mineral, which occurs in a thin crust on the hand specimen, has the following optical properties.

R.I. (lowest) between 1.55 and 1.56  
R.I (highest) " 1.59 and 1.60

Biaxial interference figure is optically negative with small angle between optical axes. The mineral is talc.

Mineral percentages by volume

Hematite	92
Limonite	6
Non-opaque minerals	2

Conclusion: the polished section examined is a slightly limonitic hematite ore, but the sample is better described as a limonitic hematite magnetite ore with minor silicates.

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Sample No. 9 (Polished section No. 1352)

Length: 40 ft.

Location: from surface outcrop

Macroscopic: Somewhat limonitic and somewhat porous ore, weakly magnetic and containing micaceous mineral in irregular veinlets.

Microscopic: bulk consists of hematite, its pattern of lamellae suggests martitization of original magnetite-grains. Magnetite does not occur in this section. Original grains range in size from 0.16 mm. to 0.6 mm.

Native Copper: Only one grain occurs in this section (0.023 mm).

Limonite: is a very small constituent only and is limited to a thin crust (0.008mm.) in cavities and occasionally between grains.

Micaceous mineral: forms a small constituent only, occurs in irregular veinlets and displays the following properties (1) pronounced cleavage yielding irregular colourless flakes (2) very soft, easily scratched by fingernail (3) flakes exhibit dark to grey colours between crossed nicols. (4) small axial angle. (5) N (Highest) between 1.58 and 1.59 (6) Biaxial negative interference figure.

The mineral is talc.

Conclusion: essentially a slightly limonitic hematite ore containing small amounts of talc.

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Sample No. 10 (Polished section No. 1353)

Length: 12 feet

Location: from surface outcrop

Macroscopic: Somewhat porous, slightly limonitic and moderately magnetic ore.

Microscopic: hematite and a little interstitial limonite form the bulk of the specimen.

Hematite: clearly show the lamellae in three directions indicating completely martitized magnetite. Only a few patches still occur. Original grainsize: from 0.12 mm. to 0.6 mm.

Limonite: a minor constituent. It occurs as a thin crust in

cavities and in cracks. Limonite forms also skeleton structures.

Ilmenite: occurs in small blebs ranging in size from 0.08mm. to 0.1 mm. It is a very small constituent only. It shows a strong reflection pleochroism from purplish grey to dark brownish grey (darker than magnetite). The blebs often occur on the wall of a small cavity in contact with hematite. It is noticed the wall of these cavities is covered by a thin crust of limonite, except on the rim of the ilmenite grain. Evidently the mineral is highly resistant to oxidation.

Talc: forms very minor constituent only.

Mineral Percentages by Volume

Hematite	92
Limonite	8
Magnetite and Ilmenite	Traces
Talc	Trace

Conclusion: a slightly limonitic hematite ore

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Sample No. 11 (Polished section No. 1354)

Length: 45 feet

Location: from surface outcrop

Macroscopic: A somewhat porous, slightly limonitic, moderately magnetic ore. One specimen contains small amounts of a white silicate mineral.

Microscopic: Hematite is the principle mineral, It clearly reveals, the lamellae texture suggestive of martitized magnetite grains. The grains range in size from 0.04 mm. to 0.4 mm.

Limonite: a minor constituent. Both structure less limonite and goethite occur. The latter has a short prismatic habit, and clearly is anisotropic, showing bluish-grey colours when nicols nearly crossed. The polished section contains 89 percent hematite and 11 percent limonite.

Ilmenite: A few blebs occur ranging in size from 0.06 mm. to 0.4 mm. Reflection pleochroism; from pale purplish grey to purplish brown, shows up clearly. Non-opaque minerals: thin section NO. 1354 was prepared from a specimen containing a white mineral, which appears to be fine grained quartz, occurring in cracks and as interstitial material. In this section the mineral percentage area: quartz 3 percent, limonite 17 percent and magnetite 80 percent.

Conclusion: a limonitic hematite-magnetite ore with quartz as minor impurity.

Sample No. 12 (Polished section No. 1355)

Length: 34 ft. Location: from surface outcrop.

Macroscopic: The ore is somewhat porous and from weakly to moderately magnetic. Limonite is a minor constituent.

Microscopic: the polished section reveals that hematite has completely replaced the original magnetite. Original grains range in size from 0.08 mm. to 0.4 mm.

Ilmenite: although a very minor mineral, is fairly regularly distributed throughout this section. Blebs range in size from 0.04 mm. to 0.16 mm.

Mineral Percentages by volume

Ilmenite	0.2
Limonite	3.8
Hematite	96

Noticeable is the complete absence of magnetite in the polished section but other specimens must still contain magnetite as indicated by their magnetic properties.

Conclusion: a limonitic hematite-magnetite-ore. Although the ilmenite content is low, the polished section contains more than a trace of this mineral.

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Sample No. 13 (Polished section No. 1356)

Length: 6 feet

Location: surface outcrop

Macroscopic: somewhat porous weakly to moderately magnetic ore chiefly composed of granular hematite, magnetite and minor limonite. The latter mineral however, forms in this sample a more prominent constituent than in the samples described above.

Microscopic: magnetite is the major constituent. Grains range in size from 0.16 mm. to 0.60 mm.

Hematite is replacing magnetite along the rims.

Limonite: is structureless and occurs in cavities and cracks.

Ilmenite: is rare and occurs in widely scattered small blebs ranging in size from 0.016 mm. to 0.060 mm.

Mineral Percentages by volume

Hematite	6
Magnetite	79
Limonite	15

Conclusions: a limonitic magnetite-hematite ore.

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Polished section No. 1344 (Sample No. 1). Pyrite (white) in magnetite matrix (pale grey, with pitted surface). Black spots are pits. Darker grey material is bakelite. Reflected light x45.

Polished section No. 1345 (Sample No. 2). Mosaic of magnetite grains (grey with black spots) altered to hematite along the rims (pale grey). Skeletal structure in N.E. quadrant represents remnants of oxidised magnetite. Dark grey material is bakelite, black spots are pits. Reflected light. x45.

Polished Section No. 1349 (Sample No. 6). Boxwork structure of hematite (white) in rims of original magnetite grains, of which the core has been leached out. Dark grey material is bakelite. Reflected light. x148.

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Polished section No. 1355 (Sample No. 12). Martite (very pale grey) showing lamellae. Blebs of ilmenite (grey) near centre and in S.W. quadrant. Reflected light. xl48.