FELDSPAR AND NEPHELINE SYENITE POTENTIAL IN BRITISH COLUMBIA

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KEYWORDS: Industrial minerals, feldspathic materials, pegmatite, feldspathic sand, nepheline syenite, phonolite, feldspar.

INTRODUCTION

Feldspathic materials are used in the glass and ceramic industries as a source of alkalis, alumina and silica. These elements affect the rate and temperature of melting, fluidity of the melt and physical properties of the finished product. Silica, sodium, potassium and alumina ratios in the feldspar product vary for each industrial user, however, iron must be limited to less than 0.1 per cent and other heavy metals such as copper and manganese must be virtually absent in the commercial product.

Glass manufacturers demand a product with grain-size in the range −40+100 mesh while ceramic producers require finer material at −200 or −325 mesh. The glass industry requires materials which are free of refractory minerals such as corundum, spinel or mica. Table 3-2-1 lists chemical analyses of some feldspathic and aluminous materials and demonstrates the wide range of products acceptable to manufacturers.

There is currently no production of feldspar or nepheline syenite in western Canada and British Columbia imports feldspathic sand from Idaho and nepheline syenite from Ontario. Market research indicates that, with an aggressive marketing strategy, there is good potential to replace imports and develop additional markets on the west coast and in Pacific Rim countries (McVey, 1988).

During 1987 the Geological Survey Branch carried out a review of nine occurrences of feldspar-rich or nepheline syenite rocks. Seven sites are discussed in this report; two prospects, Hellroaring Creek and Lumby have been described previously (White, 1988a and b). The mapping and sampling program was followed by mineral processing tests at CANMET laboratories of Energy, Mines Resources Canada in Ottawa. The sites were chosen on the basis of access and the presence of pegmatite, feldspathic sand, nepheline syenite or phonolite.

This preliminary report describes these occurrences and their physical characteristics, and evaluates their potential as a commercial source of feldspar or nepheline syenite. A more detailed Open File report on feldspar/nepheline syenite is planned. All the sites are situated in southern British Columbia; most are near established transportation networks (Figure 3-2-1).

Results indicate the Scuzzy Creek and Trident Mountain sites can produce feldspathic product which will meet commercial specifications for glass and ceramic manufacturing and are similar to material currently imported (Table 3-2-1). The Lumby and Hellroaring Creek sites, which contain glass/ceramic grade feldspathic materials, (White, 1988a and b) are presently being evaluated by industry.

PEGMATITES

COPPER MOUNTAIN (MINFILE 092H 090)

Coarse-grained pegmatite occurs in an oval-shaped intrusive body which measures 1200 by 2000 metres, in the core of the Copper Mountain stock, approximately 16 kilometres south of Princeton (Figure 3-2-1; No. 3).

Ten grab samples selected from fresh-looking, coarse-grained (greater than 5 millimetres), orange to white perthosite, collected from outcrops west of the Similkameen River were analyzed with the following results:

Major oxides	Range Weight %
SiO_2	61.70 – 64.70
Al_2O_3	19.35 – 20.98
Fe_2O_3	0.21 – 1.19
CaO	0.18 – 1.93
Na_2O	4.54 – 8.49
K_2O	2.80 – 9.94

These results indicate the rock is potentially suitable as a source of feldspar and on this basis a 20-kilogram sample was sent to CANMET for beneficiation to further assess its potential. Results are summarized below.

Magnetic Separation Mesh	Weight %
−10 + 100 (magnetic)	2.0
−10 + 100 (nonmagnetic)	86.1
−100	11.9

The nonmagnetic fraction comprised 86 per cent of the sample, with a product size acceptable to industry. Consequently, a flotation test to reduce mica-iron levels followed with the following results:

Flotation Test Product	Weight %
Slimes	13.9
Mica-iron concentrate	0.4
Feldspar concentrate	18.2
Tailings	67.5

Approximately 80 per cent of the sample reported as slimes or tailings and only 18 per cent was recovered in the feldspar concentrate. The feldspar concentrate was passed over the magnetic separator and was then analyzed with the following results:

Major oxides	Feldspar concentrate Weight %	Nonmagnetic concentrate Weight %
SiO_2	61.70	61.40
Al_2O_3	18.60	18.80
Fe_2O_3	0.31	0.34
CaO	0.52	0.50
Na_2O	6.71	6.84
K_2O	6.14	5.99

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1988, Paper 1989-1.

TABLE 3-2-1
TYPICAL ANALYSES, FELSPATHIC AND ALUMINOUS MATERIALS*

Soda Flotation Feldspar, Spruce Pine, NC		Potash Flotation Feldspar, Kings Mountain, NC		Dry Ground Feldspar, Custer, SD	
SiO_2	67.54%	SiO_2	67.04%	SiO_2	71.84%
Al_2O_3	19.25	Al_2O_3	18.02	Al_2O_3	16.06
Fe_2O_3	0.06	Fe_2O_3	0.04	Fe_2O_3	0.09
CaO	1.94	CaO	0.38	CaO	0.48
MgO	Trace	MgO	Trace	MgO	Trace
K_2O	4.05	K_2O	12.10	K_2O	7.60
Na_2O	6.96	Na_2O	2.12	Na_2O	3.72
Loss	0.13	Loss	0.30	Loss	0.20

Feldspathic Sand, Bessemer City, NC		Low Iron Aplite, Montpelier, VA		Canadian Nepheline Syenite Nephton, Ont., Canada	
SiO_2	79.20%	SiO_2	63.71%	SiO_2	61.40%
Al_2O_3	12.10	Al_2O_3	21.89	Al_2O_3	22.74
Fe_2O_3	0.06	Fe_2O_3	0.09	Fe_2O_3	0.06
CaO	0.52	CaO	5.70	CaO	0.70
MgO	Trace	MgO	Trace	MgO	Trace
K_2O	2.62	TiO_2	0.43	K_2O	4.95
Na_2O	4.80	K_2O	2.37	Na_2O	9.54
Li_2O	0.35	Na_2O	5.60	Loss	0.60
Loss	0.35	Loss	0.21		

* From Lefond, 1983

Although the original samples are high in alumina (up to 20.98 per cent), beneficiation tests could not reduce the iron content below 0.31 per cent with liberation less than 100 mesh.

Economic Potential

Chemical analyses of grab samples collected from the core of the Copper Mountain stock indicate the rock is potentially a source of feldspathic material suitable to glass and ceramic manufacturers. However, benefication tests indicate a low recovery rate of nonmagnetic feldspar concentrate and an unacceptably high iron content in the final product. It is concluded that the stock has poor potential for the production of feldpsathic materials meeting industry requirements.

SUMAS MOUNTAIN (MINFILE 092G 037)

A white to light grey, fine-grained (less than 1 millimetre) aplite intrudes Middle Jurassic Harrison Lake acidic flows approximately 9 kilometres northeast of Abbotsford, near Sumas Mountain (Figure 3-2-1; No. 4). Examination of thin

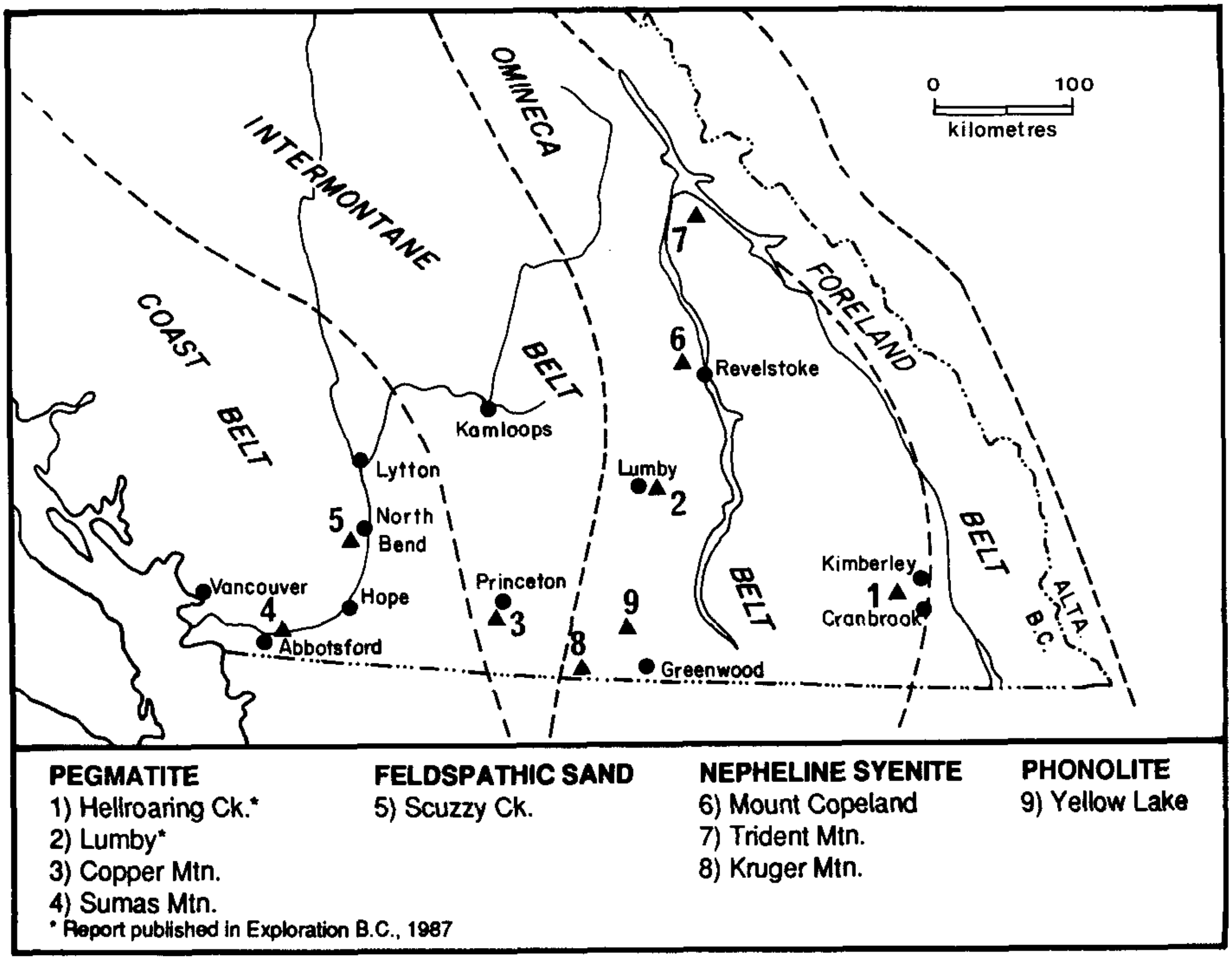

Figure 3-2-1. Feldspar and nepheline syenite occurrences in British Columbia.

sections identified albite and quartz as the main components of the aplite with trace amounts of chlorite also present. Limonite joint-filling is widespread and most likely deposited by circulating meteoric waters. Incomplete chemical analyses on two samples, collected by Z.D. Hora, are as follows:

Oxides	Weight %
Al_2O_3	15 to 18
Na_2O	approximately 8
Fe_2O_3	0.15 to 0.40

Economic Potential

Preliminary analytical results indicated the aplite might be a potential source of feldspar for glass/ceramic applications. However, a sample sent to CANMET was considered too fine grained for processing tests. Without benefication, contaminants such as iron could not be reduced to levels acceptable to manufacturers.

FELDSPATHIC SAND

SCUZZY CREEK (MINFILE 092H 052)

Large sand deposits, of probable glaciolacustrine origin, are located along Scuzzy Creek and one of its tributaries near North Bend in the Fraser Canyon (Figure 3-2-1, No. 5). The feldspathic sand consists of unconsolidated material 0.06 to 2 millimetres in grain size. The sand is composed of plagioclase and quartz with minor mica and amphibole and ranges in colour from white to light grey or dark brown. The deposits may be up to 1800 by 440 metres in area and up to 60 metres thick. Samples analyzed had the following composition:

Major oxides	Weight %
SiO_2	73.75 - 76.90
Al_2O_3	14.43 - 15.40
Fe_2O_3	0.53 - 0.76
CaO	2.77 - 3.05
Na_2O	4.44 - 4.84
K_2O	0.44 - 0.49

Analyses indicate the sand is potentially suitable for glass applications. On this basis one sample was sent to CANMET for benefication. The first process step – screen analysis, produced the following results:

Screen Analysis Mesh	Weight %
+14	1.5
−14+28	17.1
−28+48	41.5
−48+100	28.1
−100+200	9.2
−200	2.6

Approximately 70 per cent of the grains are between −28 and +100-mesh, a size considered acceptable by glass manufacturers.

The sample was next scrubbed, deslimed and a mica, iron and feldspar float produced. The feldspar concentrate was run over a dry magnetic separator. Results are tabulated as follows:

Flotation Test	Test #1 (Weight %)	Test #2
+20 Mesh	–	4.40
Mica-iron concentrate	1.0	1.20
Feldspar concentrate 1	17.60	19.60
Feldspar concentrate 2	26.50	–
Cleaner tails	3.20	5.0
Tails	35.90	65.30
Slimes, losses	15.80	4.50

Magnetic Separation Major oxides	Test 1 Concentrate 1	Test 1 Concentrate 2 (Weight %)	Test 2
SiO_2	55.80	59.60	58.90
Al_2O_3	20.90	21.90	22.0
Fe_2O_3	0.084	0.084	0.94
CaO	5.52	5.53	4.53
Na_2O	8.41	8.39	8.43
K_2O	0.52	0.45	0.53

Recovery rates for feldspar concentrates are low. After magnetic separation, tested samples are high in alumina and calcium and contain moderate amounts of iron (but less than 0.1 per cent).

Economic Potential

Although recovery rates for feldspar are low, tests indicate the Scuzzy Creek deposits contain material meeting glass manufacturers' requirements. Large indicated volumes of sand available and relatively easy access give the site good potential to produce material for the glass industry.

NEPHELINE SYENITE

MOUNT COPELAND (MINFILE 082M 255)

Nepheline syenite and syenite gneisses crop out in a 6-kilometre band on the southern flank of Mount Copeland, 15 kilometres northwest of Revelstoke (Figure 3-2-1; No. 6). The rock consists of orthoclase with subordinate nepheline and albite and small amounts of amphibole, pyroxene and magnetite. It has a banded texture and contains both fine and coarse-grained zones. For detailed geological descriptions of the Mount Copeland area the reader is referred to Pell, 1987.

Thirty-four samples collected from the deposit were analyzed with the following results:

Major oxides	Weight %
SiO_2	51.30 - 61.26
Al_2O_3	17.27 - 24.38
Fe_2O_3	0.84 - 8.21
CaO	0.04 - 9.61
Na_2O	2.74 - 8.76
K_2O	7.49 - 10.14

These analyses indicate the rocks are a potential source of feldspathic material although most samples are high in iron. To better evaluate the material, two 20-kilogram samples, low in iron, were sent to CANMET for processing. At CANMET they were crushed, run through a dry magnetic separator (−10+100 mesh) and a mica-iron float produced with the following results:

Magnetic Separation (Weight %)	Magnetic	Nonmagnetic	-100 Mesh
Sample 1	40.0	51.0	9.0
Sample 2	23.4	66.3	10.3

Flotation (Weight %)	Slimes	Mica-Iron	Concentrate/float tails Magnetic	Nonmagnetic
Sample 1	15.6	27.9	19.1	36.5
Sample 2	20.0	3.8	28.6	46.6

The nonmagnetic concentrates were then analyzed with the following results:

Major oxides (Weight %)	Separation 1	Separation 2	Flotation 1	Flotation 2
SiO_2	56.20	47.1	54.80	50.70
Al_2O_3	19.20	20.50	18.30	21.10
Fe_2O_3	0.50	1.23	0.19	0.41
CaO	1.27	1.60	0.98	0.80
Na_2O	6.58	6.02	6.44	5.48
K_2O	8.40	9.45	8.76	10.57

Economic Potential

Full liberation is achieved at less than 100 mesh. Samples processed by CANMET contain high levels of iron and titanium which could not be reduced below 0.19 per cent and 0.40 per cent respectively. This makes it difficult to produce nepheline syenite meeting market specifications.

TRIDENT MOUNTAIN (MINFILE 082M 173)

Nepheline syenite gneiss occurs as a concordant lenticular mass at Trident Mountain, approximately 85 kilometres northeast of Revelstoke (Figure 3-2-1; No. 7). The rock is white to grey, medium (1 to 5 millimetres) to coarse-grained (greater than 5 millimetres) and consists of microcline, albite and nepheline with minor biotite, ilmenite, sodalite, cancrinite, calcite, apatite, sphene, pyrochlore and zircon (Pell, 1987). The composition of three samples collected is:

Major oxides	Weight %
SiO_2	55.59 – 63.70
Al_2O_3	20.73 – 24.69
Fe_2O_3	0.17 – 0.59
CaO	0.56 – 1.20
Na_2O	8.16 – 8.39
K_2O	3.12 – 8.22

A 20-kilogram sample sent to CANMET was crushed and passed through a magnetic separator with the following results:

Mesh	Magnetic concentrate (Weight %)	Nonmagnetic concentrate
-10+35	4.1	67.7
-35+100	1.3	19.8
-100	0.5	6.6

Analyses of the nonmagnetic concentrate are:

Major oxides	-10+35 mesh	-35+100 mesh (weight%)	-100 mesh
SiO_2	56.6	58.0	62.0
Al_2O_3	16.8	17.3	18.5
Fe_2O_3	0.07	0.03	0.10
CaO	0.75	0.76	0.95
Na_2O	6.11	5.79	5.63
K_2O	7.59	8.05	8.31

Processing results indicate the nepheline syenite is low in magnetic impurities, has a high recovery rate of nonmagnetic materials and therefore a very good potential to produce commercial grade nepheline syenite. Processing indicates a product brightness of 85 per cent can be obtained.

Economic Potential

Samples tested are comparable to nepheline syenite currently imported into western Canada from Ontario. Geological mapping by Pell (1987) has documented large lenticular bodies of nepheline syenite over a distance of 7 kilometres at Trident Mountain. This large body has excellent potential to contain nepheline syenite similar to the samples tested.

KRUGER MOUNTAIN (MINFILE 082ESW 106)

A large body of medium to coarse-grained nepheline syenite, several square kilometres in size, outcrops between Keremeos and Osoyoos (Figure 3-2-1; No. 8). The rocks are mafic phases of syenite with high iron content which is present mainly as very fine-grained (–200 mesh) disseminated magnetite. Analyses of three samples collected from outcrop of a salic, light-coloured phase exposed on a hilltop west of Kruger Mountain, approximately 9 kilometres west of Osoyoos, gave the following results:

Major oxides	Weight %
SiO_2	49.55 – 74.04
Al_2O_3	14.27 – 15.13
Fe_2O_3	0.65 – 11.33
CaO	0.87 – 9.16
Na_2O	2.91 – 3.86
K_2O	4.68 – 5.91

One sample contained 0.65 per cent iron so a 20-kilogram sample was sent to CANMET for processing. It was crushed and middle-range screen fractions were passed through a dry magnetic separator with the following results:

Mesh size	End fractions	Middle-range screen fractions Magnetic (Weight %)	Nonmagnetic
+20	10.3	....	....
-20+28	....	4.1	11.2
-28+35	....	3.4	15.7
-35+140	....	5.5	37.5
-140	12.4	....	....
Totals	22.7	13.0	64.4

Moderate recovery (37.5 per cent) of nonmagnetic material was realized and analyses returned the following results:

Major oxides	-20+28 mesh	-28+35 mesh (Weights %)	-35+140 mesh
SiO_2	64.8	65.3	58.8
Al_2O_3	13.2	12.5	9.8
Fe_2O_3	0.15	0.12	0.09
CaO	0.76	0.75	0.68
Na_2O	4.08	4.02	3.59
K_2O	6.72	6.10	5.47

Economic Potential

The samples contain low alumina (up to 13.2 per cent) and high iron, indicating the rock has a limited potential to meet commercial specifications for glass and ceramic applications.

PHONOLITE

YELLOW LAKE (MINFILE 082E/SW-191)

Phonolite lava flows in the Yellow Creek member of the Eocene Penticton Group (Church, 1980, 1982; Figure 3-2-1, No. 9) outcrop north of Keremeos and Rock Creek. The rock consists of fine-grained pyroxene-rich mafic lava with locally well-developed plagioclase and aegirine-augite phenocrysts. Twelve samples collected from different outcrops were analyzed to evaluate whether the rock is a potential source of feldspar for industrial applications. Results are as follows:

Major oxides	Weight %
SiO_2	50.07 - 64.67
Al_2O_3	13.63 - 19.49
Fe_2O_3	3.30 - 6.93
CaO	1.46 - 8.47
Na_2O	3.05 - 5.86
K_2O	4.42 - 6.97

All samples tested contain high amounts of iron. The sample with the least iron was sent to CANMET for processing to determine whether impurities could be reduced to industry standards but the rock was considered to be too fine grained for mineral separation studies.

ECONOMIC POTENTIAL

Based on chemical analyses and evaluation by CANMET, the sites sampled have no potential for containing glass/ceramic grade material.

SUMMARY AND CONCLUSIONS

Based on field investigations, chemical analyses and processing studies, on samples from the seven sites described here, one, Trident Mountain, has excellent potential to produce glass/ceramic feldspar/nepheline syenite. The Scuzzy Creek feldspathic-sand deposit offers a product suitable for coloured glass applications but at relatively low recovery rates. Two other sites reported on in an earlier publication have good to excellent potential – Lumby and Hellroaring Creek (White 1988a and b).

Results presented in this paper are based on limited field investigation and laboratory studies. Mapping and sampling of outcrops is required to fully evaluate the potential of each site.

ACKNOWLEDGMENTS

I would like to express thanks to the Mineral Processing Laboratories of CANMET in Ottawa, and in particular Grant Feasby, for carrying out mineral preparation and processing tests. I would also like to acknowledge Danny Hora of the British Columbia Geological Survey Branch for suggesting the study and for contributing to and reviewing the text of this paper. David Hannay provided capable and cheerful field assistance throughout the project.

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NOTES