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INDUSTRIAL MINERALS IN LABRADOR

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ABSTRACT

An assessment of industrial minerals in Labrador continued in 1985 with investigations into dolomitic marble, silica and alumina potential, and dimension stone. The best silica prospect in western Labrador contains greater than 99.5 percent SiO_2. Preliminary geochemical analyses indicate that the dolomitic marble meets the specifications for use in the making of self-fluxing 'dolomite-type' iron ore pellets.

Silica deposits were investigated in southeastern Labrador, 25 km southwest of Mary's Harbour. Large quartz-feldspar vein systems form two northeast-trending, undulating ridges that have up to 150 m in relief. Many features within these vein systems suggest the presence of fossil hydrothermal systems and selected samples are being tested for precious metals.

Anorthosite in the Goose Bay area was evaluated as a potential source of alumina, since grab samples collected in 1984 contain up to 27 percent Al_2O_3. Preliminary investigations of the Nain anorthosite indicate that it has excellent dimension stone potential. Its tidewater exposures of massive, coarsely crystalline, medium-gray anorthosite contain uniformly distributed, chatoyant labradorite crystals, and would make extremely attractive facing stone for buildings.

INTRODUCTION

This is the second year of a program investigating the industrial mineral potential of Labrador. It was initiated in 1984 in the Wabush/Labrador City area in an attempt to strengthen and diversify the area's economic base, which is almost entirely dependent on the iron ore industry. In 1985, a total of nine holes and 183 m of core were drilled in the vicinity of the two best marble prospects discovered in 1984. New surveys were initiated in southeastern Labrador and in the Goose Bay and Nain areas (Figure 1).

INDUSTRIAL MINERAL SURVEYS

Dolomitic Marble - Labrador West

An industrial mineral survey carried out in the Wabush/Labrador City area in 1984 established the presence of high quality silica reserves and very pure dolomitic-marble deposits. During the 1985 field season, a three-week drill program was carried out to continue the assessment of the dolomitic marble in two Exempt Mineral Land blocks, which were established as a result of the 1984 sampling program.

The dolomitic marble is being investigated primarily for its potential use in the iron ore industry. To cope with the regression of iron and steel over the last 10 years, there has been a significant effort by the industries to reduce the final cost of producing raw steel from iron ore. This has led to increased beneficiation of iron ore through finer grinding, more energy efficient pelletization techniques, and the development of stronger, more reducible pellets for blast furnaces. One such pellet which may maximize these new developments is the dolomite-pellet type (Ilmoni, 1985), in which a small percentage of dolomite is mixed in with the

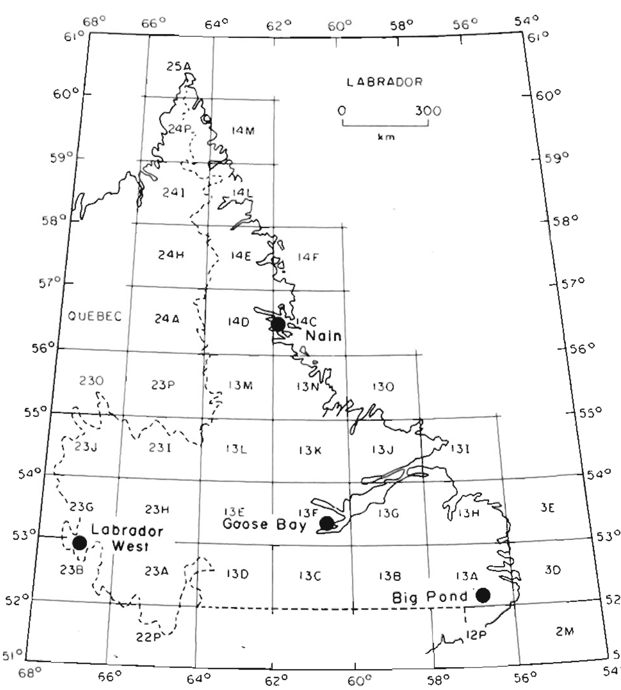


Figure 1: *Location map for 1985 industrial mineral projects in Labraodr.*

iron ore concentrate prior to balling of the pellets. The resulting self-fluxing pellets are presently used in Japanese and European blast furnaces, and with the ongoing development of these pellets their usage should become much more widespread in North America and elsewhere.

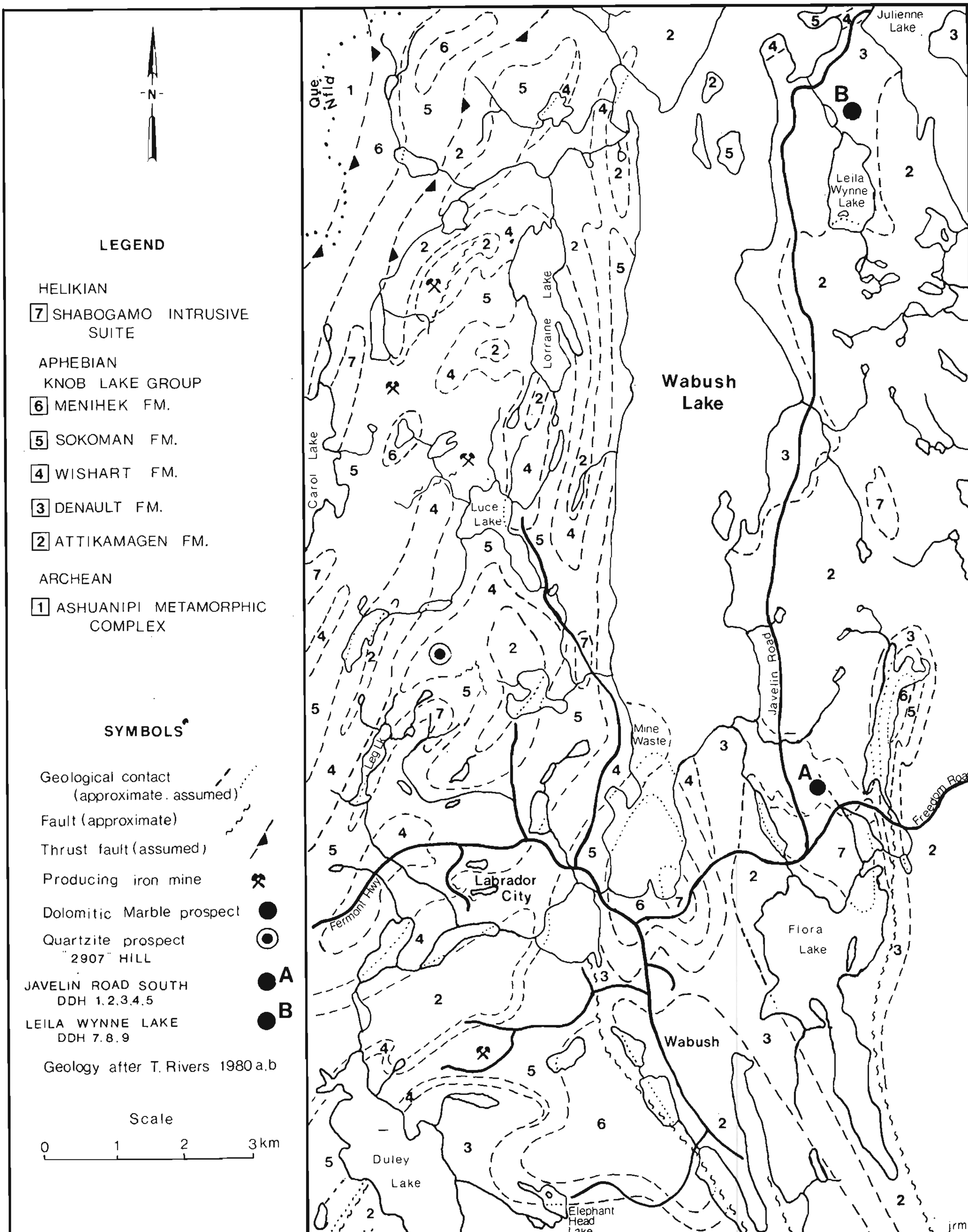


Figure 2: *Geological map of Labrador City-Wabush area.*

It is very fortunate that the sedimentary sequence which hosts the iron formations in western Labrador also contains a dolomitic marble unit, the Denault Formation. In 1984, chip and channel samples were collected from the dolomitic marble, which is exposed to the south and east of Wabush Lake (Figure 2). Geochemical analyses of these samples indicate that two areas of exposure could meet the chemical specifications for self-fluxing pellets. To assess the two areas nine holes were drilled in 1985 using a portable 'Winkie' drill.

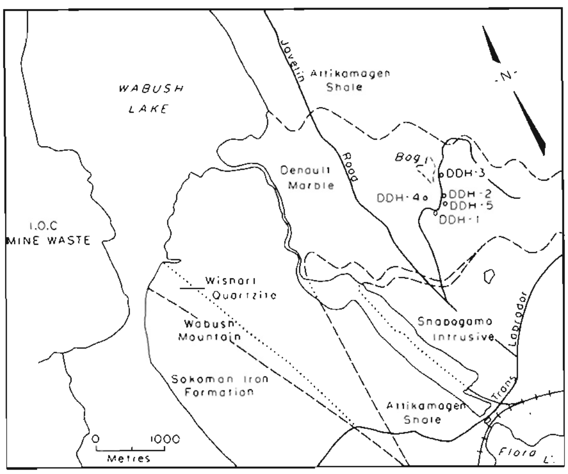


Figure 3: *Location of drillholes in Javelin Road South prospect.*

The first area drilled was the Javelin Road South prospect. It is located 7 km east of the Iron Ore Company of Canada's pellet plant and adjacent to a small dirt road that branches off the south end of the Javelin road (Figure 3). Five holes were drilled in this area and bedrock set-ups were used wherever possible, as 7 m of stoney till is maximum penetration for the Winkie drill (this was discovered in drillhole #4). This severely limited the drill program in the Javelin Road South prospect as there is very little outcrop there. The most favourable drill core in this prospect comes from drillhole #1, which contains 22 m of consistently clean, white, coarsely crystalline dolomitic marble. This reflects the excellent chip and channel sample results obtained from surface exposures at this locality in 1984. The small percentage of impurities observed in the drill core consist of: 1) light-brown to clear patches of tremolite up to 3 mm in diameter, 2) laminations of pale-green tremolite ranging from 1 to 4 mm in thickness, 3) rare quartz laminations and lenses 1 to 3 mm thick, and 4) very small amounts of finely disseminated pyrite and/or chalcopyrite. The sulfides are typically associated with the tremolite or quartz laminations. Preliminary geochemical analyses for the top of this hole are presented in Table 1. The drillhole intersects a 12 cm wide, greenish-gray band of gabbro at 11 m and it ends in similar rock at 21 m. These gabbro units are interpreted to be sills and/or veins of Shabogamo gabbro, which outcrops 1 km to the south. The dolomitic marble may continue below the gabbro.

Table 1. Preliminary geochemical analyses* from selected drill core intervals.

	Sample #	CaO	MgO	SiO_2	Al_2O_3	Fe_2O_3	P_2O_5	Sample Interval
	5445061	29.6	21.7	0.95	0.18	0.13	0.03	1.68 m (5.5')
	5444062	28.8	20.3	4.19	0.11	0.17	0.04	0.46 m (1.5')
DDH 1	5445063	29.4	21.0	2.54	0.05	0.20	0.02	1.52 m (5.0')
	5445064	29.5	21.1	1.82	0.06	0.16	0.02	1.52 m (5.0')
	5445065	28.1	20.2	6.39	0.62	0.19	0.04	1.52 m (5.0')
Average		29.13	20.9	2.96	0.22	0.17	0.03	
	5445114	26.8	19.0	11.21	0.10	0.19	0.01	0.91 m (3.0')
	5445115	25.3	17.3	15.40	0.08	0.54	0.06	0.61 m (2.0')
DDH 5	5445116	24.8	17.7	14.59	0.08	0.16	0.02	1.83 m (6.0')
	5445117	25.7	18.8	11.21	0.13	0.20	0.02	2.13 m (7.0')
	5445118	25.8	18.9	11.72	0.66	0.50	0.03	1.37 m (4.5')
Average		25.6	18.40	12.59	0.21	0.29	0.02	
	5545133	28.5	20.4	5.77	0.11	0.23	0.03	1.83 m (6.0')
	5445134	30.0	21.2	3.64	0.11	0.24	0.03	1.49 m (4.9')
DDH 7	5445135	30.1	21.0	3.31	0.11	0.29	0.06	2.29 m (7.5')
	5445136	29.6	21.3	3.00	0.11	0.37	0.06	2.29 m (7.5')
	5445137	24.9	17.4	18.17	1.34	0.40	0.22	3.05 m (10.0')
Average		28.2	20.0	7.95	0.46	0.32	0.10	
	5445156	28.9	21.5	2.51	0.06	0.20	0.05	2.44 m (8.0')
	5445157	29.7	21.9	0.96	0.05	0.30	0.08	2.44 m (8.0')
DDH 9	5445158	29.4	20.8	3.13	0.05	0.27	0.04	2.44 m (8.0')
	5445159	29.4	21.3	2.54	0.05	0.26	0.02	2.44 m (8.0')
	5445161	28.3	20.7	5.29	0.09	0.27	0.02	1.52 m (5.0')
Average		29.2	21.3	2.69	0.06	0.26	0.04	

* carried out by Iron Ore Company of Canada.

Three more holes, ranging from 25 to 37 m in depth, were drilled 150 to 400 m northeast of, and across the regional strike from drill hole #1 (Figure 3). They intersected light-gray to white, dolomitic marble that is generally banded and locally iron stained. Tremolite and quartz laminations, lenses, and patches are more abundant and thicker, averaging 3 to 8 percent over the total length of the holes. Geochemical analyses from the top of drillhole #5 (Table 1) confirm these field observations of the core. The only other encouraging drill intersections from this area are the bottom 7 m of drillhole #2 (between 30 and 37 m depth), and the top 7 m of drillhole #3. These intervals consist of white, coarsely crystalline, dolomitic marble with 1 to 4 mm patches of yellow to white tremolite.

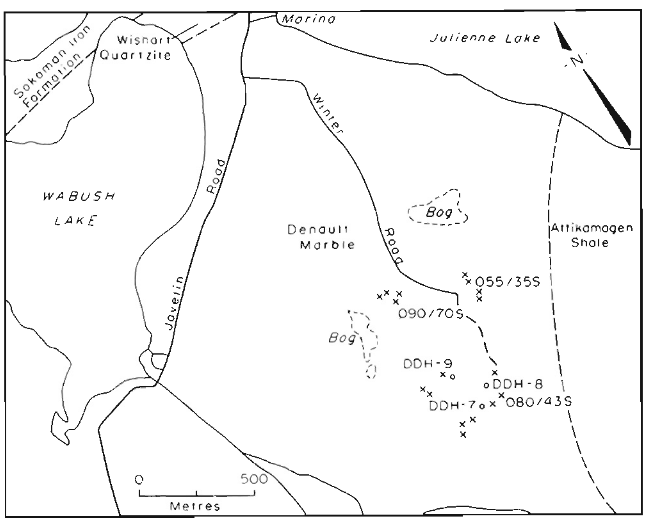


Figure 4: *Location of drillholes in Leila Wynne Lake Prospect.*

The second prospect drilled is located 1.5 km southeast of the north end of the Javelin road and 700 m north of Leila Wynne Lake (Figure 4). Access to the area is by foot or by helicopter, although there is a winter road that ends 750 m from this prospect. The exposures of dolomitic marble are much more extensive in this area and there is only a thin cover of overburden. Three holes were drilled to begin the assessment of this prospect, but there is a need for many more holes to prove its full potential. Drillhole #7, located at the site of a bulk sample collected in 1984, contains an average of nearly 10 percent quartz, tremolite and pyrite over the length of the hole (Table 1). However, 70 m to the northeast at drillhole #8, the marble is much cleaner, whiter, and more coarsely crystalline. This trend continues with drillhole #9, located 150 m northwest of drillhole #8; it intersects 25 m of extremely white dolomitic marble. The core from drillhole #9 contains rare, 1 to 3 mm wide, quartz laminations, light-brown patches of tremolite, 1 to 5 mm in diameter, and minor, widely spaced, faint-gray bands that indicate the presence of trace amounts of finely disseminated pyrite. The dolomitic marble in this hole equals the purity and consistency of the core from drillhole #1 of the Javelin Road South prospect (see Table 1), and there is much better potential for large reserves of high quality dolomitic marble in this area. Dolomitic marble of sufficient whiteness and high chemical purity is also valuable as a mineral filler, i.e., in paint, plastics, paper, rubber, carpet backing, vinyl tile, roofing materials (Guillet and Kreins, 1984) and as building and ornamental stone. This allows for the possibility of a multi-use, dolomitic-marble, mining operation in the Labrador City area.

In November, 1985, the Department of Mines and Energy invited proposals for further exploration and development of the dolomite deposits in the two Exempt Mineral Lands blocks. In January of 1986, the Department accepted a proposal from the Iron Ore Company of Canada to carry out additional drilling on both deposits with the intention of mining dolomitic marble by the summer of 1986 for use in the production of self-fluxing pellets.

Silica - Labrador West

The 1984 industrial mineral survey confirmed that the white quartzite ridges immediately to the north and west of Labrador City are particularly pure and represent significant reserves of high quality silica. The quartzite ridges vary in size from 100 to 3000 m in length, 10 to 700 m in width, and they have up to 100 m of vertical relief. During the 1984 sample program, chip samples were collected from sections measured perpendicular to the strike of the best exposed ridges. The sections were divided into 7 to 10 m intervals and rock chips were collected every 0.5 to 1 m. A total of 383 samples were collected from 33 sections measuring 25 to 500 m in length.

The results of the 1984 sample program are summarized in Table 2. Averages of most of the sampled sections are presented, along with the number of samples and a location index for each section (Figure 5). From these results it is clear that many of the sampled ridges contain quartzite which meets, or exceeds, the specifications for the manufacture of silicon, ferrosilicon, silicon carbide (carborundum), refractory brick, all types of glass (including fiberglass) (Harben, 1977), ceramics, and mineral fillers. Distance from markets and the resulting transportation costs may preclude viability in many of these industries. However, since little or no beneficiation of the quartzite is needed and the infrastructure for mining and transportation is already in place, perhaps a more finished product could be marketed. The possibilities include 'speciality sands' (very pure silica sand), ferrosilicon, silicon metal, the melting of silica and growth of optical-grade crystals, artificial abrasives, and the new 'high tech' ceramics.

Silica - Big Pond

Large quartz and quartz-feldspar veins intrude massive to poorly foliated, granite to granodiorite of Neohelikian (or earlier) age, in an area situated 20 to 25 km west-southwest of Mary's Harbour. Three, large, discontinuously exposed, northeast-trending vein systems were originally mapped by K.E. Eade of the Geological Survey of Canada in 1961, and examined by Brinco in 1982. A silica survey, consisting of a one week detailed sampling program, was carried out during the 1985 field season and concentrated on the southeastern vein system (Figure 6).

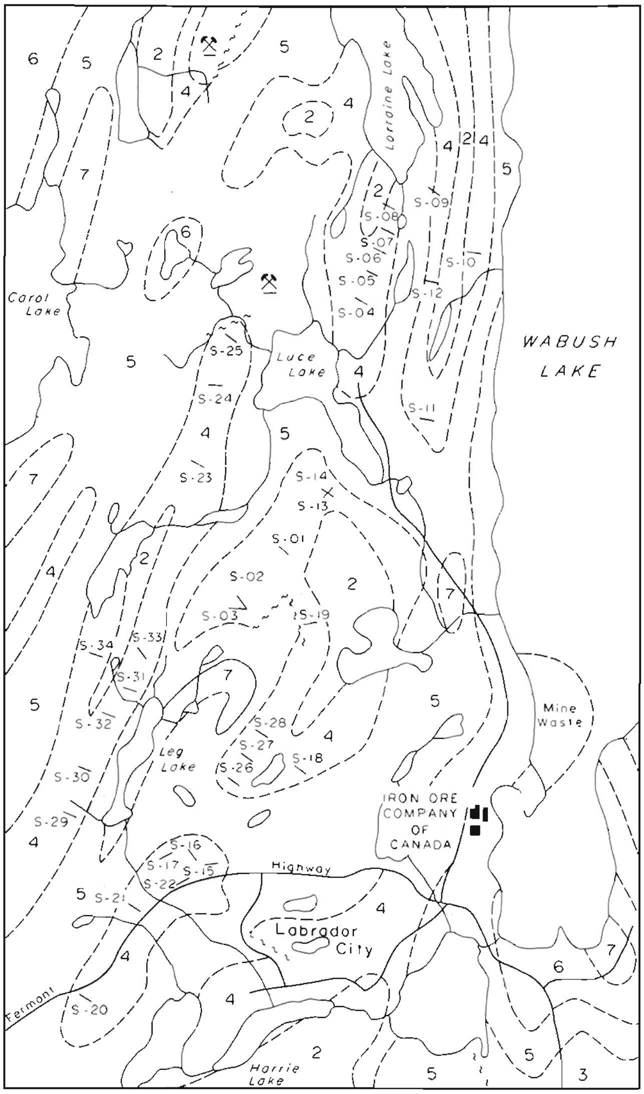
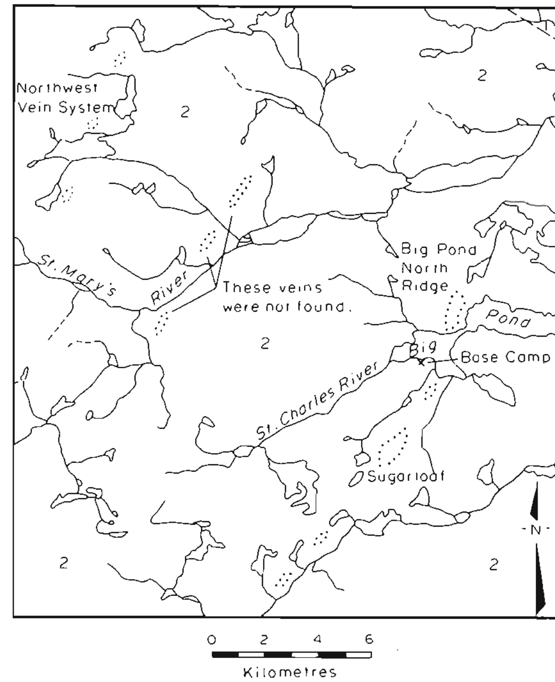


Figure 5: *Location of sections, e.g., S-16, sampled across quartzite ridges in Labrador City area. See Figure 2 for Legend.*

The southeastern vein system consists of five separate ridges, spaced up to 2 km apart in a north-northeast-trending line. They are up to 1500 m in length, 400 m in width, and are generally steep-sided with a maximum relief of 150 m. The two largest and most intensely sampled ridges are named the Sugarloaf and Big Pond North Ridge. The ridges are composed of quartz and feldspar veins displaying abundant evidence of multiple intrusion and brecciation. The breccia fragments range from large and angular to small and subrounded. Hematite-stained mylonites (Eade, 1962) are present as well.

The feldspar veins are light to dark orange and exhibit pegmatitic to microgranitic textures. Hematite and magnetite inclusions are common, and many feldspar veinlets are bordered with a dark-red hematite stain. Green epidote alteration is present in fractures within some of the feldspar fragments, and bright-orange potassium feldspar (adularia?) was observed in very late veins that are spatially associated with a vuggy texture in Big Pond North Ridge. Some of these features suggest the possibility that hydrothermal systems were operating in these vein systems; selected samples will be tested for precious metals.



LEGEND

- Quartz-feldspar veins
- 2 Massive to poorly foliated granite to granodiorite
- 1 Granite and banded gneiss

Figure 6: *Location map of Big Pond silica survey (geology after K. E. Eade, 1962).*

Clean, white, quartz veins are exposed over a 10 to 30 m wide zone that parallels the steep, southeastern flank of Sugarloaf. This is a very favourable situation for quarrying should the prospect become economically viable. The quartz is massive in outcrop and may be a single large intrusion or a series of coalescing veins. The pure quartz zone grades across strike to the northwest into massive quartz containing very light-pink silicified fragments and/or bands. This second zone of less-pure quartz grades into a mixture of dominantly feldspar and minor quartz veining. To the southeast, the boundary of the pure quartz zone is not exposed and the possibility of a wider zone could be considered. Sugarloaf is the only sampled ridge within the three major vein systems that has a wide enough zone of pure quartz to be considered a good silica prospect.

Table 2. Average chemical analyses for sections sampled across quartzite ridges (see Figure 5)

Section	No. of Samples	SiO_2	Al_2O_3	Fe_{tot}	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	P_2O_5	LOI	Total	SiO_2 calc.
S-01	3	99.47	0.10	0.10	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.22	99.97	99.49
S-02	22	99.08	0.09	0.05	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.28	99.56	99.49
S-03	23	99.10	0.13	0.07	0.02	0.03	0.02	0.03	0.01	0.01	0.02	0.27	99.67	99.40
S-04	7	99.05	0.06	0.03	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.34	99.53	99.48
S-05	4	99.09	0.10	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.25	99.53	99.52
S-06	8	99.40	0.10	0.06	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.18	99.81	99.56
S-07	11	99.36	0.08	0.17	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.26	100.04	99.38
S-08	6	99.10	0.08	0.51	0.02	0.04	0.01	0.01	0.01	0.02	0.02	0.33	100.11	98.96
S-09	6	99.12	0.12	0.23	0.01	0.02	0.01	0.02	0.01	0.01	0.02	0.18	99.71	99.36
S-10	5	98.62	0.22	0.28	0.12	0.15	0.01	0.04	0.02	0.01	0.02	0.44	99.92	98.69
S-11	10	98.47	0.27	0.60	0.08	0.03	0.01	0.03	0.02	0.01	0.02	0.23	99.75	98.69
S-12	7	97.57	0.64	0.88	0.16	0.05	0.10	0.13	0.02	0.02	0.03	0.32	99.90	97.65
S-13	14	99.18	0.08	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.20	99.53	99.61
S-14	14	98.95	0.14	0.12	0.01	0.01	0.01	0.03	0.01	0.01	0.02	0.23	99.50	99.41
S-15	5	98.57	0.10	0.10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.22	99.05	99.50
S-16	6	99.10	0.13	0.03	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.20	99.51	99.55
S-17	4	93.66	4.93	0.10	0.02	0.01	0.01	0.26	0.02	0.01	0.01	0.43	99.45	94.20
S-18	8	99.14	0.23	0.06	0.02	0.01	0.01	0.05	0.01	0.01	0.01	0.31	99.82	99.28
S-19	5	98.73	0.12	0.06	0.01	0.04	0.01	0.02	0.01	0.01	0.03	0.22	99.22	99.48
S-20	4	93.49	3.47	0.46	0.23	0.05	0.03	0.23	0.11	0.01	0.03	0.78	99.86	94.61
S-21	6	98.83	0.26	0.08	0.02	0.02	0.01	0.06	0.03	0.01	0.02	0.28	99.59	99.22
S-22	4	98.66	0.22	0.04	0.02	0.03	0.01	0.01	0.01	0.01	0.02	0.33	99.32	99.32
S-23	10	98.12	0.38	0.18	0.03	0.06	0.12	0.05	0.01	0.01	0.01	0.31	99.27	98.83
S-24	7	99.31	0.13	0.16	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.26	99.93	99.35
S-25	10	98.72	0.23	0.39	0.03	0.04	0.01	0.02	0.03	0.02	0.01	0.19	99.66	99.03
S-26	27	99.15	0.06	0.09	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.22	99.59	99.53
S-27	26	98.88	0.23	0.09	0.02	0.03	0.03	0.05	0.02	0.01	0.01	0.27	99.59	99.25
S-28	16	98.86	0.28	0.11	0.02	0.02	0.01	0.05	0.02	0.01	0.01	0.22	99.59	99.25
S-29	3	99.19	0.10	0.07	0.02	0.02	0.01	0.02	0.03	0.01	0.01	0.17	99.62	99.55
S-30	6	98.81	0.30	0.09	0.03	0.05	0.08	0.05	0.03	0.01	0.04	0.30	99.75	99.05
S-31	7	99.01	0.10	0.15	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.24	99.61	99.38
S-32	6	99.33	0.08	0.15	0.02	0.03	0.01	0.02	0.02	0.01	0.02	0.27	99.90	99.39
S-33	51	99.09	0.10	0.21	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.25	99.74	99.32
S-34	6	99.10	0.11	0.03	0.01	0.03	0.01	0.01	0.02	0.01	0.01	0.25	99.57	99.50

Numerous short traverses were conducted across the ridgetops, perpendicular to strike, collecting chip samples at 10 to 15 m intervals, depending on the degree of exposure. One hundred and forty-four samples were collected from the southeastern vein system, and ten samples were collected from reconnaissance sampling of the northwestern vein system. The middle vein system of Eade (1961) has no observable topographic expression and was not located in this survey.

Goose Bay Anorthosite Complex

The Goose Bay anorthosite complex was investigated for its industrial mineral potential. It was studied as a potential source of alumina and assessed for dimension stone. The most recent geological mapping of the Goose Bay anorthosite complex is by Ryan *et al.* (1981), and Wardle and Ash (1984, *this volume*).

Grab samples obtained in 1984 indicate that the Goose Bay anorthosite contains up to 27 percent alumina. Alumina is one of the major volume materials used in 'high-tech' ceramics (Dickson, 1985); (high purity silica, zirconia, beryllia and yttria are others). For this usage, alumina must be obtained from unweathered crystalline rocks as opposed to residual deposits, i.e., bauxite. It was the aim of this reconnaissance survey to see if large areas of accessible anorthosite containing this grade of alumina could be delineated. In this initial investigation of road and hillside outcrops in the Goose Bay - Northwest River area, it was determined that the anorthosite contains 2 to 10 percent coarsely crystalline pyroxene and ilmenite. These mineral phases would dilute the Al_2O_3 content, and would be contaminants of large bulk samples, thus limiting the alumina potential of the anorthositic rocks.

The impurities mentioned above would also limit the dimension-stone potential of the Goose Bay anorthosite. Their irregular distribution detracts from the consistency and aesthetic appearance of the stone, and upon exposure to air they tend to oxidize and stain polished surfaces on finished slabs of rock. In addition, the outcrops are cut by closely spaced joint and fracture systems which prevent the extraction of large blocks, and large (1 to 3 cm long) feldspar crystals within the rock are commonly cut by annealed fractures that now appear as irregular, 1 to 2 mm wide, wavy white lines.

The aesthetic appeal of a good dimension stone is extremely important and is dependent on color, grain size and uniformity of texture. The stone must have a 'fashionable' appearance that will catch the eye of architects, as well as being hard, durable, strong, and resistent to environmental damage (Allison, 1984).

Nain Anorthosite Complex

The Nain anorthosite complex (Taylor, 1975, 1979) was investigated to assess its dimension stone potential. The well known localities containing gem-quality labradorite (Watson, 1980) were briefly assessed at Tabor Island, Pearly Gates and John Hay's Harbour. These are generally extremely coarse grained, pegmatitic pods that are either too limited in size or too fractured to allow quarrying in large uniform blocks. However, three other localities of massive, more homogenous, fine to coarsely crystalline (0.5 to 4 cm long crystals) anorthosite were visited and have much better dimension-stone potential (Figure 7).

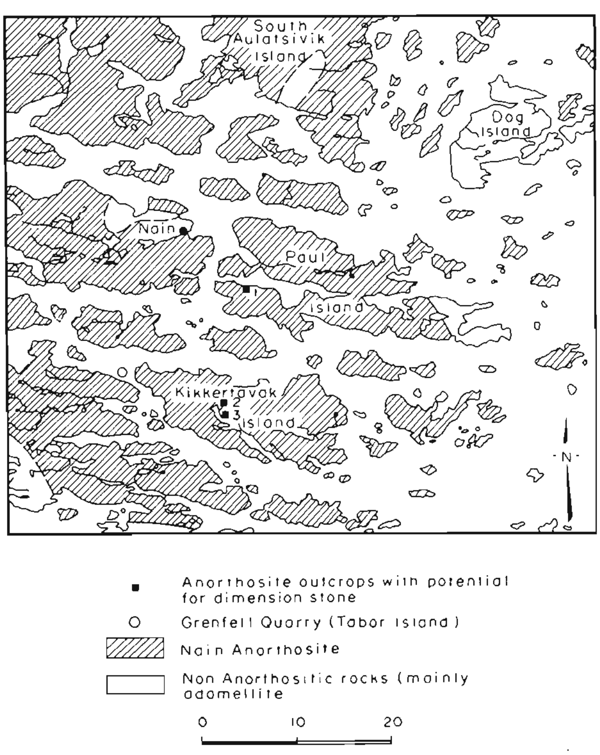


Figure 7: *Location map of dimension stone sites in the Nain anorthosite complex.*

A large area of very massive anorthosite rises steeply for 75 to 100 m up from the shoreline at Ten Mile Bay. In the early sixties, Brinex and an independent granite producer from Quebec extracted several tonnes of stone at this site. Quarrying was extremely difficult on the steep, glacially-smoothed slopes due to a lack of jointing and proper 'benches' from which the drilling and extraction process could begin. The anorthosite has a medium-gray color, providing an ideal background for the deep, purplish-blue chatoyancy of the labradorite crystals, which are uniformly distributed throughout the rock. The anorthosite is medium grained (0.5 to 1.5 cm long crystals), has no visible xenoliths, and contain only minor large feldspar phenocrysts. It does contain, however, parallel pyroxene-biotite laminae and thin white lineations (1 to 3 mm wide) that are unevenly distributed through certain parts of the outcrop. These features detract from the overall appearance of the stone at Ten Mile Bay, and in combination with the difficulty of quarrying on steep slopes, reduce the dimension-stone potential of the site.

Massive, gently sloping outcrops of anorthosite occur on the east side of Igiak Bay and, to the north, in the 'saddle' between Igiak Bay and John Hay's Harbour. The anorthosite is coarse grained (1 to 4 cm long crystals), contains minor amounts of mafic minerals, and is free of any white lineations. Within the rock there is a uniform distribution of rich, dark-blue to blue-green chatoyant crystals, giving it a relatively consistent appearance. There is a distinct lack of vertical jointing and fracturing at the Igiak Bay locality, whereas in the 'saddle' locality, a vertical fracture-joint system is well developed. Both areas appear to have enough horizontal jointing for the quarrying of large blocks of anorthosite, which would be suitable for use as high-quality, chatoyant dimension stone similar to the Scandinavian 'blue pearl'. Drilling and quarrying of test blocks from these and other areas is being planned for the 1986 field season.

SUMMARY

The industrial mineral potential in Labrador is just beginning to be appreciated and evaluated. In western Labrador there are dolomitic marble deposits that meet the chemical specifications for self-fluxing iron ore pellets, and they may play an important role in the future of the iron ore industry, which is so important to the province. Very pure deposits of quartzite just outside Labrador City meet the requirements for a variety of silica-based industries, and both the quartzite and the dolomitic marble may have potential as mineral fillers and whiteners.

A silica prospect near Mary's Harbour in southeastern Labrador occurs where massive quartz-feldspar veins outcrop within 20 km of tidewater. These veins may also have precious metal potential. Investigations of the Goose Bay and Nain anorthosite complexes were initiated to evaluate their potential as sources of alumina and dimension stone. There are several very massive exposures of anorthosite in the Nain area which have high dimension stone potential, and warrant the drilling and quarrying of test blocks during the 1986 field season.

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