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REPORT

ON

ECONOMIC ANALYSIS

of the

TASU PROJECT

Skeena

MINING DIVISION

Chas. M. Campbell Jr.

ENGINEER

February 24th, 1958

R E P O R T

on

ECONOMIC ANALYSIS OF THE TASU PROJECT

QUEEN CHARLOTTE ISLANDS, B. C.

by

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Vancouver, B. C.
February 24th, 1958

WESFROB MINES LIMITED

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WESFROB MINES LIMITED

ECONOMIC ANALYSIS OF THE TASU PROJECT

SUMMARY AND CONCLUSIONS:

The indicated ore at Tasu, as determined from the work done to date, is 5,916,800 long tons grading 58.3% Fe and 2.64% S. Of this, the section known as the Tunnel orebody contains 1,878,700 tons grading 59.6% Fe, 2.43% S and 1.32% Cu, and the section known as the T-Bone orebody contains 1,498,200 grading 60.1% Fe, 3.59% S and 0.30% Cu. The balance contains less than 0.10% Cu.

An examination of the sections indicates that 87% of this ore could be mined by open-pit methods with a waste to ore volume ratio of 1.5 to 1. The waste to ore ratio can be substantially improved with a relatively small reduction in the ore available for mining on this basis. This examination indicates that 1,474,300 tons in the copper-rich Tunnel orebody might be mined by open-pit methods.

This analysis suggests that, subject to there being a market for iron concentrates, additional capital requirements to bring Tasu into operation would be $6,300,000. Based on a daily production of 1000 tons of 68% iron concentrates, plus a copper and a pyrite concentrate, the mining of the open-pit part of the Tunnel orebody would take 3-1/2 years and produce an operating profit of $7,700,000. In arriving at this figure no allowance has been made for revenue from gold and silver in the copper concentrate nor for revenue

from the sale of a pyrite concentrate. It must also be emphasized that the figure used as the selling price of iron concentrates is an arbitrary one. This is necessary since the applicable figure can only be obtained through negotiation with a customer.

Following mining of the Tunnel ore zone the Upper T-Bone zone would be mined by open-pit methods until the waste-ore ratio made it expedient to proceed with an underground program. This might be an eighteen month period during which the operating profit would be just under a million dollars per year. Following this, open-pit operations on the lower zones would produce annual operating profits of two-thirds of a million dollars for about five years.

It should be noted that following the tax free period depreciation and depletion allowances will be such that income taxes will be negligible for a further six or seven years. Allowing for full return of all capital the indicated return on equity capital will exceed 20% over the initial ten year period.

In general this report envisages mining operations proceeding progressively from the upper high-copper zones downhill to the lower low-copper zones. This means the installation in the first instance of a fully integrated flotation mill. An alternative would be the handling of the low-copper zone first. This would mean a capital expenditure of $3,510,000. This is set out in the capital cost estimates. In this instance it may be possible to crush to minus 1/4" and eliminate sufficient of the copper by magnetic separation

to make the product acceptable. With its sulphur content of 2% it could be sintered at the smelter. Operating costs and selling price would both be correspondingly lower.

On the other hand, it may develop that the finely ground high-grade product resulting from the flotation of the copper must be pelletized. No provision has been made for this here.

In these calculations it has been assumed that in mining there will be about 15% dilution resulting in a mill-feed of 51.5% Fe. Assuming 86% recovery of Fe, this would mean a mill input of 1500 tons per day.

All of these figures, while not based on detailed engineering studies, result from an examination and study of installations dealing with similar problems. The very attractive operation which they indicate suggests the importance of both a close study of the market and the preparation of detailed estimates of the capital costs involved for a plant at Tasu. The company would then be in a firm position to negotiate when an opportunity for the sale of iron concentrates presents itself, and then, having obtained the necessary contracts, would be in a position to move forward through construction to production at the earliest possible date.

FINANCIAL SUMMARY:

Estimated selling price 68% Fe per long ton	$ 9.29
Estimated selling price Cu concentrates per long ton Fe concentrates	5.34
Estimated selling price of product	$ 14.63
Estimated operating costs, mining, milling, royalties	7.90
Estimated operating profit per long ton Fe concentrates	$ 6.73

Open-pit reserve at Tunnel orebody - 1,475,000 tons 59.6% Fe.

This is equivalent to 1,725,000 tons 51.5% Fe mill feed allowing for 15% dilution.

Concentration ratio is estimated at 3 to 2.

At 525,000 tons per year this reserve would be mined in 3-1/4 years - say 3-1/2 years, the tax free period.

Operating profit in 3-1/2 years $6.73\ (1{,}725{,}000)\frac{2}{3}$ = $7,739,000.

Capital Requirements:

Expenditures to date	-	$ 425,000.	
New Equity Capital	-	2,000,000.	
New Loan Capital @ 6%	-	4,000,000.	
Interest before Production	-	300,000.	
		$6,725,000.	
Loans to be repaid	-	$4,300,000.	
Interest on loan capital to be paid from operating profit during production and until loan is retired	-	400,000.	4,700,000.
Balance in Treasury at end of 3-1/2 years production			$3,039,000.

ORE RESERVES:

These estimates are based on the surface outcrop and diamond drill holes completed in 1957. The figures represent indicated tonnages only and may not be considered as proven tonnages in the accepted sense of that word.

S U M M A R Y

	Tons	%Fe	%S	%Cu
Tunnel	1,878,700	59.6	2.43	1.32
T-Bone	1,498,200	60.1	3.59	0.30
Lower T-Bone	704,500	57.5	1.95	
Lower Extension	917,700	55.8	2.34	____
	4,999,100	58.7	2.69	
Lower Extension Probable Additional	917,700	55.8	2.34	
	5,916,800	58.3	2.64	

NOTE: The outcrop dimensions of the Lower Extension are such that double the tonnage established by drill holes may be expected in that area.

TUNNEL DEPOSIT:

Section	Long Tons	%Fe	%S	%Cu	Tons deleted for purposes of open-pit mining.
21	69,600	61.6	2.92	1.44	
22	134,500	59.4	2.97	1.23	11,400
23	204,400	59.9	2.13	1.88	
24	195,800	60.5	2.70	1.21	
25	192,400	60.6	2.04	1.26	
26	368,200	58.0	3.14	1.38	
28	519,000	57.4	1.35	0.72	198,200
30	194,800	62.5	2.92	1.71	194,800
	1,878,700	59.6	2.43	1.32	404,400

T-BONE DEPOSIT:

Section	Long Tons	%Fe	%s	%Cu	Tons deleted for purposes of open-pit mining.
36	51,900	63.0	1.59	0.30	
39	129,100	59.9	2.56	0.32	
42	269,900	59.9	3.47	0.34	51,000
44	409,800	61.9	4.49	0.43	189,000
47	353,100	57.7	3.68	0.27	78,000
49	284,400	60.1	3.26	0.14	40,000
	1,498,200	60.1	3.59	0.30	358,000

LOWER T-BONE DEPOSIT:

61	70,100	62.1	0.88	
63	124,700	54.8	2.62	
65	126,600	57.6	0.63	
67	178,600	58.5	1.69	
69	204,500	56.7	2.97	
	704,500	57.5	1.95	

LOWER EXTENSION:

76	58,400	46.8	2.01	
77	59,400	47.6	1.20	
79	52,600	51.4	2.90	
80	103,900	46.7	2.33	
83	340,900	61.6	2.08	
84	302,500	58.4	2.82	
	917,700	55.8	2.34	

ORE-WASTE RATIO:

From the cross-sections made of the ore zone a general estimate of the waste to be removed and hence of the ore-waste ratio has been made.

In making these estimates some of the ore reserve tonnages set out under ore reserves have been deleted because of the extent of the overburden which must be moved to mine them by open-pit methods. The details of these deletions are shown on the ore reserve statement on pages 5 and 6.

INITIAL CALCULATIONS TO INDICATE WASTE ROCK TO BE REMOVED

AREA:	Long Tons Ore	Cubic Yds. Ore	Cubic Yds. Waste	Ratio Waste to Ore
Tunnel	1,474,300	420,700	620,700	1.46
T-Bone	1,140,200	325,800	754,000	2.30
Lower T-Bone	704,500	200,900	247,200	1.24
Lower Extension	917,700	315,400	216,000	0.68
	4,236,700	1,262,800	1,837,900	1.45
Lower Extension Additional	917,700	315,400	216,000	0.68
	5,154,400	1,578,200	2,053,900	1.28

ESTIMATION OF MINING COSTS AT TASU:

In the Tunnel orebody we consider 1-1/2 yards of waste must be moved at the mine for each yard of 59.6% Fe ore. Some of this waste will dilute the ore to the extent of about 15% resulting in a mined ore product of 51.5% Fe.

1 yard ore = $\frac{27}{7.7}$ = 3.42 tons containing 3.42 (2240) 59.6% or 4565 lbs Fe.

4565 lbs Fe are produced from 2-1/2 yards mined.

1 ton of 51.5% ore containing 1150 lbs Fe is therefore produced from $\frac{1150}{4565}$ (2½) or 0.63 yards.

Direct mining cost based on $2.00 per yard will therefore be $1.26 per long ton.

Cost of two mile haulage to the mine is taken at $0.34. This results in a total mining cost of $1.60 per long ton.

ESTIMATION OF MILLING COSTS:

J. M. MacKay's figure of $2.25 per long ton of ore for a 1500 ton plant producing 1030 tons of concentrate is used in this analysis.

ROYALTIES:

Under recent British Columbia legislation, there is a royalty of one cent per short ton unit of iron produced. Up to half of this may be remitted to the extent that this amount is spent on approved development work. The full royalty on

ROYALTIES - contd.

68% concentrates would be $0.76 per long ton. Queen Charlotte Islands have not yet been designated as a production area for purposes of this royalty, but we must expect that they will be and that the royalty will be as stated.

There is also a royalty of $0.25 per ton payable to Albert Jones on ore mined from those claims obtained from him. This does not include Crown-grants and certain other areas located by Wesfrob.

For our purpose here a total figure of $1.00 per ton of concentrates or $0.67 per ton of ore mined is used:

SUMMARY OF OPERATING COSTS:

	Per Long Ton 51.5% Ore	Per Long Ton 68% Concentrates
Mining	$1.60	$2.40
Milling & Loading	2.25	3.37
Overhead	0.75	1.13
Royalties	0.67	1.00
	$5.27	$7.90

DETERMINATION OF SELLING PRICE OF 68% Fe CONCENTRATES:

The establishment of a price is subject to negotiation but the following calculation suggests a figure which might reasonably be expected:

Contract price 58% Fe F.O.B. Port McNeil, B.C. This is a blocky ore beneficiated by magnetic separation with not more than 40% under 1/4 inch	- $ 8.05
Increase in value per ton due to grade increment from 58% to 68% $\frac{10}{58}$ ($8.05)	- 1.38
Saving on shipping charges to Japan resulting from increased grade and based on $5.00 rate Tasu-Japan $\frac{10}{58}$ ($5.00)	- 0.86
	10.29
Less penalty for fine-ground product	- 1.00
Suggested price F.O.B. Tasu	- $ 9.29

For comparison purposes the price of 51.5% Old Range Non-Bessemer ores at Lake Erie Ports is currently $11.70 per long ton or 22.71¢ cents per long ton unit. For 68% Fe this is equivalent to $15.45 per ton. Allowing for a pelletizing cost of $2.00 and freight on the lakes of $3.00, the net figure is $10.45. Therefore, the figure $9.29 determined above and used in these calculations does not appear unreasonable.

DETERMINATION OF SMELTER RETURNS FOR COPPER:

These calculations use assumptions made in a similar report by J. M. MacKay in September, 1957.

Estimated Cu content of Tunnel orebody		1.32%
Estimated recovery of Cu at Mill		80%
Estimated grade of copper in millfeed following dilution in mining	$\frac{51.5}{59.6}$ (1.32) =	1.14%
Assume Cu price of $0.25 per pound.		
Assume Cu concentrate grades 25% Cu.		
Recoverable copper per long ton	80% (1.14) (22.4) =	20.4 lbs.
Smelter deduction 1.3 units	$\frac{1.3}{25}$ (20.4) =	1.1
Copper recovered		19.3 lbs.
Total value of copper recovered per long ton of ore	19.3 (0.25-0.0275) =	$4.29
Value per long ton of Fe concentrate	$\frac{3}{2}$ (4.29) =	$6.43

LESS: Additional Operating Costs per long ton ore:

Freight @ $6.50 on 0.0379 long tons @ 4% moisture content	$0.2463
Drying @ $1.25 per long ton	0.0474
Smelting @ $12.00/long ton on 0.0364 dry tons	0.4368
	$0.7305

Additional costs per long ton Fe concentrates 1.5 (0.7305)	$1.09
Net returns from Cu per long ton Fe concentrate	$5.34

EFFECT OF CHANGE IN COPPER PRICE:

The effect of each one cent change in the price of copper will be

$0.29 per long ton of Fe concentrate

$101,500.00 per year

$329,875.00 for the 3-1/2 years required to mine the open-pit part of the Tunnel orebody.

COPPER RETURN FROM T-BONE OREBODY:

Estimated ore reserve grade		0.30% Cu
Estimated mill feed grade		0.25% Cu
Recoverable Cu 80% (0.25) (22.4)		4.5 lbs
Smelter deductions 1.3 units. $\frac{1.3}{25}$ (4.5)		0.2
Copper recovered		4.3 lbs.
Value of Cu recovered per long ton ore 4.3 (0.25 - 0.0275)		0.95 per long ton ore.
Value of Cu recovered per long ton Fe concentrate		1.43
Less Additional Operating Costs:		
Freight @ $6.50 on 0.0084 long tons @ 4% moisture	$0.0546	
Drying @ $1.85/long ton	0.0105	
Smelting @ $12.00/long ton on 0.008 tons	0.0960	0.16
Net return for Cu per long ton Fe concentrate		$1.27

OPERATING PROFIT FROM T-BONE ZONE:

Initial estimates suggest a waste-ore ratio on the T-Bone zone of 2.30 to 1 applicable to 1,140,200 tons. The total indicated tonnage in this zone is 1,498,2 00 tons. It is very possible that the downward extension of this zone will increase the tonnage available. At some point,therefore, it is evident that the mining method will be changed from open-pit and that it may be found desirable to make this change before the 1,140,200 tons mentioned above have been handled. It is likely, too, that for at least half of this tonnage the waste-ore ratio applicable to the Tunnel deposit will apply.

The royalty agreement with Albert Jones is subject to adjustment. It is probable that in the mining of the Tunnel zone royalty payments to him will be complete. This would result in a credit on costs of $0.24 per ton of Fe concentrates.

However, in this estimate the Tunnel zone cost of $7.90 is used.

The Cu content is 0.30% and the revenue from this is calculated in detail on page 12.

Estimated selling price 68% Fe Conc. per long ton	$ 9.29
Estimated return from Cu Conc. per long ton Fe Conc.	1.27
Total Revenue	$10.56
Less: Operating Costs	7.90
Operating Profit per long ton Fe conc.	$ 2.66

Annual operating profit 2.66 (350,000) - $931,000.

OPERATING PROFIT FROM LOWER ORE ZONES:

The lower ore zones show an appreciable improvement in the waste-ore ratio even when it is recognized that the deposits occur on a sloping hillside and allowance must be made for the handling of waste in the establishment of suitable pit floors. This will reduce operating costs. In addition, the deposits are closed to the mill and haulage costs will be correspondingly lower. At this stage of operations all royalties to Albert Jones should be taken care of with a corresponding reduction in costs. This means that mining costs in this area should be reduced by $0.50 per ton of concentrates and the operating cost figure used is therefore $7.40.

The lower zones contain negligible copper values and although there should be a return from these and from pyrite, there is no allowance made.

Estimated selling price 68% Fe Conc. per long ton	$9.29
Less: Operating costs	7.40
Operating profit per long ton Fe conc.	$1.89
Annual operating profit 1.89 (350,000)	$661,000.

CAPITAL REQUIREMENTS

SUMMARY:

Item	For Simple Magnetic Separation	For Flotation Plant
Mining Plant	$ 564,000.	$ 564,000.
Milling Plant	750,000.	2,250,000.
Wharf & Loading Facilities	392,000.	422,000.
Power Plant	250,000.	500,000.
Auxiliary Service, Shops, etc. etc.	148,000.	198,000.
Other Equipment, boats, small trucks, D8 Cat, etc.	118,000.	118,000.
Site Cleaning	95,000.	95,000.
Roads	200,000.	200,000.
Mine Camp Buildings	190,000.	448,000.
Inventory	25,000.	50,000.
Engineering Costs	108,000.	187,000.
Contingency	270,000.	466,000.
Working Capital	400,000.	500,000.
TOTALS	$3,510,000.	$5,998,000.

A. OPEN-PIT EQUIPMENT:

1.	Model 80-D North West Shovels 2-1/2 yd. capacity - 2 @ $108,000.	$ 216,000.	
2.	Gardner-Denver AT123 Air Trac with 600 C.F.M. Compressors complete with hose, steel, bits, etc. 2 @ $36,000.	72,000.	
3.	Copco rock drills--complete with steel, hose, bits, parts, etc. 4 Drills and 1 Pusher	3,000.	
4.	Motor road grader (secondhand)	15,000.	
5.	Euclid 91FD, 18 ton rear dump quarry trucks - 7 @ $32,500.	228,000.	
6.	D8 or equivalent Bulldozer	30,000.	$ 564,000.

B. MILLING PLANT:

7.	Primary and secondary crushing with simple magnetic separation equipment		750,000.

C. WHARF AND LOADING FACILITIES:

8. Stockpile Area at Wharf:

Slot excavation above loading wharf approx. 200 ft. long by 40 ft. wide by 80 ft. deep at inside end giving storage capacity of 40,000 tons.

Clearing site - 4 acres @ $5000.	$20,000.		
Excavation	33,000.		
Timber cover	9,000.		
Tunnel under stockpile	10,000.	$ 72,000.	
9.	Wharf construction for loading facilities, coastal steamer berth & float for small boats and aircraft	250,000.	
10.	Conveyor from stockpile to wharf complete with loading tower, boom spout hoist cables etc. installed	70,000.	392,000.

D. POWER PLANT:

11.	1250 H.P.Diesel Power installed @ $200. per H.P.		$ 250,000.

E. AUXILIARY SERVICE INSTALLATIONS:

12.	Sawmill - National Machinery Coy. No.3 Sawmill Unit installed complete	$ 12,000.	
13.	Machine Shop equipped with grinders, shaper, lathe, press, welding equipment, drills, pipe threaders, hydraulic jacks, etc. building and installation	40,000.	
14.	Assay Office Equipment	10,000.	
15.	Blacksmith Shop Equipped	4,000.	
16.	Woodworking Shop equipped with band saw, planer, jointer, timber saw and small tools	22,000.	
17.	Electric Shop equipped	10,000.	
18.	Powder Magazine	20,000.	
19.	Water Supply for Camp	10,000.	
20.	Water Supply for Mill	20,000.	148,000.

F. OTHER EQUIPMENT REQUIRED:

21.	Portable Compressor 105 c.f.m.	4,000.	
22.	Cement Mixer	5,000.	
23.	4 Drum Donkey Engine complete	25,000.	
24.	Emergency Boat	40,000.	
25.	D8 Cat or equivalent	30,000.	
26.	3 Small trucks, 1 4-ton truck	14,000.	118,000.

G.	SITE CLEARING		
27.	Millsite 5 acres @ $5000.	$ 25,000.	
28.	Campsite 4 acres @ $5000.	20,000.	
29.	Mine Area 10 acres @ $5000.	50,000.	$ 95,000.
H.	ROADS:		
30.	Four miles of roads between camp, mill and mine @ $50,000.		200,000.
I.	MINE CAMP INSTALLATIONS:		
31.	Camp facilities for 100 men @ $850. per man	$ 85,000.	
32.	Office, warehouse, etc. 5000 sq.ft. @ $9.00	45,000.	
33.	Six residences @ $10,000.	60,000.	190,000.
J.	ADDITIONAL REQUIREMENTS:		
34.	Warehouse Inventory	$ 25,000.	
35.	Engineering Costs - 4% of $2,707,000.	108,000.	
36.	Contingency - 10% of $2,707,000.	270,000.	
37.	Working Capital	400,000.	803,000.
	TOTAL CAPITAL COST FOR SIMPLE MAGNETIC SEPARATION		$3,510,000.

ADDITIONAL CAPITAL EXPENDITURES TO PROVIDE FOR FLOTATION PLANT.

B-1	**MILLING PLANT:**			
	38. Grinding units & flotation plant with drying equipment			$1,500,000.
C-1	**WHARF AND LOADING FACILITIES:**			
	39. Additional storage & loading facilities for copper and pyrite concentrates			30,000.
D-1	**POWER PLANT:**			
	40. An additional 1250 H.P. Diesel installation @ $200. per H.P.			250,000.
E-1	**GENERAL SERVICE INSTALLATIONS:**			
	41. Additional water supply for flotation mill			50,000.
I-1	**MINE CAMP INSTALLATIONS:**			
	42. 16 additional residences @ $10,000.		$160,000.	
	43. Additional warehouse space 2500' @ $9.		23,000.	
	44. Additional camp space 30 men @ $850.		25,000.	
	45. Recreation Building		50,000.	258,000.
J-1	**ADDITIONAL REQUIREMENTS:**			
	46. Additional warehouse inventory		$ 25,000.	
	47. Engineering costs - 4% of $1,963,000.		79,000.	
	48 Contingency - 10% of $1,963,000.		196,000.	
	49. Additional working capital		100,000.	400,000.
	TOTAL ADDITIONAL CAPITAL EXPENDITURES REQUIRED FOR FLOTATION PLANT			$2,488,000.

NOTES ON PROBLEMS TO BE CONSIDERED

ROADS:

The attached map shows the possible location of roads. The contours are plotted from photographs and locations made on the ground, and will therefore vary somewhat from those shown. The feasibility of this program is, however, clear.

A grade of 7% is considered a desirable maximum for economic haulage. This appears possible on the two miles of ore haul except for the top 2500 feet, and this may be improved upon when the location is made on the ground.

The roads shown total four miles. The ore haulage section crosses the orebody in four places.

In construction there will be a large amount of rock work. Without a complete survey cost estimates are difficult. Logging companies consider the direct cost of their roads in this area to be $35,000. per mile. They arrange to build them under favourable weather and other conditions.

In this case we may face a greater amount of rock work than normal, but on the other hand we will have acquired for the mine all of the heavy equipment necessary to the road-building operation.

In this instance, therefore, a figure of $50,000. per mile has been used for estimating. A more detailed assessment of the problem is necessary.

WHARVES:

The estimates of cost for the wharf are based on the cost of installations I have seen. In each instance to

WHARVES: - contd

reach deepwater the wharf face was over two hundred feet from shore. At Tasu adequate depth will be obtained about 70 feet from shore. This advantage may be cancelled by a hard rocky bottom, and the problem must, therefore, be studied by a competent authority.

POWER:

Provision has been made for 2500 H.P. diesel plant. Based on the experience at Texada Mines this will be adequate.

There is a possibility of developing hydro power, using two small lakes located two miles west of the mine area as a storage basin. This may not be practical but it must be investigated.

These are shown at the centre of the air photo bound in this report.

WATER:

Water flow in the creeks fluctuates widely. There is an adequate supply for camp purposes easily available from creeks in the camp area. Creeks in the immediate mine area which would supply the mill may be inadequate during some seasons - and it may, therefore, be necessary to use sea water or bring water from the creek south of the mine area or, and this is unlikely, from the lakes mentioned under "Power" above.

HAULAGE:

An alternative to truck haulage from the pits to mill might be an incline tramway. This might have certain advant-

HAULAGE: - contd.

ages. However, it seems inevitable that both ore and waste must be loaded in trucks at the pit; a road up the hillside may not be absolutely necessary with an incline, but it would certainly be desirable; an incline would require several loading points along its length, each of which would be costly; and generally the procedure would lack flexibility. It should, however,be given full consideration before a decision is made.

SAWMILL:

Heavy timber on the property must be cleared. A sawmill has been included in estimates to cut this. In design, therefore, consideration must be given to determine the economies which may be effected by using local timber, in this connection a planer mill may also be justified.

Air photo of Tasu Area taken from 35,000' elevation.
The scale is approximately 2850' per inch.

The Mine Area is shown at the bottom centre of the photograph just above Cowing Island.

The lakes, which may provide a storage basin for a high head low volume hydro plant, are located in the exact centre of the picture.

Looking west across Tasu Harbour and the Harbour entrance. The magnetite deposits are on the slope facing the camera on the left side of the photograph. The old tram line can be detected running down through the gulley on the extreme left.

The entrance to Tasu Harbour looking west from the Harbour.

Looking south up the ridge on which the magnetite deposits occur.

The ridge in the picture above as seen from the southeast.