

81- # 390-#

ASSESSMENT REPORT

Based on Costs of Sample
Collection for Metallurgical Research

OWNER/OPERATOR

BORDER RESOURCES LTD.
#1400 - 1030 West Georgia St.,
Vancouver, B.C., V6E 3C2
Telephone (604) 687-9444

PROPERTY LOCATION

New Westminster M.D.
N.T.S. Grid. 92H/6(E)

NORTH GROUP

49°29'00" N. Lat.
121°16'00" W. Long.

(17 Claims)

G 1-2, GWH 2, N 22-27, 28FR, 29FR, TAX 51-56

SOUTH GROUP

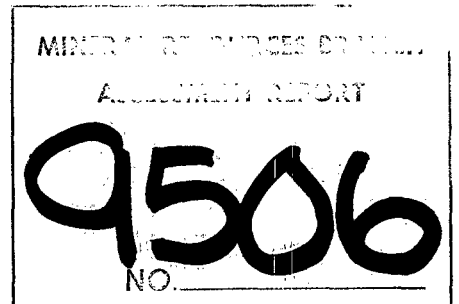
49°26'00" N. Lat.
121°14'00" W. Long.

(9 Claims)

EVE 1-2, TOY 3-9

AUTHOR: P. HALL, BA, BEd.
METALLURGIST: Dr. H.E.A. von HAHN, P.Eng.

Date: 22 May 1981



BORDER RESOURCES LTD.

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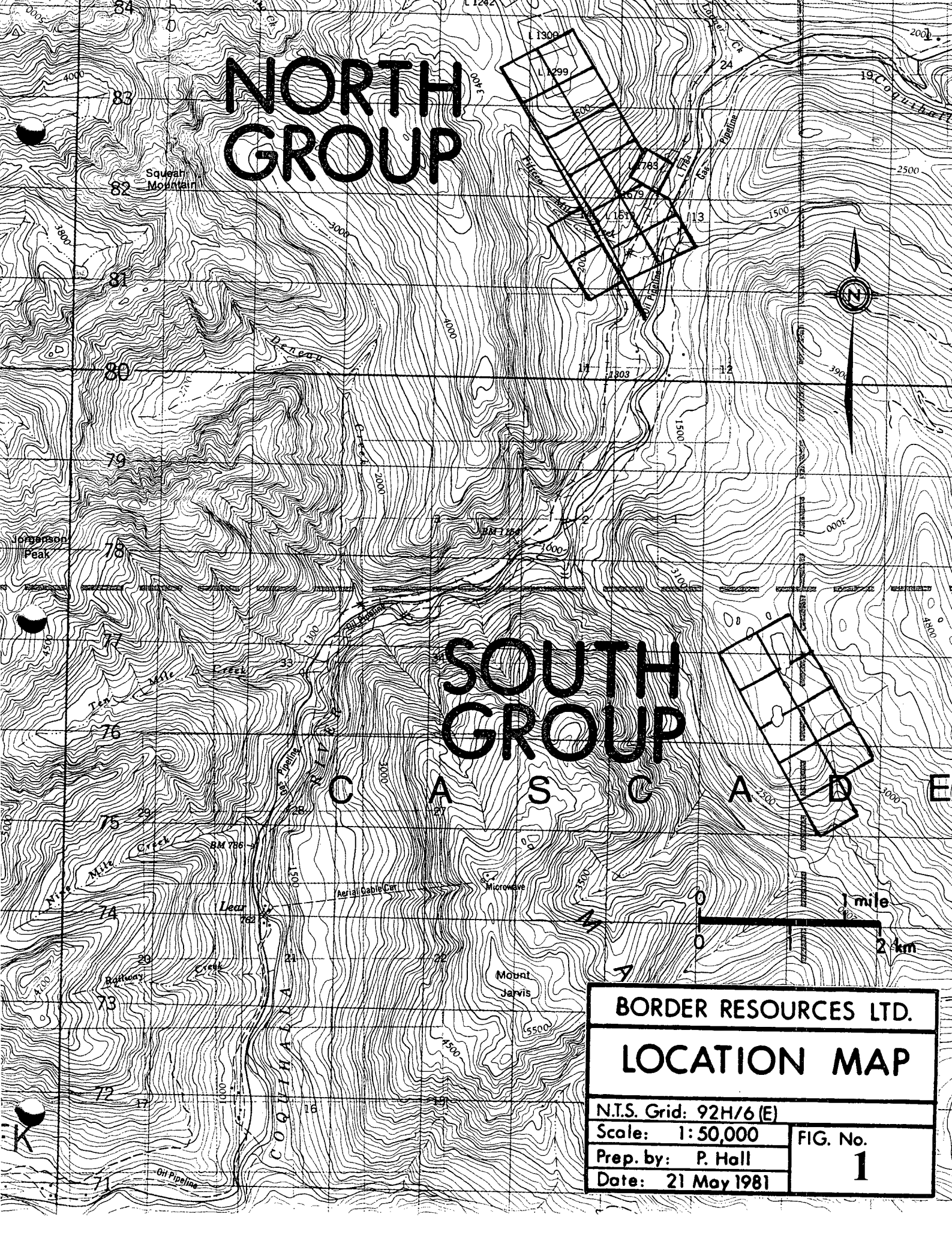
NORTH GROUP

SOUTH GROUP

C A S C A D E



BORDER RESOURCES LTD.	
LOCATION MAP	
N.T.S. Grid: 92H/6 (E)	
Scale: 1: 50,000	FIG. No. 1
Prep. by: P. Hall	
Date: 21 May 1981	



INTRODUCTION

The two groups of claims held by Border Resources Ltd. lie one on each side of the Coquihalla Valley some 9½ miles (15 km) East of Hope, B.C. The North Group is located on the mountain slope above the right bank of the Coquihalla River just to the west of the old Emancipation Mine. From there, it stretches westward to the other side of Fifteen Mile Creek. The South Group occurs along a tributary valley of the Coquihalla approximately 3 miles (5km) south on the west-facing mountainous heights above Sowagua Creek.

These two groups are the residual claims from a block of approximately one-hundred that were staked by Messers. G. Hornby and M. Judd in 1969. In 1972, M. Judd sold his interest in the property to Mr. M. Menzies, and a new company, Mountain Pass Mines Ltd., was set up to hold the claims. In 1978, Mountain Pass Mines reorganized to become the present Border Resources Ltd.

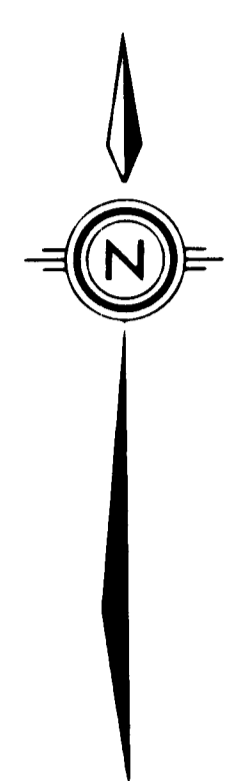
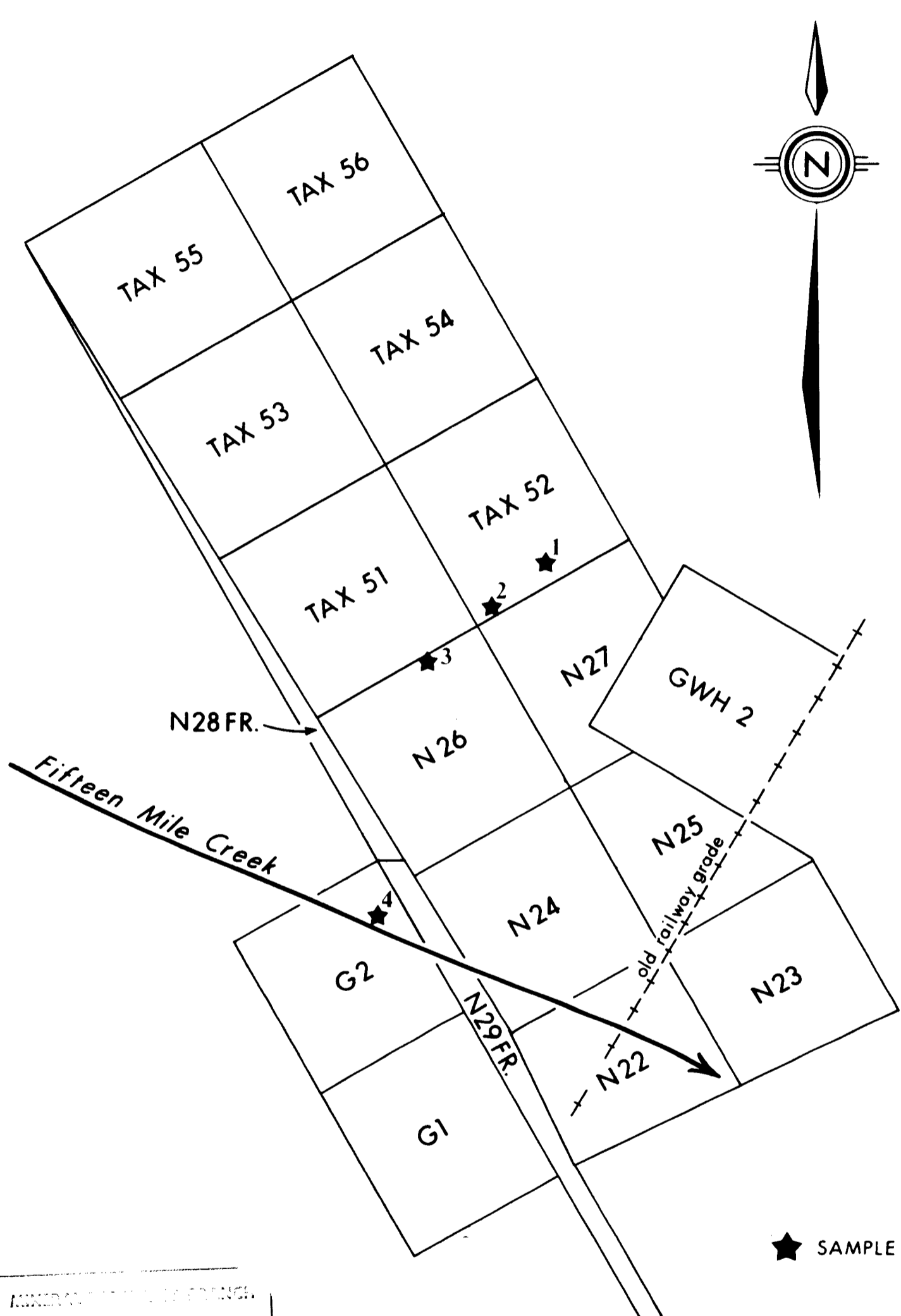
The claims are staked over a large belt of serpentine rock. The serpentine has an interesting mineralization in that it contains nickel and other valuable minerals in the form of microscopic needles. Since this type of mineral occurrence is not amenable to regular milling processes, Border Resources Ltd. has embarked on a programme of metallurgical research to develop a usable separation procedure. Resolution of the problem is not yet complete.

Research for the separation technology is being conducted by A-MIN-TECH RESEARCH LTD. of Vancouver, B.C., under the supervision of Dr. H.E.A. von Hahn, P.Eng. Copies of Dr. von Hahn's progress reports will be found in Section 2.

Appropriate quantities of serpentine sample were obtained by three expeditions to the property. These occurred on the following dates: (Refer Figs. 2,3,4)

Oct. 11-13	Sites 1,2,3
Oct. 18-19	Sites 11-12
Nov. 15	Site 4

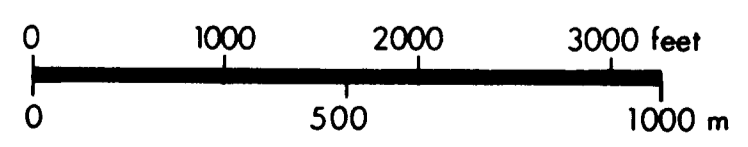
Supervision of the fieldwork was by Messers. G. Hornby and M. Menzies, both principals of the company.



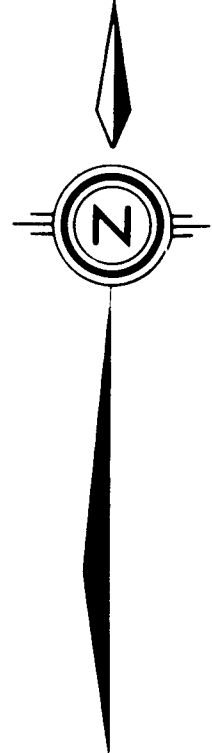
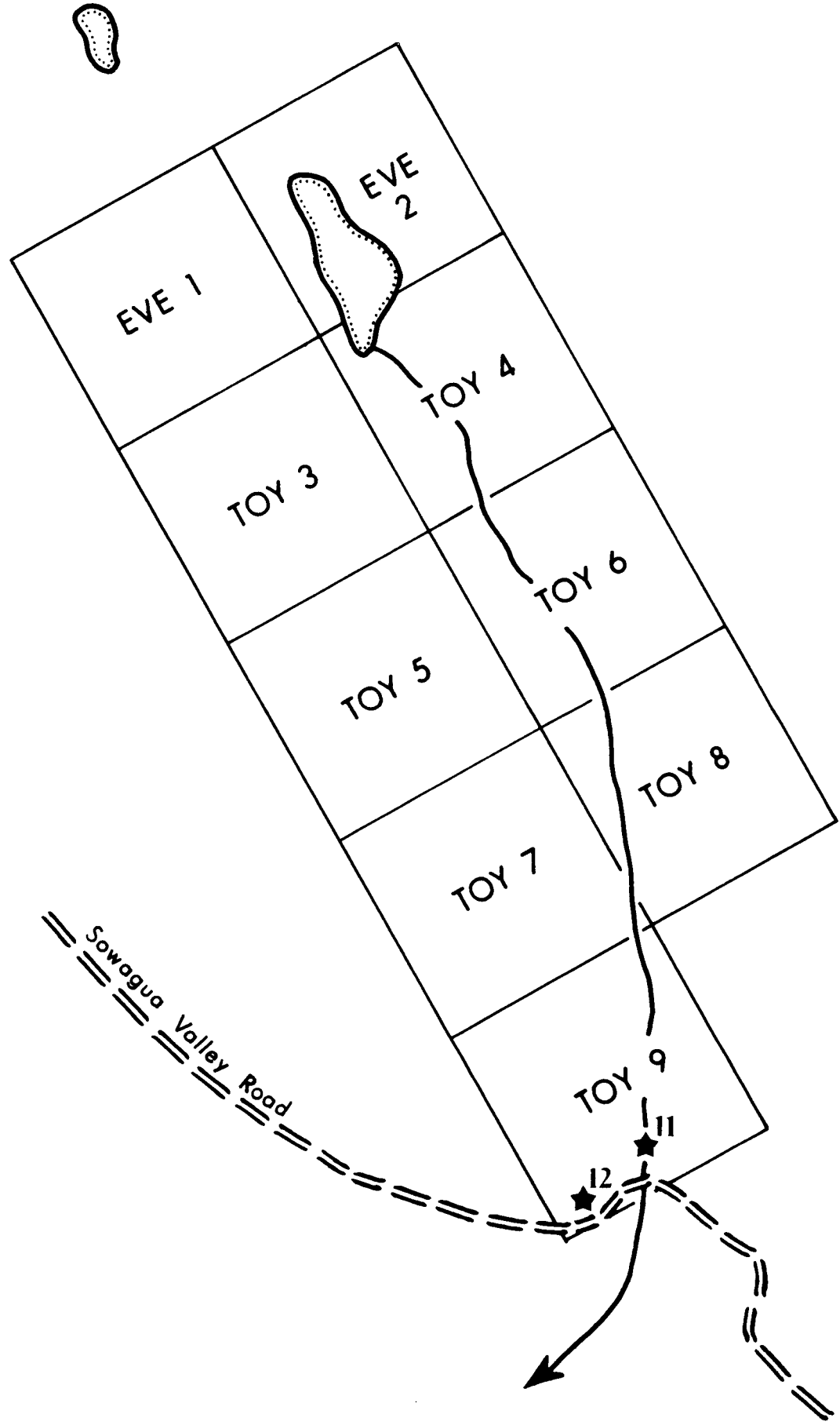
★ SAMPLE SITE

MINERAL RIGHTS OF FRONTIER
 ASSOCIATION
9506
 NO.

Map derived from base by
 Underhill & Underhill, B.C.L.S.



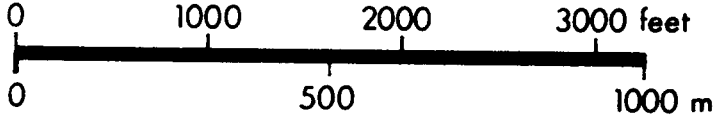
BORDER RESOURCES LTD.	
NORTH GROUP	
N.T.S. Grid: 92H/6(E)	
Scale: 1:12,000	FIG. No. 3
Drawn by: P. Hall	
Date: 21 May 1981	



MINERAL RESOURCES ACT
ASSESSMENT REPORT
9506
NO. _____

★ SAMPLE SITE

Map derived from base by
Underhill & Underhill, B.C.L.S.



BORDER RESOURCES LTD.	
SOUTH GROUP	
N.T.S. Grid: 92H/6(E)	
Scale: 1:12,000	FIG. No.
Drawn by: P. Hall	4
Date: 21 May 1981	

In order to obtain fresh, unoxidized samples, the use of a Cobra packdrill using a 4' (1.2 m) drillsteel and forcite explosive was employed. The fieldcrew comprised a licenced Ministry of Mines blaster and an assistant to help carry the equipment. Each site deformation was less than 1 m dia.

Approximately 50 lbs. (20 kg) of sample was obtained from each site. The sample was packaged in plastic ore bags, labelled as to site no., and delivered to Dr. von Hahn.

SECTION 2

PROGRESS REPORTS ON METALLURGICAL RESEARCH

A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

7

Flotation, Hydrometallurgy
Research & Testing

Project: BR-1

Progress Report #1

Date: 30 November, 1980

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

Attention: G.W. Hornby

Project: Treatment of Serpentine Rock for Recovery of Nickel
and other Valuable Minerals.

Introduction:

The work undertaken to date and in progress is on the following subjects: 1. Minerals Identification, 2. Chemical Assays.

Samples:

Serpentine rock samples were received from G.W. Hornby under the following identifications:

Site	Weight, lb
1	80 - 100
11	80 - 100
12	80 - 100
4	40 - 50

In addition samples were received from Sites 2 and 3, weighing 10 to 20 lb each. These samples were said to be diorite.

Size & Appearance: Sizes were mostly 3" to 10" across. The samples from Site 11 were mostly angular blocks, more or less equidimensional in shape, and exhibiting mostly dark green fracture faces. The samples from Site 12 were distinctly different. Most pieces exhibited strongly elongated flat shapes with sharp edges, with the fracture faces showing a lighter green colour. The samples from Sites 1 & 4 exhibited shapes and colours somewhat in between those from Sites 11 & 12, but tending more toward those of Site 12. Some pieces from Site 1 showed strong alterations and were rather brittle. In general the samples from all four sites (1, 11, 12, 4) showed easy friability, some exhibiting microcracks which would cause larger blocks to break up upon slight impact with a hard surface. The samples from Sites 2 & 3 were more or less equidimensional and had a greyish green appearance.

cont'd. p.2

A-MIN-TECH RESEARCH LTD.

Project: BR-1

P. 2

Border Resources Ltd.

Progress Report #1, cont'd.

Disposition: Two to three suitable pieces were taken from the samples of Sites 1, 11, 12 & 4 for Mineralogical and Chemical Examinations. The remainder were placed in plastic bags, tagged and stored pending further use for testwork.

Mineralogical Examinations:

Selected pieces from Sites 1, 11, 12, & 4 were cut into slabs from which areas were chosen for further cutting and preparation of Polished Sections (P.S.) and Thin Sections (T.S.). The sections are identified as follows:

Site	Section
1	1A, 1B, 1C, 1D-1, 1D-2
11	11A, 11B, 11C
12	12A, 12B, 12C
4	4A, 4B

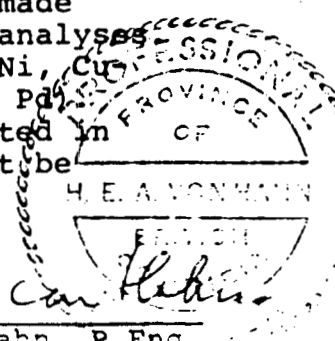
In addition a number of small slabs were cut adjacent to the sections and rough ground. These are to serve for reference purposes. They are identified as follows:

Site	Slab
1	1A, 1B, 1C
11	11A, 11B, 11B
12	12B
4	4A, 4B

No mineralogical examinations were performed as yet on the polished- and thin sections. However, a cursory scan of some polished sections under the microscope revealed the presence of sulfides (not fully identified) and also magnetite, located mainly along grain boundaries of the host serpentine rock. Mineralogical and microprobe examinations are under arrangement.

Chemical Assays:

Small samples of rock (50 -100g) were taken from cuts adjacent to those from which the polished or thin sections were made and submitted for chemical and emission-spectrographic analyses. Chemical analyses were requested for Ni sulfide, total Ni, Cu sulfide, total sulfur, and precious metals (Au, Ag, Pt, Pd). 30-element emission-spectrographic analyses were requested in addition to determine what other elements of value might be present in the rock. Results are expected shortly.



Signed: H. E. A. von Hahn
H.E.A. von Hahn, P.Eng.

A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

Project: BR-1

Progress Report #2

Date: 31 December, 1980

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

Attention: G.W. Hornby

Project Title: Treatment of Serpentine Rock for Recovery of Nickel
other Valuable Minerals.

Introduction:

This report summarizes work done to date under the following headings: Mineralogical Examinations, Chemical Analyses, Literature Survey, Discussion with Staff of Sherritt Gordon Mines Ltd., Flotation Testwork.

Mineralogical Examinations:

The Polished Sections and Thin Sections discussed in Progress Report #1 were given to Dr. J.A. Chamberlain for mineralogical examination. Results are expected within the next two or three weeks.

Chemical Analyses:

The results of the chemical and emission spectrographic analyses done by Chemex Labs Ltd. are given in the attached Assay Certificates (Appendix I). In summary the following results were obtained:

A. Chemical Analyses:

- Total Ni: 0.18 - 0.24%; Ni as sulfide: 0.11 - 0.19%.
- The 0.05% value of Ni as Sulfide of Sample 12-C appears anomalous.
- Total Sulfur: 0.1 to 0.15%.
- This is more than sufficient stoichiometrically to react with all the nickel present in the rock.
- Cu as Sulfide: less than 0.01%.
- No request was made for analysis of total copper.
- Silver: 0.01 to 0.09 oz/ton.
- Gold: 20 to 55 parts per billion.
- Platinum: less than 50 parts per billion.
- Palladium: less than 50 parts per billion.
- The 450ppb value of gold for sample 12-C and the 150ppb value of palladium for sample 1-D appear anomalous.

A-MIN-TECH RESEARCH LTD.

Project BR-1

Page 2

Border Resources Ltd.

Progress Report #2 cont'd.

The values of silver and gold are not of economic significance as such. If, however, during upgrading of the rock they report in the concentrates and are recoverable they could add some value of interest to the total.

B. Emission Spectrographic Analyses:

These analyses, being semiquantitative, designate a range rather than actual values, and the figures shown are to be interpreted in that light. The following elements of interest are discussed:

Chromium: 0.3 - 0.5%

This element is said to have been as high as 1% in earlier assays. The given range within which the present results lie would allow for this.

Cobalt: 0.015%

Often cobalt is present in association with nickel at roughly one tenth the value of nickel assays. The present results suggest that cobalt could be of some economic interest if it is recoverable together with the nickel.

Copper: 0.005 - 0.01%

These values are consistent with those of the chemical assays. Whether or not copper would be of interest economically is dependent on its recoverability and separability in any chosen metallurgical process.

Iron: 5 - 10%

This is consistent with previously stated results for this element.

Lead, Thallium, Manganese, Molybdenum, Zinc:

These elements may or may not be of interest, depending on their separability in a chosen process.

Nickel: 0.1 - 0.15%

These values are consistent with those of the chemical assays on the basis of the designated range for these values.

Silver: 1 - 5 parts per million

This is consistent with the chemical assay values and converts to about 0.03 to 0.14oz/ton.

Literature Survey:

A brief literature survey was made on Nickel recovery from low grade deposits. In the area of flotation one reference was found on research work done in the Netherlands on the development of depressants for gangue minerals, such as serpentine, talc, etc., forming the host rock of low grade nickel deposits. These reagents are said to give improved flotation recoveries and concentrate grades. Steps have been taken to obtain further information and samples of these reagents.

cont'd. Page 3

A-MIN-TECH RESEARCH LTD.

Project BR-1

Page 3

Border Resources Ltd.

Progress Report #2 cont'd.

Discussion with Staff of
Sherritt Gordon Mines Ltd.

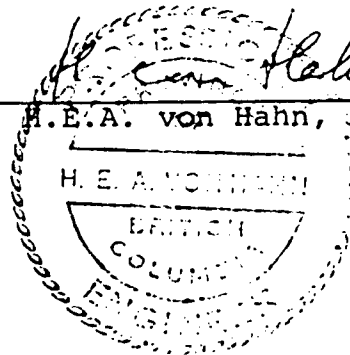
Staff of the Sherritt Gordon Mines Ltd. Research Center was asked for available information on recovery processes for low grade nickel deposits. It was learned that direct reduction-roasting followed by hydrometallurgical treatment is unlikely to be economic for low-grade nickel deposits. Flotation is the recommended route to be followed in attempting to treat such deposits.

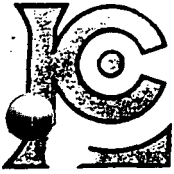
Flotation Testwork:

This testwork will include use of the serpentine and talc depressants mentioned under Literature Survey. A series of about six tests will be done to determine the efficacy of these reagents. On the basis of the results further work will be developed. Work is expected to be started in about two to three weeks or as soon as samples of the reagents are available.

Signed: _____

H.E.A. von Hahn, P.Eng.





CHEMEX LABS LTD.

212 BROOKSBANK AVE
 NORTH VANCOUVER B.C.
 CANADA V7J 2C7
 TELEPHONE (604) 984-0221
 TELEX 043-52597

• ANALYTICAL CHEMISTS • GEOCHEMISTS • REGISTERED ASSAYERS

CERTIFICATE OF ASSAY


TO : A-MIN-TECH RESEARCH LIMITED
 8464 ADERA STREET,
 VANCOUVER, B.C.,
 V6P 5E7

CERT. # : ABC11399-001-1
 INVOICE # : 13011399
 DATE : 07-JAN-91
 P.C. # : NONE

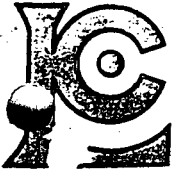
ATTN: MR. VAN PAAN ALSO CN SP841

Sample description	Prep code	Cu ^x percent	Ni percent	Ni ^x percent	S ppm	Ag g/t	
1-E CUT	207	<0.01	0.24	0.19	1570	0.09	--
11-C CUT	207	<0.01	0.18	0.10	978	<0.01	--
12-C-CUT	207	<0.01	0.19	0.05	1240	0.05	--
4-A CUT	207	<0.01	0.19	0.11	978	<0.01	--
4-B CUT	207	<0.01	--	0.12	--	<0.01	--
SITE 2	207	<0.01	<0.01	<0.01	--	0.01	--
SITE 3	207	<0.01	<0.01	<0.01	--	0.01	--

X AS SULFIDES



 Registered Assayer, Province of British Columbia



CHEMEX LABS LTD.

212 BROOKSBANK AVE
 NORTH VANCOUVER B.C.
 CANADA V7J 2C1
 TELEPHONE (604) 984-0021
 TELEX 043-52597

• ANALYTICAL CHEMISTS • GEOCHEMISTS • REGISTERED ASSAYERS

CERTIFICATE OF ANALYSIS

TO : A-MIN-TECH RESEARCH LIMITED
 2464 ADERA STREET,
 VANCOUVER, B.C.,
 V6P 5E7

CERT. # : A8011399-001-A
 INVOICE # : I8011399
 DATE : 07-JAN-81
 P.C. # : NONE

ATTN: MR. VAN HAHN ALSO ON SP841

Sample description	Prep code	AU-FA+AA ppt	Pt ppp	Pc ppb			
1-C CLT	207	25	<50	150	--	--	--
11-C CLT	207	55	<50	<50	--	--	--
12-C-CLT	207	450	<50	<50	--	--	--
4-A CLT	207	20	<50	<50	--	--	--
4-B CLT	207	5	<50	<50	--	--	--
SITE 2	207	<5	<50	<50	--	--	--
SITE 3	207	<5	<50	<50	--	--	--

certified by *Alvin Amoretti*



CHEMEX LABS LTD.

APPENDIX 1

14.

212 BROOKSBANK AVE.
 NORTH VANCOUVER B.C.
 CANADA V7J 2C1
 TELEPHONE: 984-0221
 AREA CODE: 604
 TELEX: 043-52597

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CERTIFICATE OF ANALYSIS

CERTIFICATE NO. SP 841

TO: A-MIN-TECH
 8464 Adera Street
 Vancouver, B.C.
 V6P 5E7

INVOICE NO. 41314

RECEIVED Dec. 10, 1980

ATTN: Also on A8011399

ANALYSED Dec. 31, 1980

SAMPLE NO. :	Lower Concentration Limit (PPM)	1-D Cut	11-C Cut	12-C Cut	4-A Cut	Site 2	Site 3
Antimony	50	bcl	bcl	bcl	bcl	bcl	bcl
Arsenic	50	bcl	bcl	bcl	bcl	bcl	bcl
Barium	5	5	5	5	bcl	20	20
Beryllium	5	bcl	bcl	bcl	bcl	bcl	bcl
Bismuth	5	bcl	bcl	bcl	bcl	bcl	bcl
Boron	20	100	300	700	100	bcl	bcl
Cadmium	20	bcl	bcl	bcl	bcl	bcl	bcl
Calcium	0.05%	0.1%	6.2%	0.1%	0.2%	5%	5%
Chromium	10	3000	5000	3000	3000	300	200
Cobalt	10	150	150	150	150	30	30
Copper	1	100	50	50	70	70	70
Gallium	5	bcl	bcl	bcl	bcl	10	15
Germanium	20	bcl	bcl	bcl	bcl	bcl	bcl
Indium	50	bcl	bcl	bcl	bcl	bcl	bcl
Iron	0.05%	7%	7%	5%	10%	7%	10%
Lead	5	300	300	70	50	30	30
Thallium	0.02%	< 50	< 50	< 50	< 50	< 50	< 50
Manganese	5	700	500	1000	500	700	1000
Molybdenum	10	< 100	< 100	< 100	< 100	< 100	< 100
Nickel	5	1000	1000	1500	1500	100	50
Niobium	50	bcl	bcl	bcl	bcl	bcl	bcl
Silver	1	5	1	1	bcl	bcl	bcl
Strontium	2	5	10	5	5	300	200
Tellurium	200	bcl	bcl	bcl	bcl	bcl	bcl
Thorium	200	bcl	bcl	bcl	bcl	bcl	bcl
Tin	10	bcl	bcl	bcl	bcl	bcl	bcl
Titanium	5	50	100	100	200	1500	2000
Vanadium	20	bcl	bcl	20	20	300	300
Zinc	50	200	70	70	50	70	150
Zirconium	20	bcl	bcl	bcl	20	150	150

SEMI QUANTITATIVE SPECTROGRAPHIC ANALYSES

>5000 ppm = 5000 ppm 50 ppm = 25-100 ppm
 5000 ppm = 2500-10000 ppm 20 ppm = 10-50 ppm
 2000 ppm = 1000-4000 ppm 10 ppm = 5-20 ppm
 1000 ppm = 500-2000 ppm 5 ppm = 2-10 ppm

500 ppm = 250-1000 ppm 2 ppm = 1-4 ppm
 200 ppm = 100-400 ppm 1 ppm = 0.5-2 ppm
 100 ppm = 50-200 ppm bcl = below concentration limit

Ranges for Iron, Calcium & Magnesium are reported in %

A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

PROJECT: BR-1

Progress Report #3

Date: 31 January, 1981

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

Attention: G.W. Hornby

Project Title: Treatment of Serpentine Rock for Recovery of
Nickel- and other Valuable Minerals.

Introduction:

This report summarizes work done to date under the following headings: General, Cobalt Assays, Use of Magnetite in Coal Cleaning.

General:

Most of the work done during this period was preparatory to getting the Nickel-flotation testwork underway, as detailed in Activity Record #4. Two items were done in this months, but were already reported in Progress Report #2. i.e., the discussion with staff of Sherritt Gordon Mines and the taking of polished sections & thin sections to Dr. Chamberlain for mineralogical examination.

Cobalt Assays:

Progress Report #2 showed a value of 0.015% for Cobalt as determined by emission spectrographic analysis. As this method of analysis is semiquantitative it was decided to verify the values by wet chemical analysis and in addition to determine whether some Cobalt is also present as the sulfide. The analyses obtained, as shown in the attached Assay Certificate (Appendix I), are: Total Cobalt: 0.011% to 0.015%, Cobalt as Sulfide: 0.002% to 0.008%. The Total Cobalt values are consistent with those of the emission spectrographic analyses. The Sulfide Cobalt values are of interest as they indicate the possibility that part of the Cobalt present in the Serpentine rock might be amenable to recovery by flotation.

Nickel bearing rocks or deposits often have Cobalt present in

A-MIN-TECH RESEARCH LTD.

PROJECT: BR-1

Page 2

Border Resources Ltd.

Progress Report #3 cont'd.

amounts that give rise to Co:Ni ratios ranging between 1:10 to 1:20. Table 1 shows Co:Ni ratios calculated from the assay values of Cobalt (this report) and Nickel (Progress Report #2) obtained for the five Serpentine rock samples used in this work.

TABLE 1

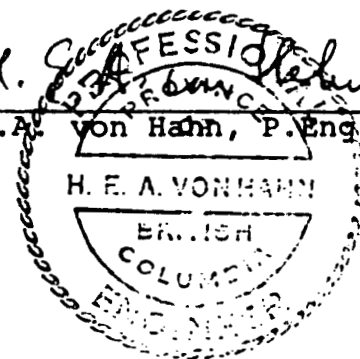
Sample	Total Ni%	Ni% as Sulfide	Total Co%	Co% as Sulfide	Ratio Total Co: Total Ni	Ratio Sulfide Co: Sulfide Ni
1-D Cut	0.24	0.19	0.015	0.008	1:16	1:24
11-C Cut	0.18	0.10	0.013	0.005	1:14	1:20
12-C Cut	0.19	0.05	0.013	0.002	1:15	1:25
4-A Cut	0.19	0.11	0.011	0.006	1:17	1:18
4-B Cut	----	0.13	0.012	0.006	----	1:22

Use of Magnetite in Coal Cleaning:

This writer was advised recently that the coal industry in British Columbia is using magnetite as a constituent in a sink-float process for the cleaning of coal. This observation was found to be confirmed when checked by a phone call to Kaiser Resources Ltd.

Signed: _____

H.E.A. von Hahn, P.Eng.





CHEMEX LABS LTD.

212 BROOKSBANK AVE
 NORTH VANCOUVER, B.C.
 CANADA
 TELEPHONE 604-984-1111
 TELEX 043-8004

• ANALYTICAL CHEMISTS • GEOCHEMISTS • REGISTERED ASSAYERS

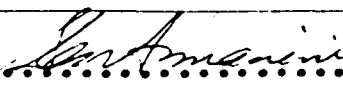
CERTIFICATE OF ASSAY

TO : A-MIN-TECH RESEARCH LIMITED
 8464 ADERA STREET,
 VANCOUVER, B.C.,
 V6P 5E7

CERT. # : A8110110-071-A
 INVOICE # : 18110110
 DATE : 30-JAN-81
 P.O. # : NONE

ATTN: MR. VON HAUN

Sample description	Prep code	Co percent	Co (%) sulphide				
1-D CUT	214	0.015	0.008	--	--	--	--
11-C CUT	214	0.013	0.005	--	--	--	--
12-C CUT	214	0.013	0.002	--	--	--	--
4-A CUT	214	0.011	0.006	--	--	--	--
4-B CUT	214	0.012	0.006	--	--	--	--



 Registered Assayer - Province of British Columbia

A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

PROJECT BR-1

Progress Report #4

Date: 28 February, 1981

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

Attention: G.W. Hornby

Project Title: Treatment of Serpentine Rock for Recovery of Nickel-
and other Valuable Minerals.

Report Title: Flotation Tests for Nickel and Cobalt Recovery on
Site 4 Serpentine Rock.

Summary:

Five Flotation tests were done on a sample of Nickel-bearing Serpentine rock designated Site 4. The purpose of this work was to establish the conditions under which acceptable recoveries and upgrading of nickel sulfide minerals could be attained.

Previous flotation testwork(1) on similar material had given an overall recovery for nickel of 46.4% at a combined concentrate grade of 0.68% Ni. In other testwork(2) overall recovery and combined concentrate grade were only 30% Ni and 0.56% Ni respectively.

There are two main problems associated with the treatment of this material. One is the fineness of the nickel sulfide particles - of the order of 40 microns and less(3,4)- in the rock, the other is the ready floatability of the serpentine gangue material.

In the present testwork the first two tests, BRF-1 and BRF-2, showed no significant upgrading, largely due to strong flotation of gangue. Depramin 12 was used as the gangue dispersant in these two tests.

The results of test BRF-3 were as follows:

	% Weight	Grade	Ni% Recovery	Grade	Co% Recovery
Concentrate 1	0.94	6.60	30.12	0.320	26.79
Concentrate 2	1.16	2.32	12.99	0.120	12.33
Concentrate 1&2	2.10	4.24	43.11	0.210	39.12

cont'd p.2

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Progress Report #4 cont'd.

The results of tests BRF-4 and BRF-5 were as follows:

	% Weight		Ni%		Co%	
	Grade	Recovery	Grade	Recovery	Grade	Recovery
BRF-4						
Concentrate 1	1.46	2.04	14.36	0.105	13.47	
Concentrate 2	2.45	0.96	11.34	0.048	10.34	
Concentrate 1&2	3.91	1.36	25.70	0.069	23.81	
BRF-5						
Concentrate 1	1.02	1.81	8.67	0.098	9.04	
Concentrate 2	2.00	1.50	14.08	0.068	12.28	
Concentrate 1&2	3.02	1.61	22.75	0.078	21.32	

Carboxymethylcellulose (CMC) gangue dispersant was used in tests BRF-3 and BRF-4. In tests BRF-4 and BRF-5 Aero 407 promoter was used in addition to the Xanthate collector. In test BRF-5 the collectors for the first stage were added to the grinding mill rather than to the flotation cell.

The tests BRF-3 to BRF-5 have shown that considerable upgrading of both nickel and cobalt can be achieved; however recoveries cannot yet be considered satisfactory. Further testwork under conditions similar to those used in test BRF-3 is in progress.

The recovery figures for cobalt resemble those for nickel to an extent that suggests that cobalt occurs in the rock in close association with the nickel sulfides.

The presence of cobalt in the serpentine rock samples received has been reported in Progress Report #3.

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Progress Report #4 cont'd.

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Progress Report #4 Cont'd.

Introduction:

This report presents results of flotation testwork done on a sample of nickel-bearing serpentine rock designated Site 4, and provided by G.W. Hornby.

Previous mineralogical examinations(3,4) on similar material had shown the presence of nickel-sulfides.

Previous flotation testwork(1,2) on similar material had shown that nickel sulfides could be floated, however, recoveries and grades had been low. Thus, in one test(1) the combined recoveries from four rougher concentrates had been 46.4% Ni and the combined grade 0.68% Ni. In other testwork(2) the combined recoveries and grades from three rougher concentrates had been 30% Ni and 0.56% Ni respectively.

Two main problems are associated with the treatment of this nickel-bearing serpentine. One is the fineness of the nickel-sulfide particles whose sizes are mainly of the order of 40 microns or less(3,4). The other is the ready floatability of the serpentine gangue.

To overcome the first problem fine grinding is necessary. The second problem requires the use of suitable gangue depressants or dispersants that will prevent flotation of the serpentine gangue while at the same time not affecting adversely flotation of the nickel sulfides. Recent publications(5,6) that addressed themselves to this problem recommend the use of Carboxymethyl-cellulose (CMC) or similar reagents (some under the trade name Depramin(6)) as gangue dispersants in nickel flotation from serpentinitic or talcose host rocks.

The present testwork was undertaken with the following aims in mind: 1. Improve nickel recoveries and concentrate grades, 2. Investigate the efficacy of Depramin and/or CMC as gangue dispersants, 3. Establish the floatability of cobalt minerals; the presence of cobalt, both sulfide and non-sulfide had been reported in Progress Report #3 of this project.

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Progress Report #4

Experimental:

Material: Serpentine Rock from Site 4 in lumps ranging in size from 2" to 8" and assaying approximately 0.21% Ni and 0.011% Co.

Crushing: Crushing of grinding mill feed to -1/8" was done in a laboratory jaw crusher.

Grinding: The flotation charges were ground in a Denver laboratory steel rod mill of about 8 liter capacity. Grinding was done to a size distribution of about 95% -200 mesh and 80% -325 mesh. Vancouver tap water was used for slurry makeup. A cleaning grind was done before each test grind.

Flotation: Flotation was done with a Denver D-1 laboratory flotation machine with a 1000gm square cell. Impeller speed was set at 2100 rpm. Reagents were added as aqueous solutions. Froth drawing was done manually. Drawing times were varied in accordance with visual estimation of the endpoint.

Test Conditions:

Tables 1 to 5 list the test conditions for each test. The main variables investigated were the types of reagents added. The collector Aero 317, Na- Isobutyl Xanthate, was kept the same in all tests. In tests BRF-4 and BRF-5 a sulfide promoter, Aero 407, was used in addition to the collector. A gangue dispersant was used in all tests except BRF-5. In tests BRF-1 and BRF-2 the dispersant was Depramin 12, in tests BRF-3 and BRF-4 it was Carboxymethyl-cellulose (CMC). Dowfroth 250 was used as the frother in all tests except BRF-1. This frother provides stable froths and is easy to apply because of its solubility in water.

The reagents were added to the pulp in the flotation cell. An exception was made in test BRF-5 where the collector and promoter for the first flotation stage were added to the grinding mill.

The pulp density for grinding was set at 50% solids. The pulp density for flotation was set at 32% solids in tests BRF-1 and BRF-2, and at 24-25% in tests BRF-3 to BRF-5. The flotation pulp densities are lower than what is normally used in rougher flotation. This was considered necessary because of the fine grinding required in this testwork.

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Progress Report #4 cont'd.

The pH of the flotation pulp was 9.4. This is the natural value for this pulp, and it is the same as the natural pH of previous work(1).

The starting temperature of the flotation pulp was 20°C. Because of the strong stirring used, it tended to rise to about 30°C during the course of the test.

Results and Discussion:

The results of the flotation tests are given in Tables 6 to 10.

Tests BRF-1 and BRF-2 (Tables 6 and 7) showed no significant upgrading of nickel. This is attributed to the strong flotation of gangue that occurred in these tests. Because of this the recoveries achieved cannot be considered to have any significance.

The results of tests BRF-3 to BRF-5 are shown in Tables 8 to 10. Shown below is a summary of the grade and recovery figures for the concentrates obtained.

	%	Ni%		Co%	
	Weight	Grade	Recovery	Grade	Recovery
BRF-3					
Concentrate 1	0.94	6.60	30.12	0.320	26.79
Concentrate 2	<u>1.16</u>	2.32	<u>12.99</u>	0.120	<u>12.33</u>
Concentrate 1&2	2.10	<u>4.24</u>	<u>43.11</u>	0.210	<u>39.12</u>
BRF-4					
Concentrate 1	1.46	2.04	14.36	0.105	13.47
Concentrate 2	2.45	0.96	<u>11.34</u>	0.048	<u>10.34</u>
Concentrate 1&2	<u>3.91</u>	1.36	<u>25.70</u>	0.069	<u>23.81</u>
BRF-5					
Concentrate 1	1.02	1.81	8.67	0.098	9.04
Concentrate 2	<u>2.00</u>	1.50	<u>14.08</u>	0.068	<u>12.28</u>
Concentrate 1&2	3.02	1.61	<u>22.75</u>	0.078	<u>21.32</u>

The nickel grades and recoveries achieved in tests BRF-3 to BRF-5 show considerable improvements over those of the first two tests. No appreciable gangue flotation occurred during these tests. The reasons for this difference are not quite clear. Depramin 12 was used as the gangue dispersant in the first two tests.

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Project BRF-1

Progress Report #4 cont'd.

In tests BRF-3 and BRF-4 the dispersant was Carboxymethylcellulose (CMC). In test BRF-5 no dispersant was used.

The recoveries of cobalt in tests BRF-3 to BRF-5 resemble closely those of nickel. This is the case for the individual concentrates as well as for the combined concentrates. The degree of upgrading is also very similar for nickel and cobalt, as seen from calculations of the ratios of concentrate grade to feed grade. These findings suggest that cobalt occurs as part of the nickel sulfide minerals rather than as separate minerals.


The reasons for the lower recoveries obtained in tests BRF-4 and BRF-5 as compared to those of test BRF-3 are not understood at present. Aeration of the pulp prior to flotation is being investigated as a possible factor for achieving improvements.

In test BRF-5, where the collector reagents for the first stage were added to the grinding mill, the recoveries in concentrate 1 were lower than those in concentrate 2. These results can be attributed to a lack of aeration during grinding.

In tests BRF-4 and BRF-5 a sulfide promoter, Aero 407, was used in addition to the Xanthate collector. No apparent improvement is evident from the use of this reagent. However, no conclusions can be drawn at this stage because of the possible other factors affecting recoveries.

Tests BRF-3 to BRF-5 have shown that considerable upgrading of both nickel and cobalt can be achieved by two stages of rougher flotation of the serpentine rock. However, recoveries cannot yet be considered satisfactory. Further testwork under conditions similar to those used in test BRF-3 is in progress.

Signed:



H.E.A. von Hahn, P. Eng.

H. E. A. VONHANN

BRITISH
COLUMBIA

ENGINEER

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Project BR-1

Progress Report #4 cont'd.

Table 1

FLOTATION TEST BRF-1, TEST CONDITIONS

Material: Serpentine Rock, Site 4

STAGE	1	2	3	4
	Grinding	Condi- tioning	Flotation	Tailing Sample
Weight of solids in pulp, gm	1000	1000	904	800
Water added, ml (makeup & wash)	1000	1100 (2)	-	-
Pulp volume, ml	1400	2500	2250	-
Pulp density, percent solids	50	32	32	-
REAGENTS ADDED				
lb per ton of solids feed				
-Depramin 12 (3)	-	1.0	-	-
-Aero 317 (4)	-	0.1	-	-
-MF-142 (5)	-	0.17	- (6)	-
pH, natural	-	-	9-10	-
Pulp temperature, °C	-	-	20-22	-
SAMPLES TAKEN				
-Pulp volume, ml	-	-	250	-
-Weight of solids, gm	-	-	96.4	103.3
Time of operation, min	50	5	3	-
Time elapsed, min	50	75	78	-

(1) 98% -200 mesh, 83% -325 mesh

(2) Includes 100 ml Depramin solution

(3) Silicate depressant, Akzo Plastics, Holland

(4) Na-Isobutyl Xanthate, Cyanamid

(5) Alcohol frother, Canadian Industries Ltd

(6) by pH test paper

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Table 2

FLOTATION TEST BR-2, TEST CONDITIONS

Material: Serpentine Rock, Site 4

STAGE	1	2	3	4
Grinding (1)	1000	1000	767	671
Conditioning		1050 (2)		
Flotation		2450		
Tailing Sample		32		
Weight of solids in pulp, gm	1000	1000	767	671
Water added, ml (makeup & wash)	1000	1050 (2)	-	-
Pulp volume, ml	1400	2450	-	-
Pulp density, percent solids	50	32	-	-
REAGENTS ADDED				
lb per ton of solids feed				
-Depramin 12 (3)	-	0.5	-	-
-Aero 317 (4)	-	0.2	-	-
-Dowfroth 250 (5)	-	0.02	-	-
pH, natural	-	-	9 (6)	-
Pulp temperature, °C	-	-	20-22	-
SAMPLES TAKEN				
-Weight of solids, gm	-	-	232.9	95.5
Time of operation, min	50	6	3	-
Elapsed time, min	50	88	91	-

(1) 98% -200 mesh, 81% -325 mesh, approx.

(2) Includes 50 ml Depramin 12 solution

(3) Silicate depressant, Akzo Plastics, Holland

(4) Na-Isobutyl Xanthate, Cyanamid

(5) Glycyl frother, Dow Chemical Company

(6) by pH test paper

cont'd. p.10

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Progress Report #4 cont'd.

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Table 3

FLOTATION TEST BRF-3, TEST CONDITIONS -

Material: Serpentine Rock, Site 4

STAGE	1	2	3	4	5	6	7	8	
	Grinding	Condi-	Head	Condi-	1st	Condi-	2nd	Tailing	
	(1)	tioning	Sample	tioning	Flotation	tioning	Flotation	Sample	
								Reagents	
Weight of solids in pulp, gm	750	750	700	700	694	694	686	640	-
Water added, ml (makeup & wash)	750	1500 (2)	50	-	40	100 (2)	40	-	-
Pulp volume, ml	1050	2550	2450	2450	2460	2560	2560	2410	-
Pulp density, Percent solids	50	25	24	24	24	23	23	-	-
REAGENTS ADDED, lb per ton of solids feed									
-Aero 317 (3)	-	0.066	-	-	-	0.133	-	-	0.199
-CMC (4)	-	1.33	-	1.33	-	-	-	-	2.66
-Dowfroth 250	-	-	-	0.055	-	-	-	-	0.055
pH, natural	-	9.4	-	-	-	-	-	-	-
Pulp temperature, °C	-	-	-	-	25	-	30	-	-
SAMPLES TAKEN									
-Pulp volume, ml	-	-	150	-	30	-	40	150	-
-Weight of solids, gm	-	-	49.6	-	6.6	-	8.1	45.3	-
Time of operation, min	27	20	-	11	12	10	10	-	-
Time elapsed, min	27	66	63	77	89	104	114	-	-

(1) 96% -200 mesh, 78% -325 mesh

(2) Includes 100 ml CMC solution

(3) Na-Isobutyl Xanthate, Cyanamid

(4) Carboxymethylcellulose, Domtar Carboxel 435

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Table 4
 FLOTATION TEST BRF-4, TEST CONDITIONS
 Material: Serpentine Rock, Site 4

STAGE	1	2	3	4	5	6	7
	Grinding	Condi- (1) tioning	Head Sample	Flota- tioning	Condi- tioning	Flota- tioning	Tailing Sample
							Total Reagents
Weight of solids in pulp, gm	750	750	707	697	697	680	-
Water added, ml (makeup & wash)	750	1500 (2)	50	70	-	100	-
Pulp volume, ml	1050	2550	2450	2450	2450	2450	-
Pulp density, percent solids	50	25	24	24	24	24	-
REAGENTS ADDED, lb per ton of solids feed							
-Aero 317 (3)	-	0.05	-	-	0.05	-	0.10
-Aero 407 (4)	-	0.05	-	-	0.05	-	0.10
-CMC (5)	-	2.0	-	-	-	-	2.0
Dowfroth 250	-	0.02	-	-	0.02	-	0.04
pH, natural	-	-	-	-	-	-	-
Pulp temperature, °C	-	20	-	-	30	-	-
SAMPLES TAKEN							
-Pulp volume, ml	-	-	150	70	-	100	-
-Weight of Solids, gm	-	-	42.7	10.3	-	17.3	-
Time of operation, min	27	20	-	7	12	6	-
Time elapsed, min	27	70	74	82	95	103	-

(1) 95% -200, 73% -325 mesh
 (2) Includes 150 ml CMC solution
 (3) Na-Isobutyl Xanthate, Cyanamid
 (4) Promoter for sulfides, Cyanamid
 (5) Carboxymethylcellulose, Domtar Carboxel D435

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Table 5
 FLOTATION TEST BRF-5, TEST CONDITIONS
 Material: Serpentine Rock, Site 4

STAGE	1	2	3	4	5	6	7	Total Reagents
	Grinding (1)	Condi- tioning	Head Sample	1st Flotation	Condi- tioning	2nd Flotation	Tailing Sample	
Weight of solids in pulp, gm	750	750	704	697	697	683	637	-
Water added, ml (makeup & wash)	750	1500	20	60	20	30	-	-
Pulp volume, ml	1050	2550	2420	2410	2430	2360	2210	-
Pulp density, percent solids	50	25	25	25	25	25	-	-
REAGENTS ADDED								
lb per ton of solids feed								
-Aero 317 (2)	0.05	-	-	-	0.05	-	-	0.10
-Aero 407 (3)	0.05	-	-	-	0.05	-	-	0.10
-Dowfroth 250	-	0.02	-	-	0.02	-	-	0.04
pH, natural	-	-	-	9.4	-	-	-	-
Pulp temperature, °C	-	-	-	22	-	27	-	-
SAMPLES TAKEN								
-Pulp vol, ml	-	-	150	70	-	100	150	-
-Weight of solids, gm	-	-	46.0	7.2	-	14.1	46.1	-
Time of operation, min	27	2	-	8	11	8	-	-
Time elapsed, min	27	41	41	49	65	73	-	-

- (1) 92% -200 mesh, 70% -325 mesh
- (2) Na-Isobutyl Xanthate, Cyanamid
- (3) Promoter for sulfides, Cyanamid

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Table 6

FLOTATION TEST BRF-1, RESULTS

Product	% Weight	Ni% Assay	Ni% Distribution
Concentrate	9.64	0.34	15.35
Tailings	90.36	0.20	84.65
Head, Calculated	100.00	0.21	100.00

Table 7

FLOTATION TEST BRF-2, RESULTS

Product	% Weight	Ni% Assay	Ni% Distribution
Concentrate	23.29	0.28	29.83
Tailings	76.71	0.20	70.17
Head, Calculated	100.00	0.22	100.00

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Table 8
 FLOTATION TEST BRF-3 RESULTS

Product	% Weight	Ni%		Co%	
		Assay	Distribution	Assay	Distribution
Head	-	0.21	-	0.011	-
Concentrate 1	0.94	6.60	30.12	0.320	26.79
Concentrate 2	1.16	2.32	12.99	0.120	12.33
Tailings	97.90	0.12	56.89	0.007	60.88
Head, Calculated	100.00	0.207	100.00	0.011	100.00
INDIVIDUAL RESULTS					
Concentrate 1	0.94	6.60	30.12	0.320	26.79
Concentrate 1&2	2.10	4.24	43.11	0.210	39.12
CUMULATIVE RESULTS					

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Table 9

FLOTATION TEST BRF-4 RESULTS

	Product	% Weight	Ni%		Co%	
			Assay	Distribution	Assay	Distribution
INDIVIDUAL RESULTS	Head	-	0.22	-	0.011	-
	Concentrate 1	1.46	2.04	14.36	0.105	13.47
	Concentrate 2	2.45	0.96	11.34	0.048	10.34
	Tailings	96.09	0.16	74.30	0.009	76.19
	Head, Calculated	100.00	0.207	100.00	0.011	100.00
CUMULATIVE RESULTS	Concentrate 1	1.46	2.04	14.36	0.105	13.47
	Concentrate 1&2	3.91	1.36	25.70	0.069	23.81

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Table 10
 FLOTATION TEST BRF-5 RESULTS

Product	% Weight	Ni% Assay	Ni% Distribution	Co% Assay	Co% Distribution
INDIVIDUAL RESULTS					
Head	-	0.21	-	0.011	-
Concentrate 1	1.02	1.81	8.67	0.098	9.04
Concentrate 2	2.00	1.50	14.08	0.068	12.28
Tailings	96.98	0.17	77.25	0.009	78.68
Head, Calculated	100.00	0.213	100.00	0.011	100.00
CUMULATIVE RESULTS					
Concentrate 1	1.02	1.81	8.67	0.098	9.04
Concentrate 1&2	3.02	1.61	22.75	0.078	21.32

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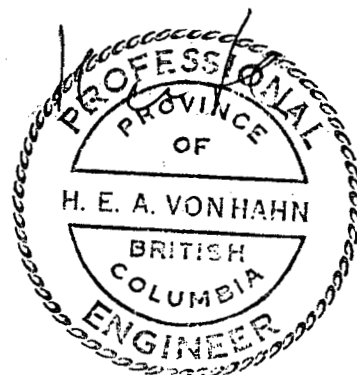
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CHEMEX LABS LTD.

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• GEOCHEMISTS

• REGISTERED ASSAYERS

CERTIFICATE OF ASSAY

TO : A-MIN-TECH RESEARCH LIMITED
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CERT. # : 48110419-001-1
 INVOICE # : 18110419
 DATE : 06-MAR-81
 P.O. # : NONE

Sample description	Prep code	Ni percent	Co percent				
TEST 1 CONC	0	0.34	--	--	--	--	--
TEST 1 TAILS	0	0.20	--	--	--	--	--
TEST 2 CONC	0	0.28	--	--	--	--	--
TEST 2 TAILS	0	0.20	--	--	--	--	--
BRF-2 HEAD	0	0.21	0.011	--	--	--	--
BRF-3 CONC 1	0	6.60	0.320	--	--	--	--
BRF-3 CONC 2	0	2.32	0.120	--	--	--	--
BRF-3 TAILS	0	0.12	0.007	--	--	--	--
BRF-4 HEAD	0	0.22	0.011	--	--	--	--
BRF-4 CONC 1	0	2.04	0.105	--	--	--	--
BRF-4 CONC 2	0	0.96	0.048	--	--	--	--
BRF-4 TAILS	0	0.16	0.009	--	--	--	--
BRF-5 HEAD	0	0.21	0.011	--	--	--	--
BRF-5 CONC 1	0	1.81	0.098	--	--	--	--
BRF-5 CONC 2	0	1.50	0.068	--	--	--	--
BRF-5 TAILS	0	0.17	0.009	--	--	--	--



.....*S. J. Morrison*.....
 Registered Assayer, Province of British Columbia

A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

PROJECT BR-1

Progress Report #5

Date: 30 April, 1981

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

Attention: G.W. Hornby

Project Title: Treatment of Serpentine Rock for Recovery of Nickel-
and Other Valuable Minerals.

Report Title: Settling of Flotation Tailings.

Summary:

Settling tests done with the flotation tailings of a number of flotation experiments showed the ground serpentine solids to possess good settling characteristics. A clear supernatant liquid was achieved in all tests, and the "mudline" was always sharp.

No settling agents were added to the pulps. The only reagent present in the pulp that could aid settling was Carboxymethylcellulose. This reagent served as a gangue dispersant in all flotation tests except test BRF-5. Its effect, if present, was not significant.

Initial settling rates were quite similar for all tests for the first 10 minutes approximately. After that the rates decreased more rapidly for the tests with Site 1 material than for the tests with Site 4 material.

Final "Percent Settled" figures were greater for Site 4 material than for Site 1 material.

These differences are assumed to be related to differences in the nature of the serpentine rock.

No significant correlation was observed between screen analyses of the tailings pulp and final "Percent Settled" figures, except for test BRF-6 where a coarser grind was used. The final "Percent Settled" figure for this test is higher than for the two other tests (BRF-7 & BRF-9) in which Site 1 material was used.

cont'd. p.2

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Page 2

Project BR-1

Progress Report #5 cont'd.

Settling Tests, Tailings Slurries:

Introduction: Settling tests were done with the tailings slurries of several flotation experiments to determine the settling characteristics of the ground serpentine rock.

Experimental: The slurries were placed in a graduated 3 liter pyrex beaker of 5.5" I.D. and allowed to settle. Periodic readings were taken of the level of the "mudline", and the "percent settled" was calculated. The "percent settled" is taken as the height of the clear supernatant liquid divided by the total height of the liquid plus solids in the beaker. The "mudline" is the designation of the interface between clear supernatant liquid and top level of the settling solids.

Results and Discussion: Results of the settling tests are shown below together with calculated "percent settled" figures.

Test BRF-4; Site 4 Material

Time min	Mudline Level	Percent Settled
0	2400	0
11	1500	37.5
23	1200	50.0
62	1000	58.0
86	950	60.4
139	915	61.8
4035	890	62.9

Test BRF-5, Site 4 Material

Time min	Mudline Level	Percent Settled
0	2250	0
4	2130	5.3
7	1900	15.5
14	1580	29.8
22	1350	40.0
80	1000	55.6
136	900	60.0
1309	850	62.2

Test BRF-6, Site 1 Material

Time min	Mudline Level	Percent Settled
0	2500	0
2520	1000	60.0

Test BRF-7, Site 1 Material

Time min	Mudline Level	Percent Settled
0	2240	0
10	1700	24.1
24	1500	33.0
39	1375	38.6
57	1320	41.1
1248	1060	52.7

Test BRF-8, Site 4 Material

Time min	Mudline Level	Percent Settled
0	2125	0
29	1150	45.9
53	1000	52.9
1340	800	62.4

Test BRF-9, Site 1 Material

Time min	Mudline Level	Percent Settled
0	2250	0
8	1750	22.2
28	1500	33.3
45	1380	38.7
2824	1000	55.6

cont'd. p.3

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Page 3

Project BR-1

Progress Report #5 cont'd.

The final mudline levels, reached after the slurries have settled overnight or longer, give "percent settled" figures between 53 and 63.

The supernatant liquid was clear in all tests, and the mudline was always sharp.

For purposes of correlation the final "percent settled" figures are compared with the screen analyses for each test and the material used in the test, as shown in the table below.

Test #	Material from Site	% -200 mesh	% -325 mesh	Percent Settled Final
BRF-4	4	95	73	62.9
BRF-5	4	92	70	62.2
BRF-6	1	53	47	60.0
BRF-7	1	94	72	52.7
BRF-8	4	97	79	62.4
BRF-9	1	92	70	55.6

There is virtually no variation evident in the final "percent settled" figures for Site 4 material. For Site 1 material a higher "percent settled" figure is evident for test BRF-6 than for tests BRF-7 and BRF-9. This, of course, is a result of the coarser grind used in BRF-6.

The final "percent settled" figures are lower for the tests in which Site 1 material was used as compared to the figures for Site 4 material. The reason for this is not clear. It is assumed to be related to possible variations in the nature of the host serpentine rock.

To analyze this question further plots were prepared of "percent settled" vs. time as shown in Figure 1. It is noteworthy that initial settling rates, up to a time of about 10 minutes, are quite similar for most tests. After that the settling rates decrease more rapidly for those tests in which Site 1 material was used as compared to those for Site 4 material. Again, these differences in rates are presumably related to possible variations in the host serpentine rock.

It should be noted that no settling agents were used in these tests. The only reagent that could enhance settling, and being present in the slurries, was Carboxymethylcellulose. It was used during flotation in all tests except BRF-5.

cont'd. p.4

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Page 4

Project BR-1

Progress Report #5 cont'd.

The results of these preliminary settling tests look encouraging from a tailings disposal point of view.

Results of further settling tests, including on material from Site 11 and 12, will be reported when they become available.

Signed: *H. E. A. VonHahn*
H.E.A. VonHahn, Eng.

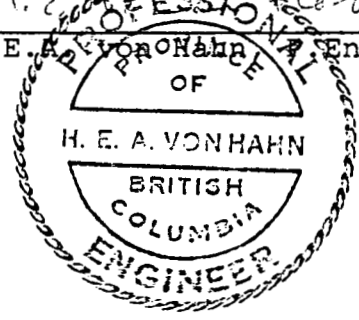
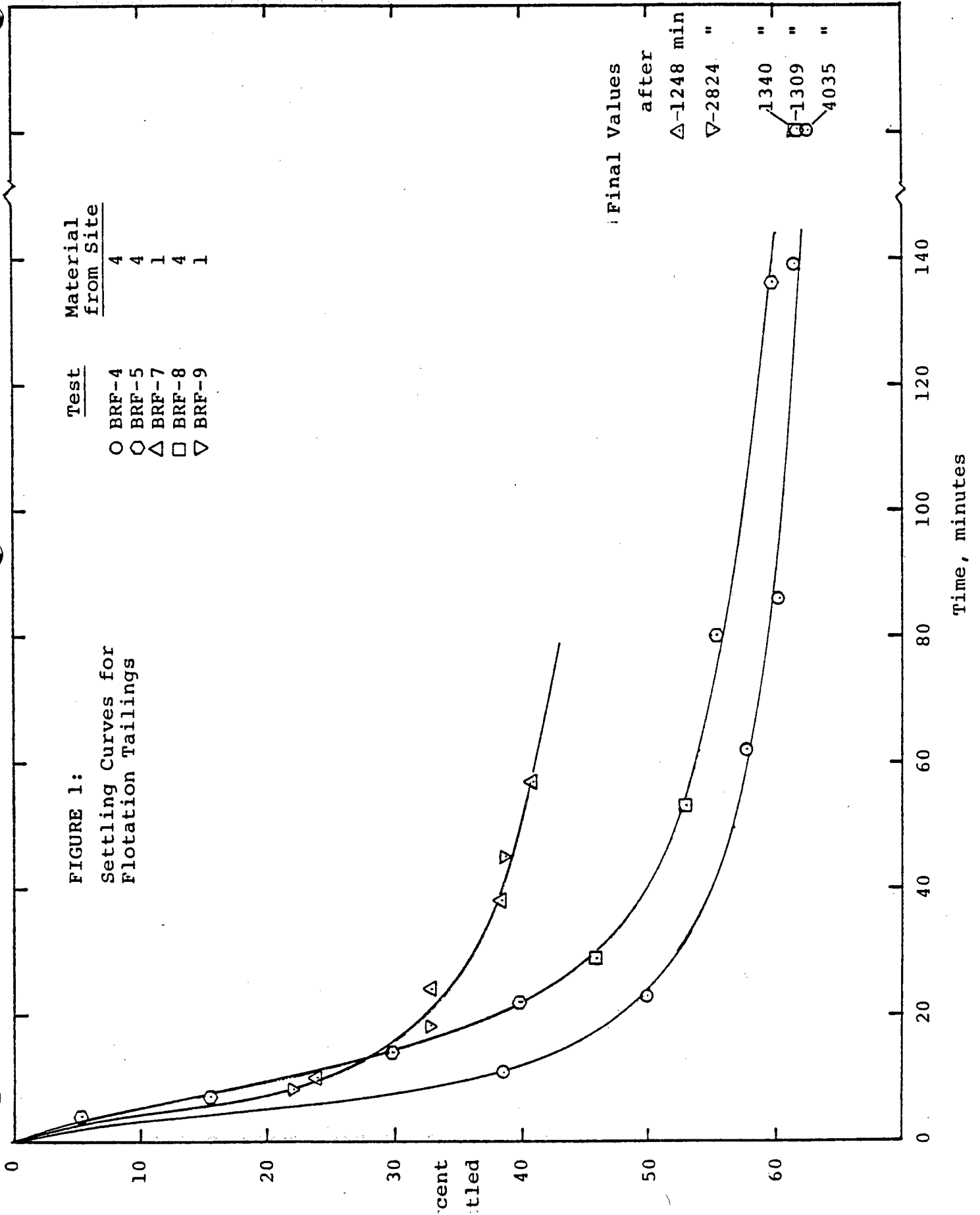


FIGURE 1:
 Settling Curves for
 Flotation Tailings

Test	Material from Site
○ BRF-4	4
○ BRF-5	4
△ BRF-7	1
□ BRF-8	4
▽ BRF-9	1

Final Values
 after
 △-1248 min
 ▽-2824 "
 " 1340 "
 " 1309 "
 " 4035 "



A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

PROJECT BR-1

Progress Report #6

Date: 30 April, 1981

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

Attention: G.W. Hornby

Project Title: Treatment of Serpentine Rock for Recovery of Nickel
and Other Valuable Minerals.

Report Title: Specific Gravity of Serpentine Rock.

The specific gravity of serpentine rock was measured for the purpose of calculating pulp density changes during flotation.

A single piece of serpentine rock of Site 4 material was taken for this determination.

Pulp density was determined by dividing into the weight of the piece of rock its volume as measured by displacement of water.

The result was as follows:

Weight of rock: 637.7 gm
Displacement volume: 260 cc

Specific gravity: $637.7\text{gm} \div 260\text{cc} = \underline{2.45\text{gm/cc}}$

This figure, although somewhat lower, is in close agreement with the specific gravities of Antigorite: ≈ 2.61 , and Chrysotile: ≈ 2.55 the main constituents of serpentine (Ref: Encyclopedia of Minerals, Roberts, Rapp & Weber, Van Nostrand Reinhold Company, Toronto).

Signed: _____

H. E. A. von Hahn, P. Eng.

H. E. A. VONHANN

BRITISH
COLUMBIA

A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

PROJECT BR-1

Progress Report #7

Date: 30 April, 1981

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

Attention: G.W. Hornby

Project Title: Treatment of Serpentine Rock for Recovery of Nickel
and Other Valuable Minerals.

Report Title: Moisture Content of Serpentine Rock.

The moisture content of the serpentine rock was measured for the purpose of determining its effect, if any, on the material balance calculations of flotation tests.

A sample of crushed rock of Site 4 material was weighed, heated in an oven at 103°C overnight and weighed again. The weight loss was taken as being the moisture content.

The result was as follows:

Weight of rock before heating:	180.1gm
Weight of rock after heating:	<u>178.5gm</u>
Weight loss:	1.6gm

Moisture content:	$\frac{1.6 \times 100}{180.1} = 0.89\%$
-------------------	---

Because of its low value the moisture content was ignored in the material balance calculations of flotation tests.

Signed: _____

H.E.A. von Hahn, P. Eng.

H. E. A. VONHAHN

BRITISH

COLUMBIA

ENGINEER

SECTION 3 - STATEMENT OF COSTS

(1) FIELDWORK:

Oct. 11-14:	
Meals and accommodation	\$194.13
Equipment rental (Cobra packdrill)	161.00
Explosives	11.74
Sundries	8.27
Transportation (4X4 truck & car)	120.72
Wages:	
Supervision (J. Hornby) (1 day @ \$200.00/day)	200.00
Driller/blaster (P.Hall) (4 days @ \$150.00/day)	600.00
Assistant (K.Shaw) (3 days @ \$75.00/day)	225.00
	<hr/>
	\$1520.86
Oct. 18-19:	
Meals and accommodation	\$122.90
Equipment rental (Cobra packdrill)	111.00
Explosives	8.46
Sundries (incl. lost drillbit)	39.94
Transportation (4X4 truck & car)	124.60
Wages:	
Supervision (M.Menzies) (2 days @ \$200.00/day)	400.00
Driller/blaster (P.Hall) (2 days @ \$150.00/day)	300.00
Assistant (J. Menzies) (2 days @ \$75.00/day)	150.00
	<hr/>
	\$1256.90
Nov. 15-16:	
Meals and accommodation	\$39.30
Equipment rental (Cobra packdrill)	61.00
Explosives	4.48
Sundries	6.31
Transportation (4X4 truck)	72.36
Wage:	
Driller/blaster (P.Hall) (2 days @ \$150.00/day)	300.00
Assistant (K.Shaw) (1 day @ \$75.00/day)	75.00
	<hr/>
	\$558.45

SECTION 3 (Continued)

(1) FIELDWORK TOTAL:	\$ 3336.21
(2) METALLURGICAL RESEARCH:	
A-MIN-TECH invoices:	
31 December 1980	\$ 1223.00
31 January 1981	507.00
28 February 1981	1179.50
31 March 1981	1773.52
30 April 1981	1845.76
29 May 1981	1764.75
	<u>\$ 8293.53</u>
DOLMAGE-CAMPBELL invoice:	
8 April 1981	\$ 225.32
(3) REPORT AND MAP PREPARATION:	
(3 days at \$200.00/day)	\$ 600.00
Reprographics, maps, and stationery supplies	19.93
	<u>\$ 619.93</u>
	<u> </u>
TOTAL THIS REPORT:	\$12,474.99

G. Hall

A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

INVOICE

PROJECT: BR-1

Date: 31 December, 1980

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

For:

1. Professional Services re mineralogical and metallurgical work on rock samples supplied and as per attached Activity Record #3. \$661.50

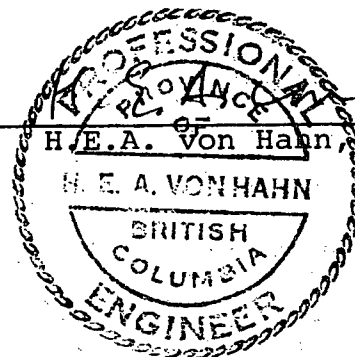
2. Cash outlays as per attached invoice copies:

To Vancouver Petrographics Ltd.	21.50
To Vancouver Petrographics Ltd.	48.00
To Chemex Labs Ltd.	342.00
To Chemex Labs Ltd.	<u>150.00</u>

Total \$1223.00

Signed: _____

H.E.A. Von Hahn, P.Eng.



A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

INVOICE

PROJECT: BR-1

Date: 31 January, 1981

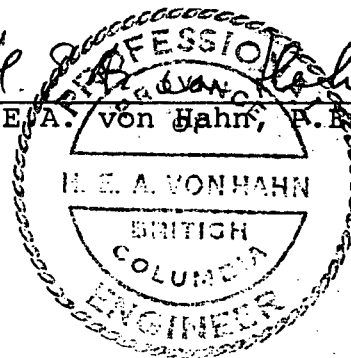
To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

For:

1. Professional services re metallurgical work on serpentine rock samples supplied and as per attached Activity Record #4.	\$413.00
2. Long distance telephone calls and telex: a. Hollimex Ltd., Edmonton, b. Sherritt-Gordon Mines Ltd., Fort Saskatchewan, c. Akzo Plastics Ltd., Holland.	26.50
3. Outlay as per attached invoice of Chemex Labs Ltd.	<u>67.50</u>
Total	\$507.00

Signed: *H. E. A. von Hahn*

H.E.A. von Hahn, B. Eng.



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A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

INVOICE

PROJECT BR-1

Date: 28 February, 1981

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

For:

Professional services re metallurgical work on
serpentine rock samples supplied and as per
attached Activity Record #5

\$1179.50

Signed: H.E.A. von Hahn

H.E.A. von Hahn, P.Eng.

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Flotation, Hydrometallurgy
Research & Testing

INVOICE

PROJECT BR-1

Date: 31 March, 1981

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

For:

1. Professional Services re metallurgical work on serpentine rock samples supplied, and as per attached Activity Record #6	\$1428.00
2. Long distance telephone calls to Sherritt Gordon Mines Ltd., Fort Saskatchewan, \$16.82, and to B.C. Coal, Sparwood, \$2.70	19.52
3. Outlays as per attached invoices:	
To Chemex Labs Ltd.	176.00
To Vancouver Petrographics Ltd.	60.00
To Chemex Labs Ltd.	<u>90.00</u>
TOTAL	\$1773.52

Signed: _____

H. E. A. von Hahn, P. Eng.



A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

INVOICE

PROJECT BR-1

Date: 30 April, 1981

To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

For:

1. Professional Services re metallurgical work on serpentine rock samples supplied, and as per attached Activity Record #7	\$1659.00
2. Long distance phonecalls to Sherritt Gordon Mines Ltd., Fort Saskatchewan, \$3.14 & \$1.62, and Lynn Lake, Man., \$9.00	13.76
3. Outlays as per attached invoices:	
To Chemex Labs Ltd.	114.00
To Chemex Labs Ltd.	38.00
To Chemex Labs Ltd.	<u>21.00</u>
TOTAL	\$1845.76

Signed: _____

H. E. A. H. FOR HONOR. P. Eng.



A-MIN-TECH RESEARCH LTD.

A Minerals Technology Service

Flotation, Hydrometallurgy
Research & Testing

INVOICE

PROJECT BR-1

Date: 29 May, 1981,

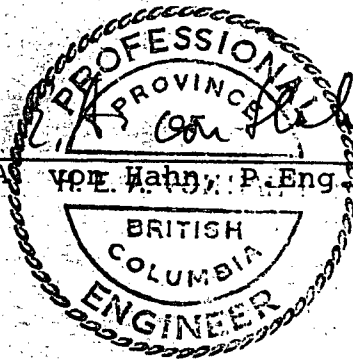
To: Border Resources Ltd.,
412 Granville Square,
200 Granville Street,
Vancouver, B.C.,
V6C 1S4

For:

1. Professional services re metallurgical work on serpentine rock samples supplied and as per attached Activity Record #8	\$1305.50
2. Outlays as per attached invoices:	
To Arnold W. Greenius, P.Eng., consultant	33.25
To Chemex Labs Ltd.	93.00
To Chemex Labs Ltd.	19.00
To Chemex Labs Ltd.	72.00
To Vancouver Petrographics Ltd.	32.00
To Bacon & Donaldson & Associates Ltd.	210.00
TOTAL	\$1764.75

Signed: *H. E. A. von Hahn*

H. E. A. von Hahn, P. Eng.





DOLMAGE CAMPBELL & ASSOCIATES (1975) LTD.
CONSULTING ENGINEERS

SUITE 1000-1055 W. HASTINGS STREET
VANCOUVER, CANADA V6E 2E9
TELEPHONE (604) 681-2345

G.W. HORNBY,
4547 West 5th Avenue
Vancouver, B.C.
V6R 1S6

Statement
CONSULTING SERVICES

Invoice No.: 5265
Invoice Date: April 8, 1981
Month of: March, 1981

COQUIHALLA PROJECT

MICROSCOPY AND REPORT

Dr. J.A. Chamberlain (4 hrs @ \$50)

\$200.00

\$200.00

EXPENSES

Jan. 14 Dominion Blueprint
Mar. Photocopies

23.97

1.35

25.32

TOTAL THIS INVOICE

\$225.32

& O. E.

SERVICE CHARGE OF 1½% PER MONTH CHARGED ON OVERDUE ACCOUNTS.
ACCOUNTS OVERDUE AFTER 10TH OF MONTH FOLLOWING DATE OF INVOICE.

STATEMENT OF QUALIFICATIONS

I am a graduate of the University of British Columbia in Resource Geography.

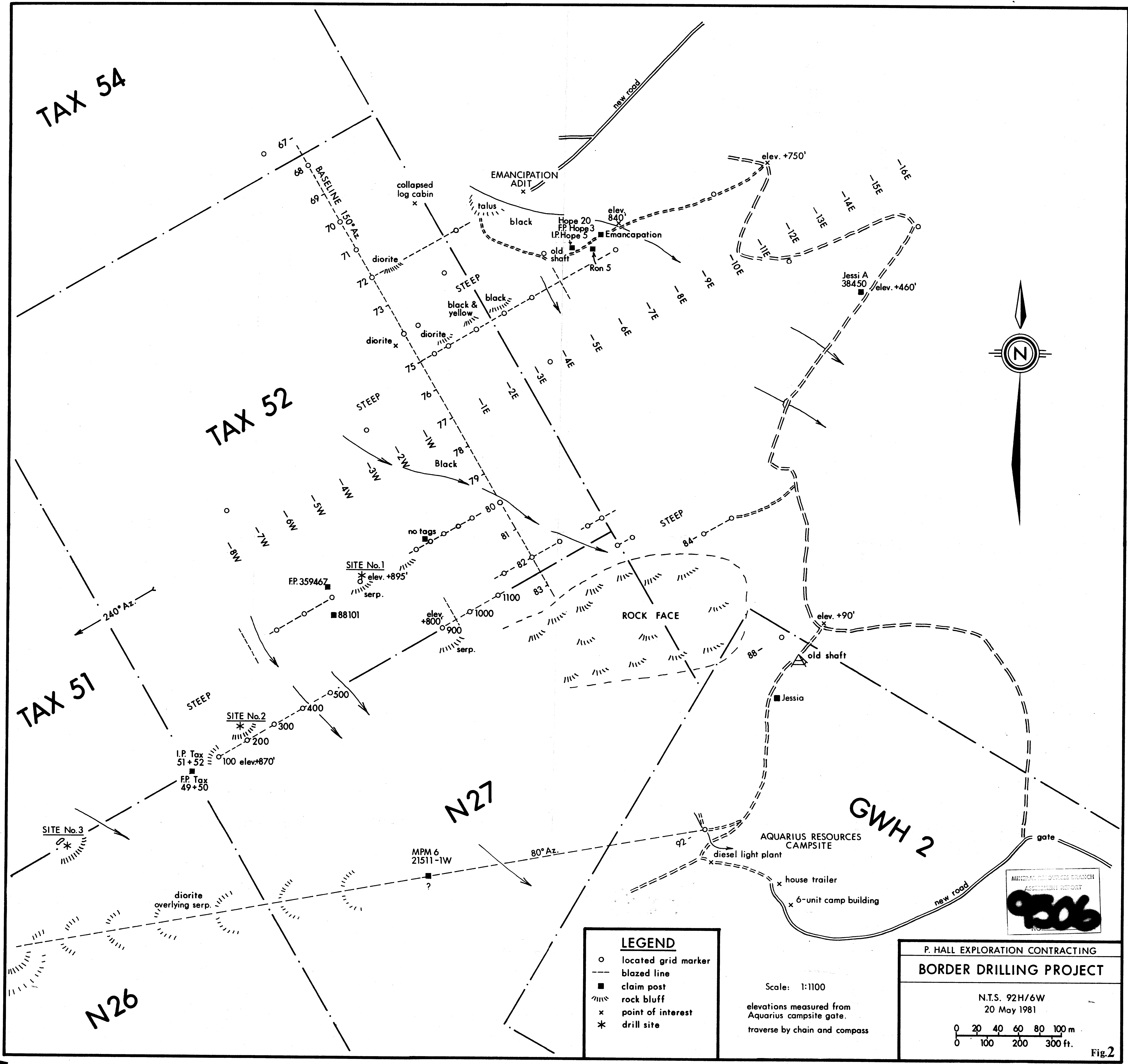
I have worked in all phases of mineral exploration and as a Mineral Lands Manager with B.C. mining companies since 1969.

I participated in the performance of the fieldwork about which this report is based and can attest that the costs listed herein are both reasonable and correct.

Vancouver, B.C.
May 22, 1981.



P. Hall, BA



LEGEND

- located grid marker
- blazed line
- claim post
- ⋄ rock bluff
- x point of interest
- * drill site

Scale: 1:1100
 elevations measured from
 Aquarius campsite gate.
 traverse by chain and compass

P. HALL EXPLORATION CONTRACTING
BORDER DRILLING PROJECT
 N.T.S. 92H/6W
 20 May 1981

0 20 40 60 80 100 m
 0 100 200 300 ft.

Fig.2