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MAGNETIC CONCENTRATION OF VANADIUM-BEARING TITANIFEROUS MAGNETITE FROM PROSPECTORS AIRWAYS COMPANY, LIMITED, IN PAPINEAU TOWNSHIP, ONTARIO

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

The vanadium in the ore could not be eliminated by magnetic concentration at -200 mesh. Most of the ilmenite, approximately 98%, was rejected by magnetic concentration at -100 mesh.

The -100 mesh concentrates from Samples 180 and 181 had the following analyses:

	Sample 180	Sample 181
Iron	68.1 %	69.6 %
Titanium dioxide	0.14 %	0.17 %
Vanadium pentoxide	1.45 %	1.50 %

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

CONTENTS

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LIST OF TABLES

INTRODUCTION

Shipment

A shipment of two samples, Nos. 180 and 181, was received August 25, 1960. Sample No. 180 consisting of drill core, net weight 5 lb 5 oz, and Sample No. 181, trench material, net weight 10 lb 14 oz, were submitted by Mr. E. O. Chisholm, Chief Geologist, Prospectors Airways Co.,Ltd., Suite 1616, 44 King Street West, Toronto 1, Ontario.

Location of the Property

The property is located in Papineau township, Ontario, near Mattawa.

Purpose of the Investigation

The samples were submitted for concentrating tests to determine the grade and recovery in concentrates, and to determine if the deposit could be exploited economically by present or new processes in which titanium-bearing concentrates could be used as smelter feed.

Description of the Property

In his letter, dated August 22, 1960, Mr. H. A. Pearson, of Prospectors Airways Co.,Ltd., stated in part, that the two Samples Nos. 180 and 181 came from a vanadium-bearing titaniferous magnetite deposit staked in Papineau township, Claims P.S. 5237, 5240, 5241, and 5243. Samples No. 180 and No. 181 were taken, respectively, from diamond drill core and surface trenches on the claims. The diamond drilling has indicated 3,800,000 tons of material averaging 22% iron and 0.4 to 0.5% vanadium pentoxide. A selected 1,980,000 tons averages 28% iron, 10%

titanium and 0.6% vanadium pentoxide. The vanadium mineral was thought to be coulsonite.

SAMPLING AND ANALYSIS OF THE SHIPMENT

TABLE 1

Chemical Analysis of the Head Samples

	Sample 180	Sample 181
Total iron	32.85 %	42.0 %
Titanium dioxide	8.28 %	10.55 %
Vanadium pentoxide	0.41 %	0.63 %
Sulphur	0.91 %	0.30 %
Phosphorus	none detected	none detected

TABLE 2

Semi-Quantitative Spectrographic Analysis of the Head Samples

	Sample 180	Sample 181
Major constituents	Fe, Ti, Mg	Fe, Ti, Mg, Si
Intermediate constituents	V, Al, Si, Mn	Al, V, Mn
Minor constituents	Co, Ni	Ca, Co
Trace constituents	Cu, Ca, Cr	Ni, Cu, Cr

MINERALOGICAL EXAMINATION*

Five polished sections from Sample No. 180, and four polished sections from Sample No. 181, were prepared and studied microscopically. A part of each sample was separated into fractions by means of the elutriating tube, hand magnet, Franz iso-dynamic separator, heavy liquids and the super-panner. Certain fractions were then scanned with the X-ray diffractometer to check for associated minerals and to determine the hematite content in the ilmenite.

In order to determine the distribution of vanadium in the ore minerals, spectrochemical analyses were made on the head samples, the magnetite fractions, the ilmenite fractions, and the gangue fractions.

Mineralogy and Ore Microscopy

The metallic minerals present in the samples are chiefly magnetite, ilmenite, hematite, and minor amounts of pyrite, pyrrhotite, chalcopyrite, and sphalerite. The non-metallic minerals are hastingsite (iron-rich hornblende), almandine (iron-aluminum garnet), augite, quartz and feldspar. An estimate of the mineral content of the samples was obtained by concentrating the minerals, weighing the concentrates, and identifying them under the microscope. The results are summarized in Table 3.

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* Internal Report MS-60-107, by W. Petruk, Mineral Sciences Division, November 18, 1960.

TABLE 3

Estimated Mineral Contents of Sample No. 180 and Sample No. 181

Mineral	Estimated Percentages in Sample No. 181	Estimated Percentages in Sample No. 180
Magnetite	46	32
Ilmenite + hematite	29	17
Hornblende	12	27
Pyroxene (augite)	--	11
Garnet	11	7
Quartz and feldspar	1	5
Sulphides	1	1
	100	100

The mineralogy of both samples is similar, but Sample No. 181 contains a higher proportion of metallic minerals than Sample No. 180. The magnetite:ilmenite + hematite ratios, however, are quite similar in both samples, i.e. 1.6 and 1.9 respectively.

Magnetite, which is the principal metallic mineral present, occurs in masses and irregularly shaped grains associated with the ilmenite (see Figure 1). It contains very narrow lamellae of a mineral that could not be positively identified, but whose optical properties suggest that it may be hoegbomite ($Mg(Fe,Al,Ti)_4O_7$) (see Figure 2). X-ray diffraction and spectrochemical analyses of the magnetite support this suggestion.

The ilmenite occurs in subhedral grains as massive aggregates and as small assemblages disseminated in the magnetite. The ilmenite

grains typically range between 0.5 mm and 1.0 mm in diameter. They contain parallel hematite lamellae which are probably also parallel to the (0001) direction of the ilmenite (see Figure 3 and Figure 4). The hematite lamellae are present in two distinct widths depending upon the type of surrounding ilmenite. The hematite lamellae in the disseminated ilmenite are about 20 microns wide; those in the massive aggregates of ilmenite are about $\frac{1}{2}$ micron wide and can be seen only under high magnification. A relatively small number of hematite lamellae were observed, however, which are 50 microns wide, and it is noteworthy that these in turn enclose ilmenite lamellae (see Figure 5). The amount of hematite present in the ilmenite is about the same in both types. X-ray diffraction analyses indicate that the hematite content in the ilmenite is roughly 16% in Sample No. 180, and 12% in Sample No. 181. The accuracy of this determination is regarded as perhaps plus or minus 6%, so these figures are of doubtful significance.

A mineral which may be hoegbomite (see page 4) occurs with hematite along narrow veinlets in the ilmenite (see Figure 4).

A small number of angular and rounded pyrite grains that range between 0.01 mm and 1.0 mm in diameter are present in both the ore and gangue minerals (see Figure 1 and Figure 6). Small quantities of pyrrhotite occur as irregular masses up to 1.0 mm in diameter, and as tiny veinlets in the magnetite and ilmenite. Very minor amounts of chalcopyrite and sphalerite are associated with the pyrrhotite (see Figure 6).

Results and Interpretations of Spectrochemical Analyses

Individual fractions of the two samples were analysed spectrochemically in the Analytical Chemistry Section with the results shown in Table 4. The gangue fractions consisted largely of hornblende with small amounts of garnet or augite; the magnetite and ilmenite fractions were estimated to contain less than 3% gangue minerals.

The analysis shows that Al, Mg, Si, Ca, Fe, and Na are the principal elements in the gangue and that the minor elements are Ba, V, Mn, Ni, and Co.

Vanadium occurs chiefly with the magnetite and ilmenite, with some apparent preference for the magnetite. Estimates, based on the figures in Table 3 and Table 4, indicate that the magnetite contains about 65% of the total vanadium content in both samples.

Conclusion

Magnetite and ilmenite are the major metallic minerals present in the ore. The magnetite is relatively pure, but the ilmenite contains roughly 12 to 16% hematite. The ratio of magnetite to ilmenite in the ore is probably constant, and it was estimated to be 1.6:1 and 1.9:1 for Sample No. 181 and Sample No. 180 respectively.

The vanadium occurs in both magnetite and ilmenite, but spectrochemical analysis indicates that it shows a slight preference for magnetite. Spectrochemical analysis indicates that the magnetite contains around 1% vanadium, which would account for approximately 65% of the vanadium in the head sample.

TABLE 4

Results of Spectrochemical Analysis

Element	Sample No. 181				Sample No. 180			
	Bulk sample Wt %	Gangue Wt %	Ilmenite+ Wt %	Magnetite* Wt %	Bulk sample Wt %	Gangue Wt %	Ilmenite+ Wt %	Magnetite* Wt %
Fe	PC	PC	PC	PC	PC	PC	PC	PC
Ti	9	1	PC	0.8	8	1	PC	0.2
Si	7	PC	1.0	0.3	PC	PC	0.4	0.5
Al	6	10	0.8	2	6	9	0.6	1
Mg	3	9	2	0.3	4	10	2	0.2
Ca	1	6	0.06	tr.	2	8	tr.	0.04
Na	0.4	1	--	--	0.6	2	--	--
V	0.7	0.1	0.5	1	0.5	0.1	0.8	1
Mn	0.4	0.7	0.3	0.02	0.3	0.1	0.3	0.02
Ba	0.01	0.02	--	tr.	0.01	0.03	--	--
Cr	0.02	tr.	tr.	0.03	0.01	tr.	tr.	0.05
Ni	0.01	0.04	0.01	0.01	0.01	0.01	0.01	0.01
Co	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.04
Cu	0.01	0.02	tr.	0.01	0.02	0.02	tr.	0.02
Zr	tr.	0.01	--	--	--	tr.	--	--

* contains hoegbomite (?), garnet, sulphides and ilmenite impurities.

+ contains garnet, hornblende, and sulphide impurities.

PC - principal constituent, wt % not estimated.

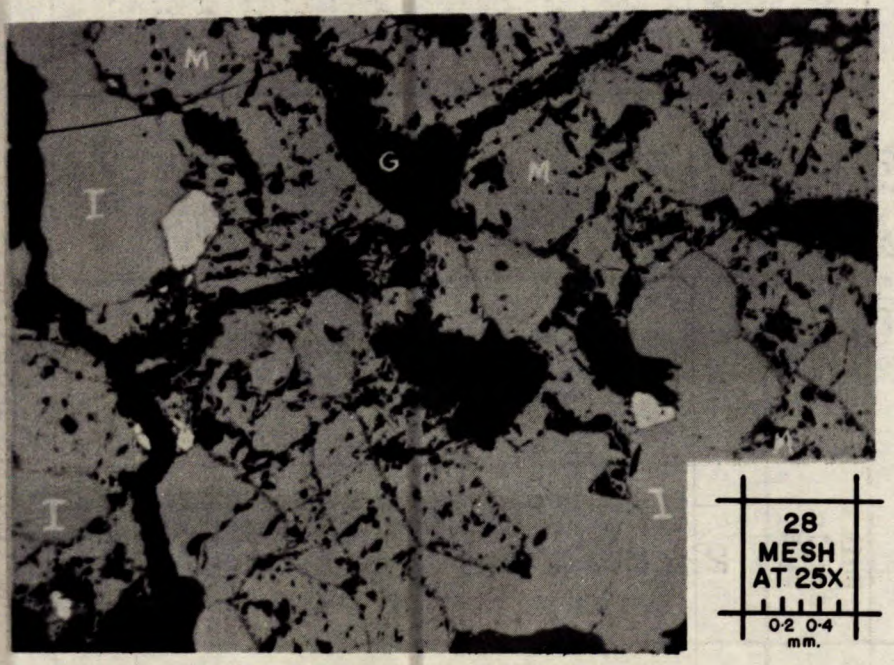

Figure 1. - General field showing the relationship between magnetite (M) and ilmenite (I). The dark grey patches (G) are gangue and white (P) is pyrite.

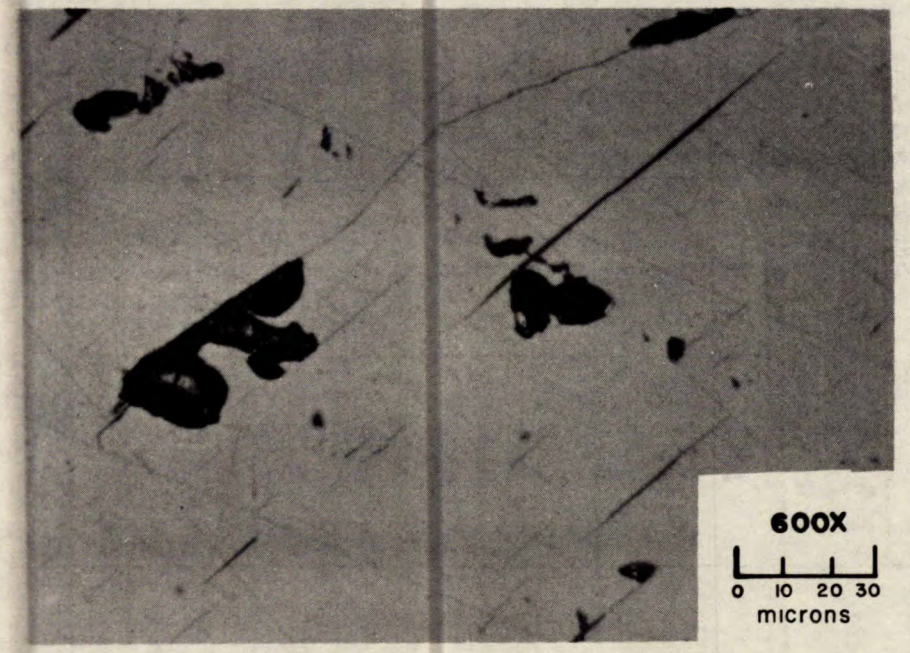

Figure 2. - Hoegbomite (?) lamellae in magnetite.

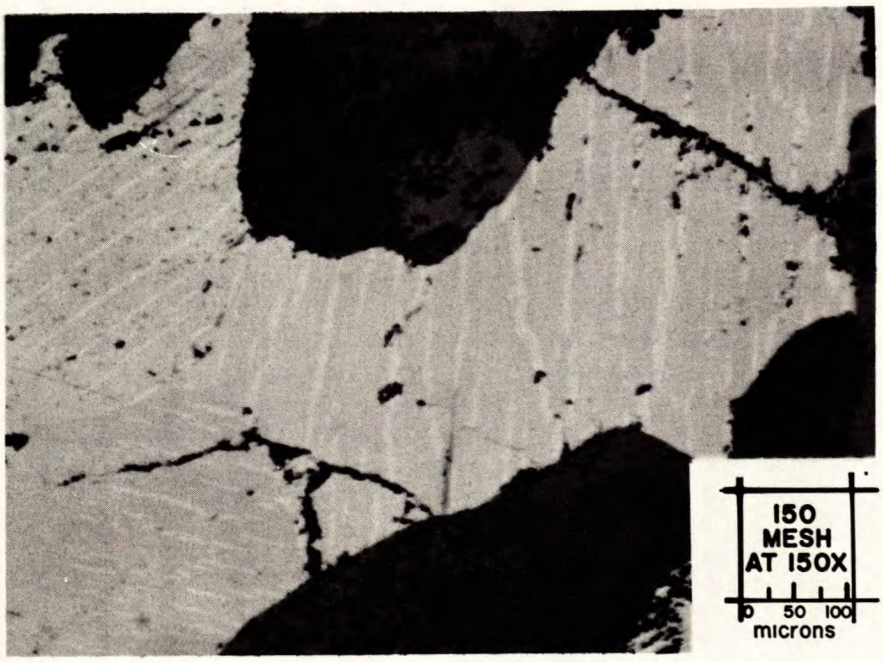

Figure 3. - Hematite lamellae (white) in ilmenite (grey).

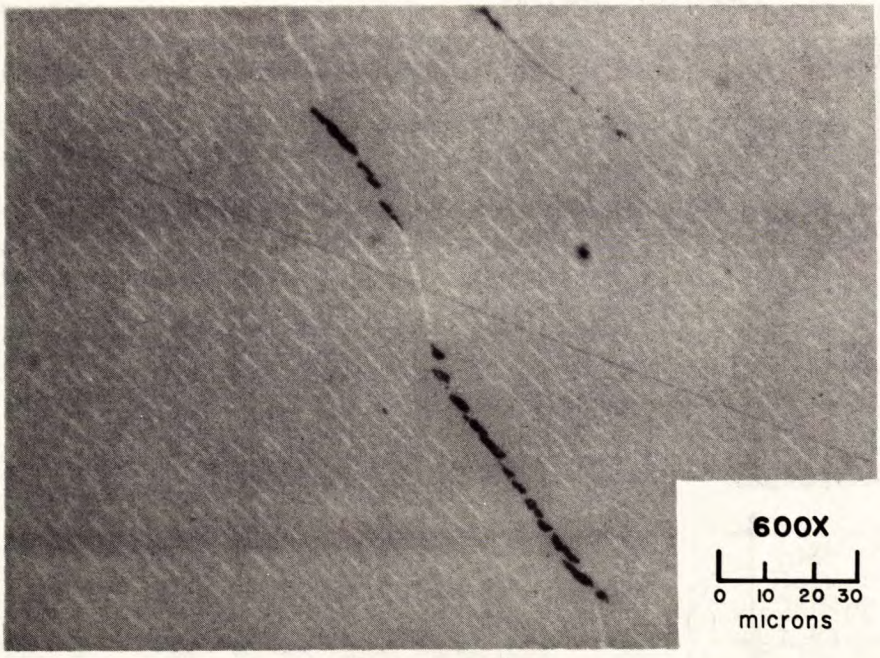

Figure 4. - Hematite lamellae (white), and hoegbomite (?) veinlets (dark grey), in massive ilmenite (grey).

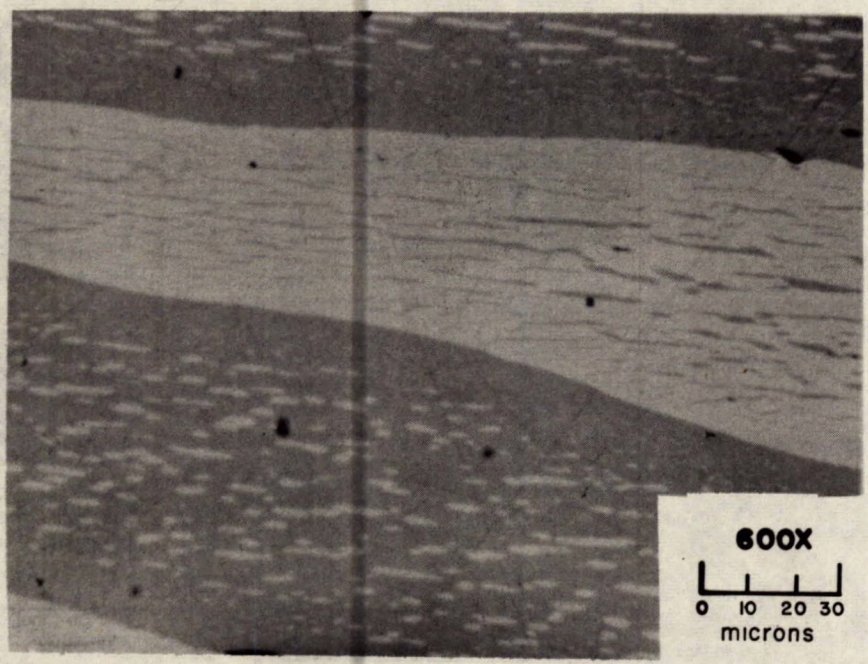

Figure 5. - Large ilmenite grain (medium grey) containing fine hematite lamellae (white), as well as a large hematite lamellae which in turn enclose ilmenite lamellae.

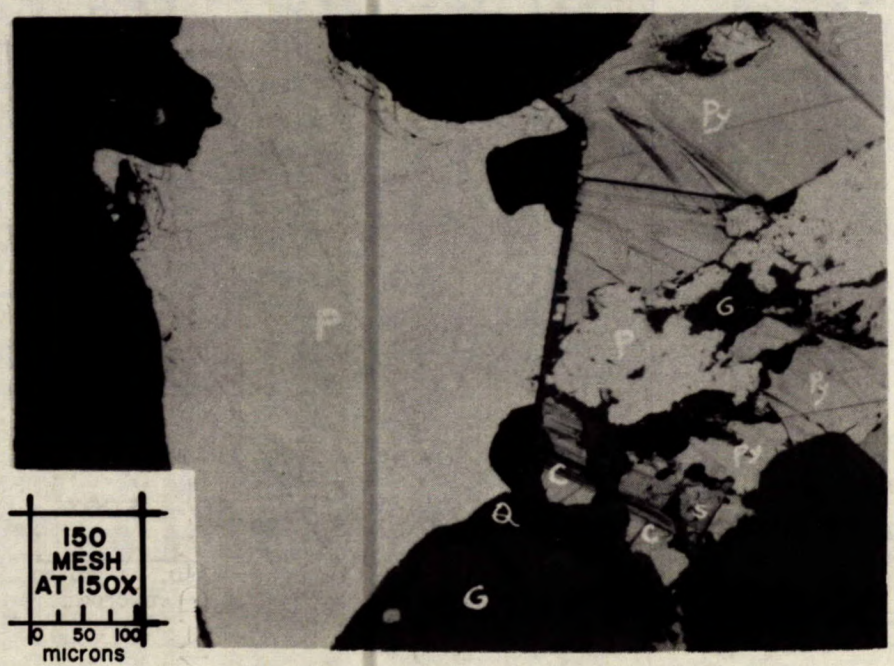

Figure 6. - Relationship between pyrite (P), pyrrhotite (Py), chalcopyrite (C), sphalerite (S), quartz (Q), and other gangue minerals (G).

TEST PROCEDURE AND RESULTS

Portions of the samples were crushed to -100 and -200 mesh for magnetic concentration. The -100 mesh ore was concentrated by a Jeffrey-Steffensen 3 drum wet separator, which produced a concentrate, a middling and a tailing. The -200 mesh ore was concentrated by a Davis tube separator. A concentrate and tailing were produced.

The test products were analysed for total iron, titanium dioxide and vanadium pentoxide.

TABLE 5

Results of Magnetic Concentration of -200 Mesh Ore by the Davis Tube Separator

Test No. 1 Feed -200 mesh ore of Sample 180

Product	Weight, %	Analysis, %			Distribution, %			Ratio of concentration
		Fe	TiO_2	V_2O_5	Fe	TiO_2	V_2O_5	
Feed*	100.0	32.09	8.33	0.41	100.0	100.0	100.0	
Conc	25.8	67.85	0.48	0.90	54.6	1.5	56.6	3.9:1
Tailing	74.2	19.65	11.06	0.24	45.4	98.5	43.4	

Test No. 2 Feed -200 mesh ore of Sample 181

Feed*	100.0	41.34	11.42	0.63	100.0	100.0	100.0	
Conc	37.6	67.80	0.17	1.08	61.7	0.6	64.3	2.7:1
Tailing	62.4	25.40	18.20	0.36	38.3	99.4	35.7	

*calculated

TABLE 6

Results of Magnetic Concentration of -100 Mesh Ore by the Jeffrey-Steffensen 3 drum Separator

Test No. 3 Feed -100 mesh ore of Sample 180

Product	Weight, %	Analysis, %			Distribution, %			Ratio of concentration
		Fe	TiO_2	V_2O_5	Fe	TiO_2	V_2O_5	
Feed*	100.0	32.9	8.43	0.48	100.0	100.0	100.0	
Conc	24.2	68.1	0.14	1.45	50.1	0.4	73.7	4.0:1
Midds	2.8	52.15	3.00	1.05	4.5	1.0	6.3	
Tailing	73.0	20.5	11.4	0.13	45.4	98.6	20.0	

Test No. 4 Feed -100 mesh ore of Sample 181

Feed*	100.0	40.5	11.6	0.64	100.0	100.0	100.0	
Conc	32.1	69.6	0.17	1.50	55.1	0.5	75.0	3.0:1
Midds	3.6	55.05	5.33	1.07	4.9	1.7	6.1	
Tailing	64.3	25.18	17.7	0.19	40.0	97.8	18.9	

*calculated

CONCLUSIONS

It is apparent from the results of the tests that most of the titanium dioxide is rejected from the magnetic concentrate at -100 mesh. The vanadium occurs in both magnetite and ilmenite (as stated in the mineralogical examination report), and up to 75% of the vanadium in the feed is recovered in the magnetic concentrate. The concentrate of test No. 4 assayed 1.50% vanadium pentoxide.

If an investigation is desired to determine the feasibility of leaching vanadium from the concentrate, this problem should be referred to Dr. K. W. Downes, Chief of the Extraction Metallurgy Division, who has agreed to make the required investigation.

WSJ:EBM