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GEOLOGY OF THE PALEOPROTEROZOIC BLUEBERRY LAKE GROUP, GRENVILLE PROVINCE, WESTERN LABRADOR

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Labrador Mapping Section

ABSTRACT

In the Gabbro Lake area, western Labrador, the Blueberry Lake group includes greenschist-facies clastic sedimentary and felsic volcanic rocks. The sedimentary sequence consists of a basal polymictic conglomerate, which is overlain by a succession of massive quartz wacke, conglomeratic wacke, turbiditic quartz wacke, and quartz wacke–shale turbidites. The felsic volcanic rocks consist mainly of felsic crystal and lithic tuff and lesser amounts of rhyolite, and an andesite to dacite porphyry. The presence of layers of felsic tuff and tuffaceous sandstone in the sedimentary succession demonstrates that Blueberry Lake group sedimentation and felsic volcanism were contemporaneous. A U–Pb zircon age of 1652 ± 5 Ma obtained from a Blueberry Lake group felsic volcanic rock is interpreted to represent the age of volcanism.

The Blueberry Lake group is contained in a northwest-vergent imbricate thrust structure, which makes up the northeastern part of the Grenvillian Gagnon terrane. Thrusting also involved rocks of the Paleoproterozoic Knob Lake Group and sub-Knob Lake Group gneisses inferred to be Archean. The thrusts are ductile to brittle greenschist-facies structures. Rocks within the thrust sheets contain penetrative Grenvillian fabrics. The structurally lowest thrust is defined as the Grenville Front.

INTRODUCTION

A short mapping program that focused on the Paleoproterozoic Blueberry Lake group (Wardle, 1979) was carried out in July 1994. The mapping was concentrated in the area around Gabbro Lake (Ossokmanuan Reservoir) and principally involved investigation of the superb outcrops exposed around the lake shore. The study area includes parts of NTS map areas 23H/11, H/12, H/13 and H/14 (Figure 1). Mapping was accomplished by a two-person field crew working from a base camp at the Gabbro Control Structure on the Esker Road.

The purpose of this project is to upgrade the mapping of the Blueberry Lake group and to improve our understanding of the geology and economic potential of these felsic volcanic and sedimentary rocks. To some extent, this project was also prompted by U–Pb geochronological studies of two samples of presumed Blueberry Lake group rhyolite (Connelly, 1993, 1994). The geochronology indicated that one sample was Paleoproterozoic, whereas the other was Archean. The contrasting ages suggested that the Blueberry Lake group needed to be subdivided and redefined, or that one or both of the samples were not representative of the Blueberry Lake group. These possibilities and the geochronological data are discussed in a subsequent section.

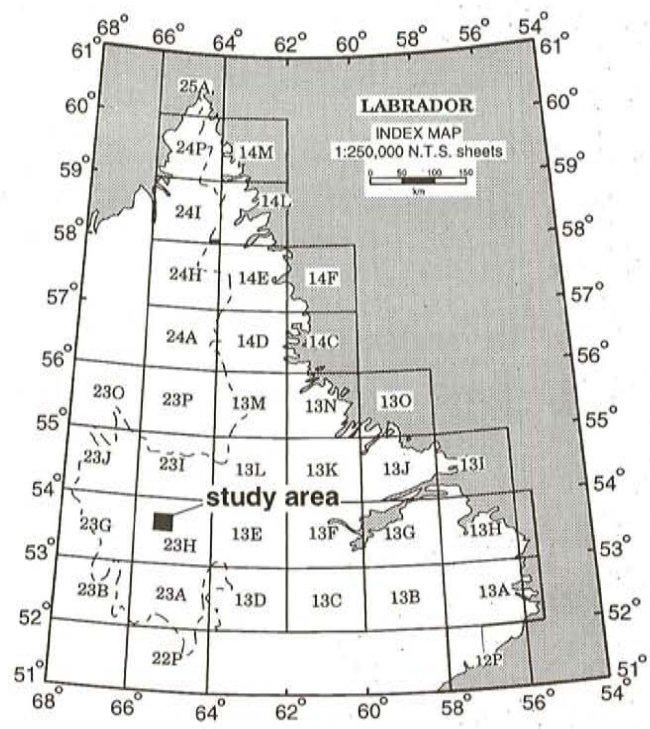

Figure 1. *NTS index map of Labrador showing location of the study area.*

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PREVIOUS WORK

Felsic volcanic and sedimentary rocks occurring around the northern end of Gabbro Lake were mapped by Wynne-Edwards (1961). He correlated these rocks with the basal units of the Labrador Trough sequence (Paleoproterozoic Knob Lake Group) based on lithological similarities, and the fact that the sedimentary rocks at Gabbro Lake rested unconformably on granitoid gneisses, which occur near the outlet of the McKay River on the west side of Gabbro Lake. Frarey (1961) had previously noted the unconformable relationship between the Knob Lake Group and gneisses of the Archean Superior Province. In effect, Wynne-Edwards (*op.cit.*) had correlated the McKay River unconformity with the sub-Knob Lake Group unconformity, although he speculated that the basement gneisses at McKay River were younger than the rocks in the Superior Province.

On the basis of subsequent mapping, Wardle (1979) named the felsic volcanic and sedimentary rocks at Gabbro Lake the Blueberry Lake group. He also recognized the lithological similarities between the Blueberry Lake group and the Knob Lake Group (Seward and Attikamagen formations), but noted that there are no contact relations between rocks of the Blueberry Lake group and those of the Knob Lake Group. This prompted Wardle (*op.cit.*) to speculate that the Blueberry Lake group was unrelated to the Labrador Trough sequence, and that it might be correlative with the lithologically similar Bruce River group (Smyth *et al.*, 1975) in eastern Labrador.

Brooks *et al.* (1981) dated a felsic volcanic rock from the Blueberry Lake group at 1540 ± 40 Ma using Rb–Sr methods. This data confirmed that the Blueberry Lake group is not correlative with the Knob Lake Group. Based on the geochronological data, and the spatial relationship between the Blueberry Lake group and rocks of the Labradorian-age Trans-Labrador batholith, Wardle *et al.* (1986) inferred that the Blueberry Lake group felsic volcanic rocks were the extrusive equivalents of the younger, high-level components of the Trans-Labrador batholith. This is consistent with the chemistry of the volcanic rocks, which suggests that they were derived from upper-crustal level magmas that were tapped by fractures (Gower and Ryan, 1986). Wardle (1979) inferred the Blueberry Lake group sediments to be the distal-facies equivalents of the volcanic rocks based on the presence of felsic volcanic detritus in the sediments.

REGIONAL FRAMEWORK

The Blueberry Lake group occurs in several thrust sheets, which make up the northeastern part of the Gagnon terrane (Rivers *et al.*, 1989) in the Grenville Province of western Labrador (Figure 2; and see Rivers, 1985). In the study area, the Gagnon terrane is a northwest-vergent, Grenvillian fold-and-thrust belt and includes Paleoproterozoic rocks of the Knob Lake Group, ca. 1650 Ma granitic rocks of the Trans-Labrador batholith, ca. 1450 Ma Shabogamo Gabbro, and some granitoid gneisses of inferred Archean age. The Gagnon terrane is thrust over autochthonous pre-Grenvillian Laurentia including Archean rocks of the southeastern Rae Province, Paleoproterozoic rocks, which make up the New Quebec Orogen (Knob Lake Group) and granite plutons of inferred Labradorian age. The structurally lowest thrust of the Gagnon terrane is the Grenville Front.

The age of Grenvillian deformation in western Labrador is constrained by U–Pb geochronological data to be ca. 1010 to 980 Ma (Connelly and Heaman, 1993). In the study area, Grenvillian deformation is attendant with greenschist-facies metamorphism.

DESCRIPTION OF UNITS

The 1994 field season focused on the Blueberry Lake group in the Gabbro Lake area. Only the Blueberry Lake group rocks in the study area (Units 8 to 12), the granitoid gneisses (Units 1 and 2), and some of the Trans-Labrador batholith rocks (Units 13 and 14) are described. Rocks of the Knob Lake Group and some of the intrusive units (e.g., Units 15 and 16) were not mapped and are not described in this report. The units not mapped in 1994 are compiled on Figure 3 from Rivers (1985).

RAE PROVINCE GRANITOID GNEISS: UNIT 1

Granitoid gneiss, which occurs to the north of the Grenville Front in the study area, is defined as Unit 1 (Figure 3). These rocks make up a part of the southwestern Rae Province. The unit was not mapped in detail in 1994.

Unit 1 is a heterogeneous division consisting of polydeformed, pink and grey- or white-weathering granitoid gneisses that contain biotite and local hornblende. The rocks contain relics of mafic dykes, which predate the oldest deformation and high-grade metamorphism in the host rocks, variable amounts of pink granitic leucosome, and several generations of variably deformed, fine-grained granitic dykes (Plate 1). The rocks also contain dykes of K-feldspar megacrystic granite. The megacrystic granite dykes postdate the gneissosity and the oldest foliation in the host gneisses, but are themselves deformed and contain a strong foliation, and locally, a porphyroclastic structure.

Near the north end of Gabbro Lake, 2.5 km southeast of the Gabbro Control Structure, there are several outcrops of granitoid gneiss previously mapped as Blueberry Lake group felsic volcanic rocks. The rocks are white- to pale-green-weathering and fine grained. They are pervasively sheared by ductile to brittle, greenschist-facies high-strain zones. The shearing has mainly obliterated the pre-existing gneissosity, which is only locally preserved in lesser strained blocks within the outcrops (Plate 2). The age of the high-strain zones and attendant greenschist-facies metamorphism is inferred to be Grenvillian. Locally, the outcrops in this area also contain an anastomosing network of amphibole and epidote-filled alteration zones that postdate the high-strain zones.

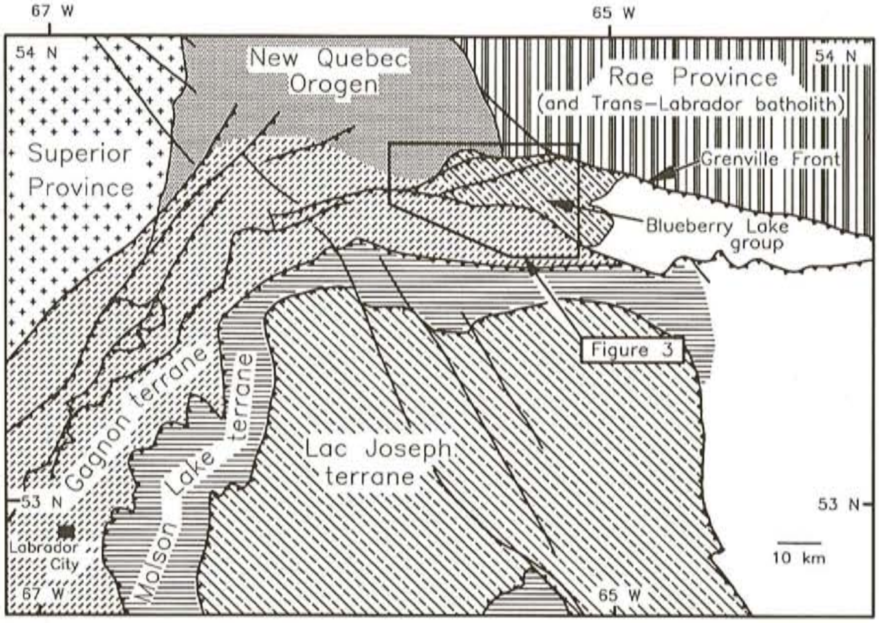


Figure 2. *Principal tectonic units of the Grenville Province in western Labrador. The Gagnon terrane is a low- to high-grade Grenvillian fold-and-thrust belt consisting of Paleoproterozoic rocks of the Knob Lake Group, reworked pre-Knob Lake Group (Superior Province) basement, Blueberry Lake group rocks, intrusions of the Trans-Labrador batholith, and Shabogamo Gabbro. The Molson Lake terrane is a medium- to high-grade Grenvillian thrust nappe consisting of Trans-Labrador batholith rocks and Shabogamo Gabbro. The Lac Joseph terrane is a Grenvillian nappe consisting mainly of Labradorian (ca. 1.67 to 1.62 Ga) high-grade metasedimentary gneisses and mafic intrusions. The Lac Joseph terrane has mainly escaped Grenvillian metamorphism.*

Unit 1 also includes several outcrops of megacrystic granite containing biotite. The granite is foliated and locally sheared, and contains more than 15 percent coarse-grained K-feldspar megacrysts. On the basis of lithology, the megacrystic granite is correlated with the ca. 1650 Ma granitic rocks of the Trans-Labrador batholith.

The granitoid gneisses of Unit 1 are inferred to be derived from Archean granitic intrusions (see discussion on the age of the Blueberry Lake group). The age of leucosome formation and attendant high-grade deformation is also inferred to be Archean. The ages of the granitic dykes, which postdate the leucosome, are unconstrained; they could be Archean, Paleoproterozoic (ca. 1.84 to 1.80 Ga), Labradorian (ca. 1.65 to 1.62 Ga) or Grenvillian.

GRANITOID GNEISS: UNIT 2

Several outcrops of granitoid gneiss and migmatite occur near the outlet of the McKay River (e.g., 344790E, 5949376N UTM coordinates), south of the Grenville Front. The rocks consist of alternating layers of grey- to rusty-weathering quartzofeldspathic paleosome containing biotite, and white-weathering granitoid leucosome. The outcrops contain approximately 20 percent leucosome. They also contain numerous mafic dykes, up to 2 m thick, which are discordant to the gneissosity in the host rocks but are themselves deformed and metamorphosed to greenschist facies. The mafic dykes are mainly north-northeast striking.

The age and affinity of the Unit 2 rocks are unknown. However, the fact that these high-grade gneisses occur in a thrust sheet, which also contains greenschist-facies Knob Lake Group rocks, indicates that the Unit 2 rocks are older than the Knob Lake Group. The fact that the Knob Lake Group rests unconformably on the Archean Superior Province, may suggest that the Unit 2 rocks are part of the Superior Province and not the Rae Province. However, relations between the Unit 2 gneisses and the Knob Lake Group are undefined in the study area. Further study of the Unit 2 and Unit 1 gneisses are necessary to test this model.

BLUEBERRY LAKE GROUP

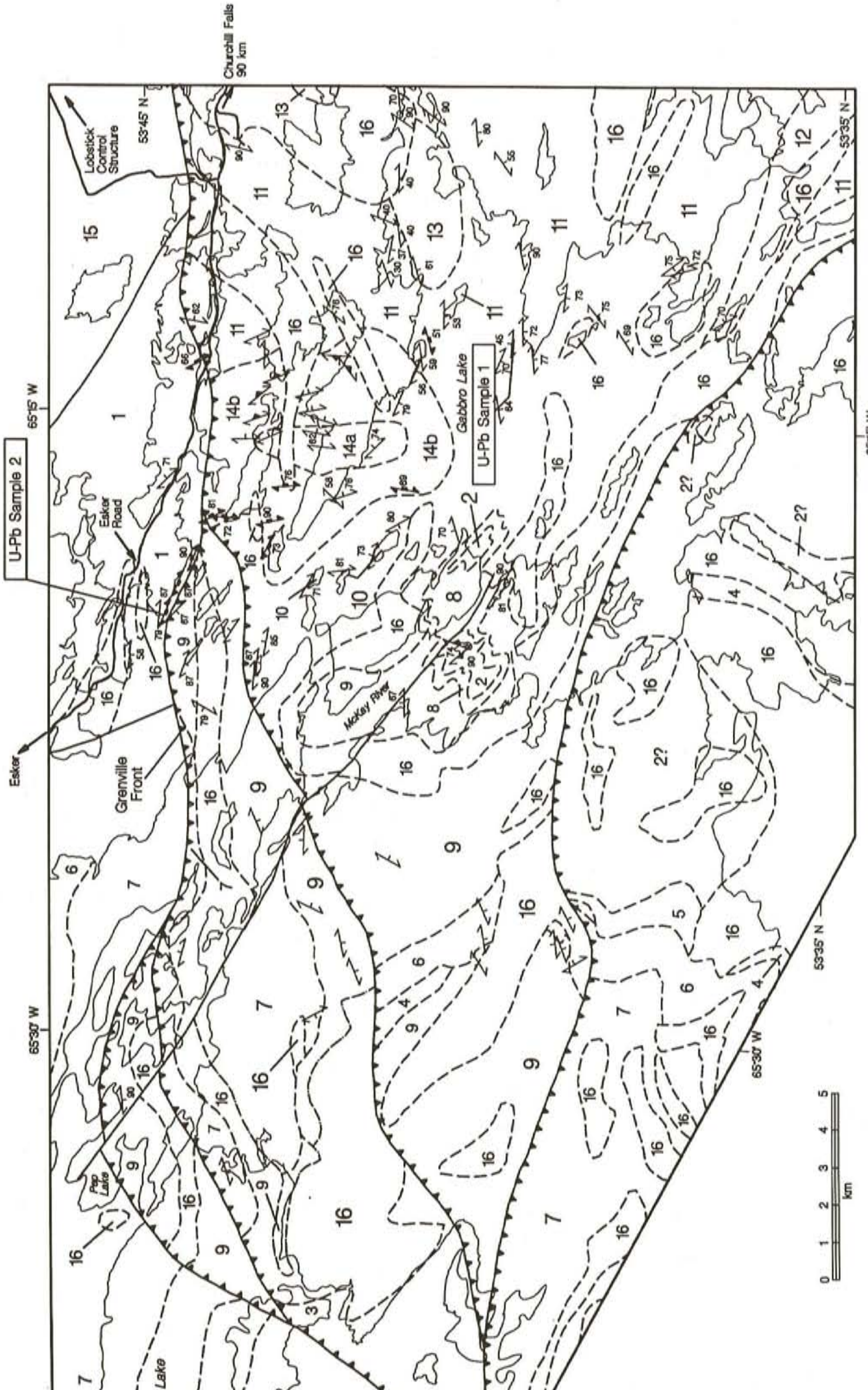
Sedimentary Rocks

Unit 8: Conglomerate

Near the outlet of the McKay River, granitoid gneisses of Unit 2 are unconformably overlain by polymictic conglomerate of the Blueberry Lake group (Plate 3). The unconformity was not observed, although it is inferred on the basis of unequivocal clasts of Unit 2 granitoid gneiss in the conglomerate. The conglomerate is estimated to be less than 200 m thick.

The unit consists mainly of completely unsorted, framework-supported conglomerate containing clasts from 1 to 75 cm in diameter. The clasts include: a white-weathering, fine-grained granitoid rock presumed to be derived from the leucosome of Unit 2, white- to grey-weathering granitoid gneiss clasts (Unit 2 paleosome), white-weathering, K-feldspar megacrystic granite of uncertain correlation, quartz inferred to be derived from quartz veins, quartz wacke and grey- to black-weathering shale. Clasts of felsic lithic tuff occur locally. The presence of beds of quartz wacke and shale in Unit 8 suggests that derivation of the quartz wacke and shale clasts was probably quite local. On the basis of lithology, the felsic lithic-tuff clasts are correlated with the Blueberry Lake group felsic volcanic rocks (Unit 11).

The stratigraphy of the unit could not be mapped in detail because of the limited number of outcrops and because the unit is exposed on a number of small islands in the McKay River. However, it appears that the amount of quartz wacke in Unit 8 increases with stratigraphic height in the unit.



LEGEND

MESOPROTEROZOIC

16	*Shabogamo Gabbro (ca. 1450 Ma)*

PALEOPROTEROZOIC

Trans-Labrador batholith (ca. 1650 Ma)

15	*Atikonak River pluton*

14a *K-feldspar megacrystic granite*

14b *highly strained megacrystic granite and granite gneiss*

13 *granite and megacrystic granite*

10 *shale (phyllite), quartz wacke–shale turbidites*

9 *quartz wacke, shale (phyllite), quartz wacke containing beds of felsic tuff and tuffaceous sandstone, and conglomeratic quartz wacke*

8 *polymictic conglomerate*

Knob Lake Group (>1880 Ma)

7 *Menihek Formation*

6 *Sokoman Formation*

5 *McKay River Formation*

4 *Denault Formation*

3 *Attikamagen Formation*

Blueberry Lake group (ca. 1650 Ma)

12 *andesite–dacite porphyry*

11 *felsic volcanic rocks including felsic crystal- and lithic-tuff, rhyolite and rhyolite breccia, minor amounts of mafic volcanic rocks*

ARCHEAN

2 *granitoid gneiss and migmatite*

Rae Province

1 *granitoid gneiss and migmatite*

Figure 3. *Generalized geological map of the Blueberry Lake group in the Gabbro Lake area, western Labrador.*

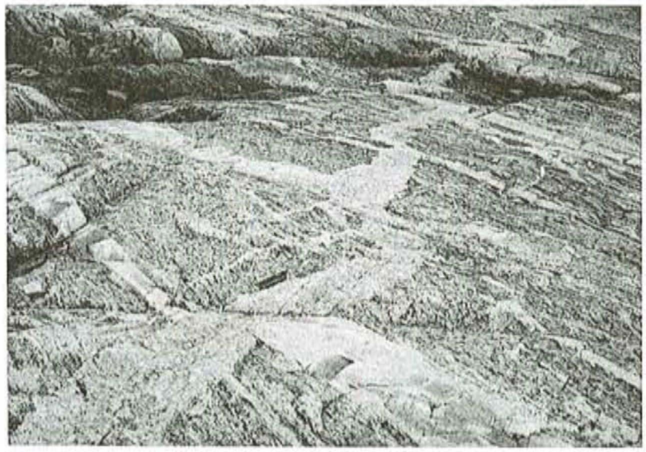


Plate 1. *Outcrop of granitoid migmatite (Unit 1) containing variably deformed granitic dykes of several ages.*

Plate 2. *Mylonitic granitoid gneiss of Unit 1 that is overprinted by greenschist-facies brittle structures. This outcrop occurs along the Grenville Front, near the north end of Gabbro Lake.*

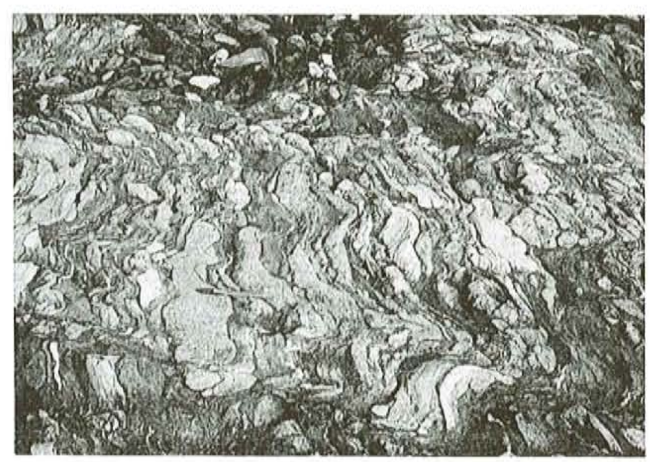


Plate 3. *Basal polymictic conglomerate of the Blueberry Lake group (Unit 8).*

Units 9 and 10

The conglomerate (Unit 8) is overlain by fine-grained clastic sedimentary rocks that have been broadly subdivided into two units. Unit 9, which is the most abundant of the two, consists of thick-bedded quartz wacke and lesser amounts of interbedded quartz wacke and shale, conglomeratic quartz wacke, felsic tuff and tuffaceous sandstone (Plates 4 and 5). Unit 10 mainly consists of shale (phyllite) and interbedded quartz wacke and shale, which are interpreted as turbidites (Plates 6 and 7).

Plate 4. *Typical field aspects of conglomeratic quartz wacke and massive quartz wacke of Unit 9.*

It is not possible to map a continuous stratigraphic section through the sedimentary units (Units 8 to 10), although the presence of quartz wacke beds in the stratigraphically highest levels of Unit 8, and of local, thin (<2 m) beds of conglomeratic quartz wacke in the lowest parts of Unit 9 suggests that the relationship between Units 8 and 9 is transitional. The conglomeratic quartz wacke in Unit 9 contains clasts less than 10 cm long. The clasts consist of quartz, quartz wacke, shale, a distinctive black-weathering slate, and felsic volcanic rocks. Unit 9 is inferred to be unconformable upon the Knob Lake Group (Units 4 to 7), although this contact was not mapped in 1994.

The quartz wacke, which makes up a large part of Unit 9, is grey- to pale-brown-weathering, and is commonly fine grained, massive (i.e., non-graded) and thick (>1 m) to thin (10 to 15 cm) bedded. It is locally interlayered with thin (<1 m) beds of grey- to pale-green-weathering shale (phyllite) and white- to grey-weathering felsic tuff and tuffaceous sandstone. The beds of tuff and tuffaceous sandstone are equally distributed throughout Unit 9, whereas the amount of shale appears to increase upward in the stratigraphic section, and suggests a transitional relationship between Units 9 and 10.

Unit 10 consists of grey- to pale-green-weathering shale (phyllite), interbedded quartz wacke and shale, and a minor amount of felsic tuff. The quartz wacke–shale couplets consist of alternating beds of fine-grained quartz wacke (<50 cm) and thin, parallel-laminated quartz wacke and shale. Fine-grained, parallel-laminated and graded sandstones (Plate 8) occur locally. In the study area, Unit 10 is inferred to underlie much of the central part of Gabbro Lake.

Plate 5. *Example of thin-bedded quartz wacke (bottom) and tuffaceous sandstone and felsic lithic tuff (top) (Unit 9).*

Volcanic Rocks

Unit 11: Felsic Volcanic Rocks

The felsic volcanic rocks of the Blueberry Lake group principally occur in the eastern part of the study area. Unit 11, which is the most abundant volcanic unit, consists mainly of white- to grey-weathering felsic lithic and crystal tuff (Plate 9). These rocks are commonly bedded (1 to 15 cm) but locally massive. They contain abundant, felsic lithic fragments (up to 1 cm long), and locally, fine-grained quartz crystals. The felsic tuffs are locally interbedded with minor amounts of tuffaceous sandstone and conglomerate consisting of clasts of felsic lithic tuff (Plate 10). In one outcrop, felsic tuffs are interbedded with a mafic to intermediate volcanic flow having a spherulitic texture.

In the study area, rhyolite is less abundant than felsic tuff. The rhyolite is pink-weathering and massive. Unit 11 also contains several occurrences of rhyolite breccia. The best exposures of breccia occur in the northeastern part of the

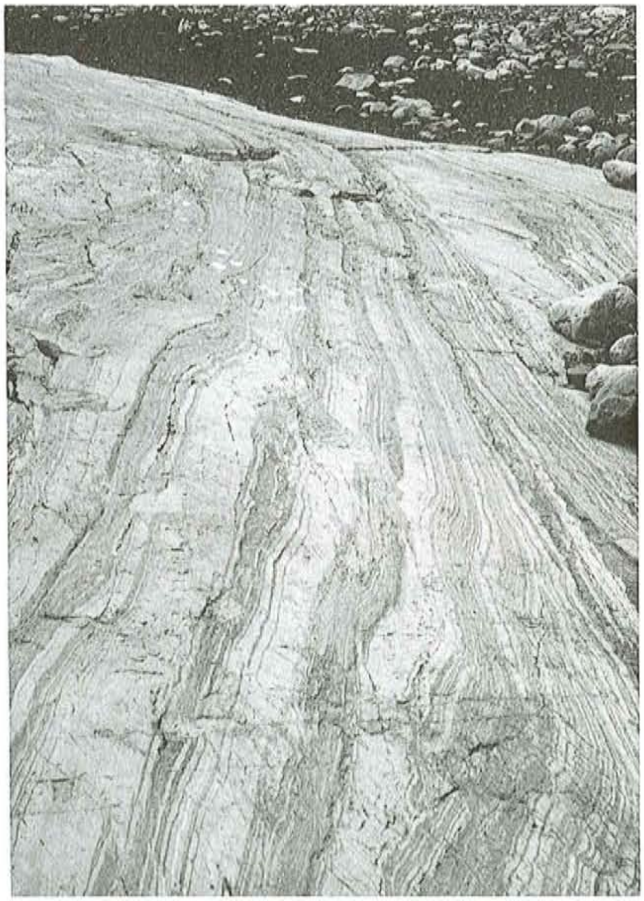


Plate 6. *Outcrop of Unit 10 turbidites consisting of massive quartz wacke, and thin-bedded and parallel-laminated quartz wacke and shale.*

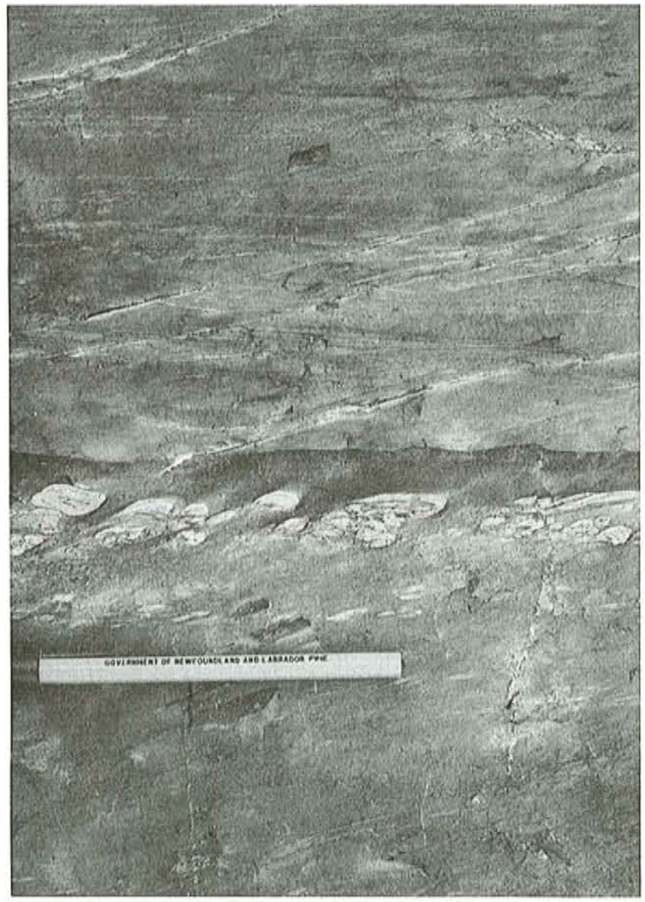


Plate 7. *A detailed photograph of Unit 10 turbidites showing examples of soft-sediment (load cast?) structures.*

study area, north of the Esker Road (353938E, 5956299E UTM coordinates). The breccia consists of more than 50 percent angular clasts of pink-, white- and black-weathering rhyolite up to 20 cm long (Plate 11).

Unit 11 also contains a very minor amount of clastic sedimentary rocks, which are similar to rocks in Units 9 and 10. Of particular interest is an outcrop at Blueberry Lake (357427E, 5941626N UTM coordinates), consisting of trough crosslaminated quartz wacke overlain by parallel-laminated quartz sandstone and pelite. The sandstone contains several beds (15 to 30 cm thick) of a parallel-laminated rock consisting mainly of diopside and minor epidote and carbonate, possibly representing metamorphosed stromatolites.

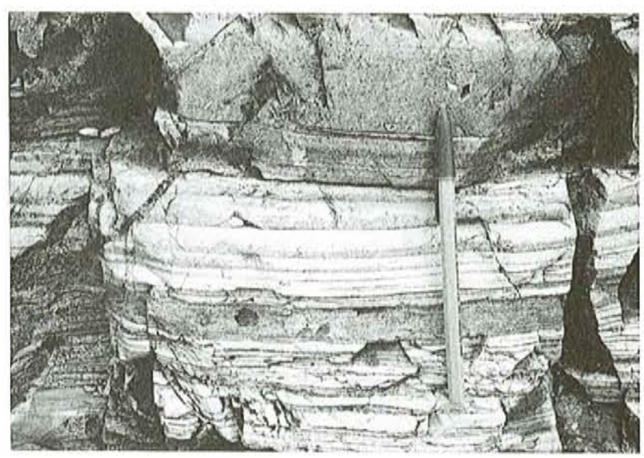


Plate 8. *Parallel-laminated and graded turbiditic sandstone (Unit 10).*

Unit 12: Porphyry

The Blueberry Lake group volcanic rocks also contain a unit of grey- to pale-brown-weathering porphyry. Based on their colour, the rocks are inferred to have a composition of andesite to dacite. They consist of a very fine-grained groundmass and medium- to coarse-grained, subhedral to anhedral feldspar phenocrysts (Plate 12). The rocks commonly contain between 20 and 30 percent phenocrysts. They also contain less than 10 percent epidote and plagioclase-filled amygdules.

One outcrop of Unit 12 porphyry, which occurs along the eastern shore of Gabbro Lake (352806E, 5950203N UTM coordinates), consists of a porphyritic flow overlain by breccia, conglomeratic lithic wacke, and parallel-laminated

Plate 9. *Typical field aspects of an outcrop of bedded, felsic lithic tuff (Unit 11).*

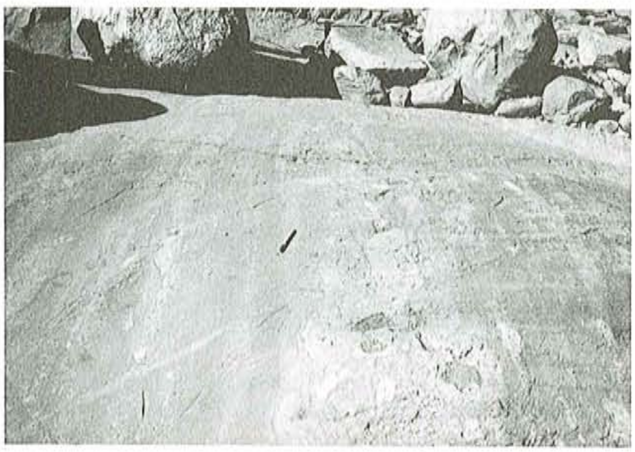


Plate 10. *An example of an outcrop consisting of conglomerate, which contains clasts of felsic volcanic rocks derived from Unit 11, and beds of graded lithic wacke. These rocks are interbedded with the Unit 11 felsic lithic tuffs shown in Plate 9.*

Plate 11. *Blueberry Lake group rhyolite breccia (Unit 11).*

and graded lithic wacke. The breccia contains clasts of the underlying porphyry (Plate 13). The sedimentary rocks are

Plate 12. *Blueberry Lake group andesite to dacite porphyry (Unit 12).*

overlain by a second flow of Unit 12 porphyry. These relations demonstrate that at this location, the porphyry is an extrusive rock. However, elsewhere in the Blueberry Lake group, these porphyritic rocks could be intrusive.

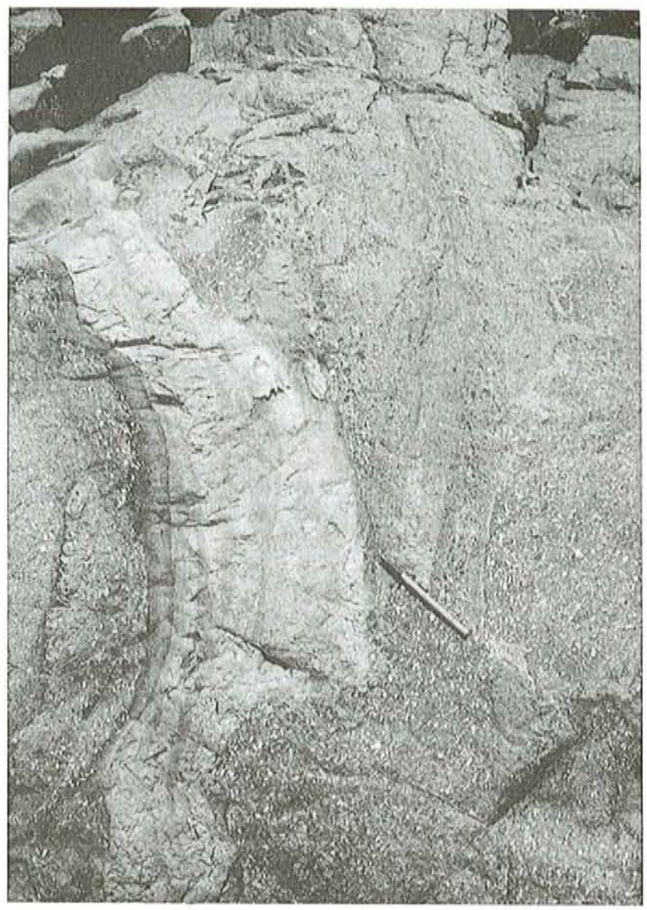


Plate 13. *Porphyritic flows of Unit 12. The flows are separated by a thin zone of interflow sediments including conglomeratic lithic wacke, breccia, and a bed of graded quartz wacke.*

TRANS-LABRADOR BATHOLITH

Units 13 and 14

Unit 13 consists mainly of pink-weathering, fine- to medium-grained isotropic granite. The rocks contain a minor amount of biotite. Unit 13 appears to be locally gradational into K-feldspar megacrystic granite similar to Unit 14 megacrystic granite. Inclusions of older units were not found in Unit 13 granite. The contact relations between Units 13 and 14 are undefined.

Intrusive rocks defined as subunits 14a and 14b form a body in the central part of the study area. The core of the body mainly consists of coarse-grained, K-feldspar megacrystic granite defined as subunit 14a. The subunit 14a rocks are pink-weathering, and contain abundant, coarse-grained, anhedral K-feldspar megacrysts (Plate 14). They also contain medium- to coarse-grained blue quartz, and less than 10 percent fine-grained biotite.

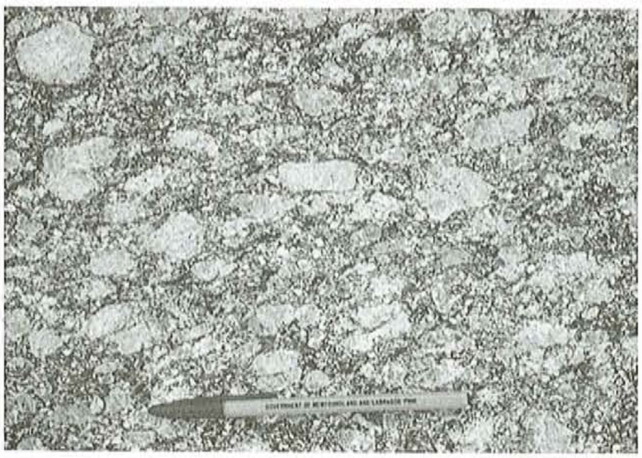


Plate 14. *Foliated, K-feldspar megacrystic granite typical of subunit 14a.*

The subunit 14a megacrystic granite is overprinted by a high-strain planar fabric with increasing intensity toward the margins of the body. This results in the transformation of the megacrystic granite to an augen gneiss and to mylonite (Plate 15). The highly strained rocks are defined as subunit 14b. The increase in strain from subunit 14a to 14b is heterogeneous and there are several examples of mylonitic granite, which contain relics of lesser strained megacrystic granite, near the margin of the body.

Inclusions of country rocks in Unit 14 are not common, although there are a few occurrences of quartz wacke and granitoid gneiss inclusions that are found in the highly strained margins of the body. The inclusions of sedimentary rock are provisionally correlated with Unit 9. The origin of the granitoid gneiss inclusions is uncertain.

Units 13 and 14 are provisionally correlated with the ca. 1650 Ma granitic rocks of the Trans-Labrador batholith. Units 13 and 14 have not been dated.

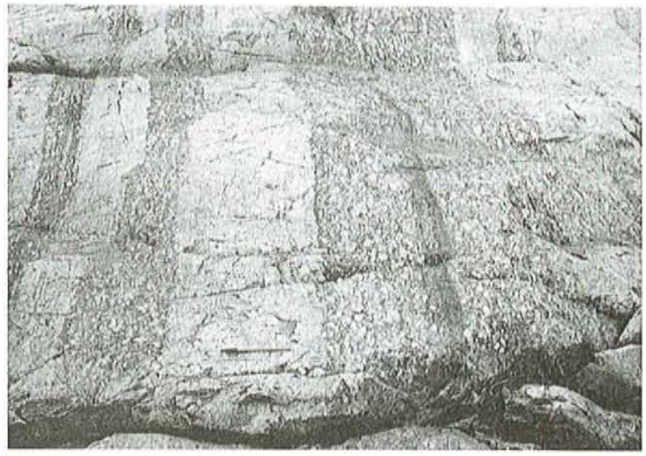


Plate 15. *An example of porphyroclastic K-feldspar megacrystic granite containing sheets of mylonitic granite. This outcrop occurs near the western margin of the body of Unit 14 rocks at Gabbro Lake.*

AGE OF THE BLUEBERRY LAKE GROUP

Using River's (1985) 1:100 000-scale compilation map of the Gabbro Lake area as a guide, two samples of presumed Blueberry Lake group felsic volcanic rocks were collected in 1990 and 1993 for U–Pb isotopic studies. The isotopic data was collected prior to mapping in 1994. Sample 1 (Table 1) is a schistose, porphyritic rhyolite or felsic crystal tuff collected from Unit 11. Three of the four fractions of zircon collected from Sample 1 define a discordia line with upper and lower intercepts of 1652 $\pm$ 5 Ma and 339 $\pm$ 225 Ma respectively (Figure 4 and Table 1). The upper intercept is interpreted to represent the crystallization age. The lower intercept is not thought to represent a distinct thermal event. Fraction Z2 is interpreted to contain inheritance and thus does not plot on the discordia line. It is interesting to note that there is no evidence from the zircons in this sample of Grenvillian metamorphism. This is in spite of very high concentrations of uranium in this sample and thus greater lattice damage due to radioactive decay (Connelly, 1994). The age of volcanism determined from this sample indicates that the Blueberry Lake group is time equivalent with the Trans-Labrador batholith.

Sample 2 (Table 1, Figure 5) was collected in 1990 from presumed Blueberry Lake group rhyolite. However, the 1994 field work has shown that Sample 2 is not a Blueberry Lake group volcanic rock. Instead, Sample 2 is from an outcrop consisting of very fine-grained, greenschist-facies quartzofeldspathic mylonite. The mylonite is derived from a Unit 1 granitoid gneiss. The mylonitization in Sample 2 is thought to be Grenvillian and related to ductile thrusting along the northern margin of the Grenville Province.

Five fractions of zircon from Sample 2 plot on a discordia line between 3058 $^{+92}_{-80}$ Ma and 2577 $^{+22}_{-28}$ Ma with a 96 percent probability of fit (Connelly, 1993). All fractions consisted of zircons of comparable colour and high uranium

Table 1. U–Pb Analytical Data

Sample 1: Blueberry Lake group (Unit 11); field number: DJ-93-5200; location: 352845E, 5948189N

Fraction	Concentration (ppm)			Measured		Corrected Atomic Ratios				Age (Ma)		
	weight (mg)	U	Pb (1)	Pb (2)	$^{206}Pb/^{204}Pb$	$^{208}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$
Z1	0.033	338	112.4	12	16579	0.2398	0.28811	4.0255	0.10133	1632	1639	1649
Z2	0.111	739	240.6	232	6412	0.1991	0.29035	4.1513	0.10370	1643	1664	1691
Z3	0.025	1247	532.2	169	3126	0.7171	0.27220	3.7753	0.10059	1552	1558	1635
Z4	0.097	942	294.4	227	7061	0.1950	0.28012	3.9071	0.10116	1592	1615	1645

Sample 2: mylonitic granitoid gneiss (Unit 1); field number: DJ-90-2013; location: 346134E, 5957213N

Fraction	weight (mg)	U	Pb (1)	Pb (2)	$^{206}Pb/^{204}Pb$	$^{208}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$
Z1	0.085	156	90.4	21	20294	0.1032	0.52151	13.6488	0.18982	2706	2726	2741
Z2	0.067	157	88.6	21	16215	0.0997	0.51139	12.9930	0.18427	2663	2679	2692
Z3	0.096	159	89.9	35	14213	0.0935	0.51478	13.1898	0.18583	2677	2693	2706
Z4	0.008	166	94.4	25	1734	0.0636	0.52710	14.0112	0.19279	2729	2750	2766
Z5	0.009	408	212.3	4	28291	0.0433	0.49674	11.9997	0.17520	2600	2604	2608

Pb (1)–total radiogenic lead after correction for blank, common Pb and spike; Pb (2)–total common lead includes laboratory blank (in pg). Atomic ratios corrected for fractionation, laboratory blank, spike and initial common Pb.

Sample 1 Fractions
Z1–best, light brown grains
Z2–seconds of Z1
Z3–single, large (>100 μm) grain
Z4–17 mottled, brown grains

Sample 2 Fractions
Z1–elongate, brown grains
Z2–small (<50 μm), rounded grains
Z3–fractured, light brown, elongate grains
Z4–large (>100 μm), brown grain (single)
Z5–large (>100 μm), brown grain (single)

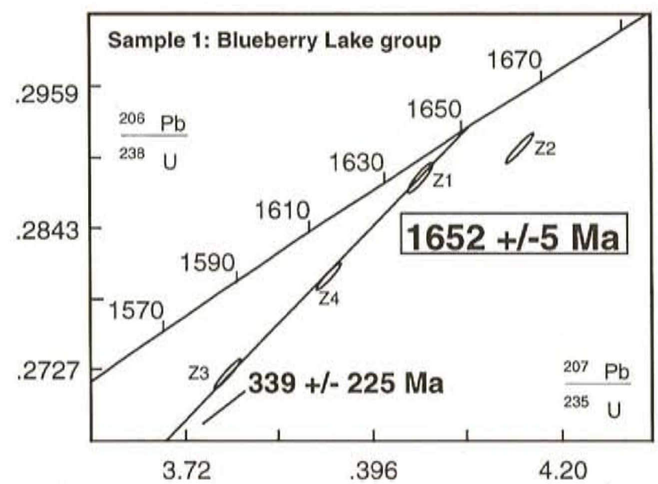


Figure 4. *U–Pb concordia diagram for a sample of Blueberry Lake group felsic volcanic rock (Unit 11). Z1 to Z4 are zircon fractions.*

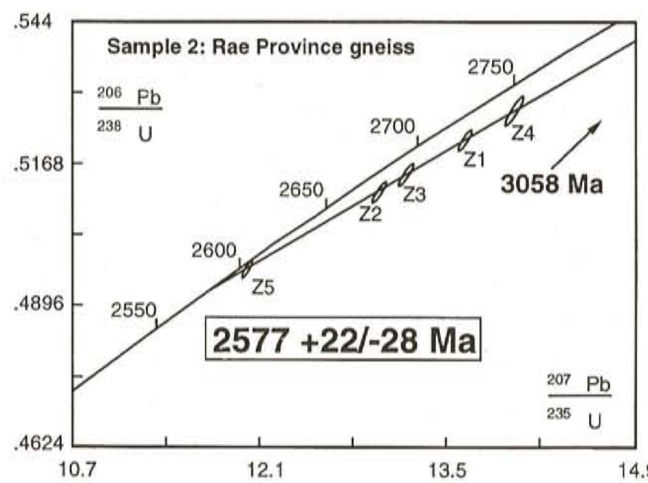


Figure 5. *U–Pb concordia diagram for a sample of mylonitic granitoid gneiss (Unit 1). Z1 to Z5 are zircon fractions.*

content, and are inferred to have a common, igneous origin. One possible interpretation of the data is that the lower intercept represents the crystallization age of this rock and that the zircons analyzed contain a significant inherited component of a common age, namely ca. 3058 Ma. The large errors assigned to the lower intercept age are a consequence of the low intersection angle between the discordia line and the concordia and cannot be avoided, in spite of the low errors on the individual, extreme points. An interesting feature of the analyzed zircons from this rock is that they do not contain any evidence of resetting by Paleoproterozoic (1.84 Ga to 1.80 Ga), Labradorian (1.70 Ga to 1.60 Ga) or Grenvillian events. This last point is perhaps the most surprising feature of the data considering that this rock occurs near a major Labradorian intrusion of the Trans-Labrador batholith, and that it is overprinted by penetrative Grenvillian deformation. In addition, Archean gneisses of the Rae Province, which occur to the north of the study area, preserve isotopic evidence of a ca. 1.80 Ga thermal event (James *et al.*, *in press*).

STRUCTURE

The Blueberry Lake group is interpreted to be contained within an imbricate thrust structure, which makes up the northeastern part of the Grenvillian Gagnon terrane. The thrusts have not been mapped but are inferred principally on the map pattern of the rock units. The thrusts shown in Figure 3 are re-interpreted from Rivers' (1985) map and are also based on the 1994 field work.

Highly strained Rae Province gneisses, located 3 km southeast of the Gabbro Control structure are inferred to occur along the structurally lowest thrust in the study area. This structure is defined as the Grenville Front. The rocks contain greenschist-facies mylonitic fabrics, which are overprinted by brittle cataclastic structures. Kinematic indicators were not mapped. The other thrusts are presumed to also be greenschist-facies ductile to brittle structures. The fact that the unconformity between Blueberry Lake group conglomerate and Unit 2 gneisses is preserved within one of the thrust sheets, demonstrates that thrusting involves all of the rock units along the southern margin of pre-Grenvillian Laurentia.

Within the thrust sheets, the sedimentary and volcanic rocks of the Blueberry Lake group are variably foliated. Most rocks contain a moderate to strong, penetrative S_1 foliation defined by parallel alignment of phyllosilicate (metamorphic) minerals, or they have a pressure solution cleavage. S_1 is generally east- to southeast-striking and is axial planar to F_1 folds of bedding in the Blueberry Lake group and of intrusions of Shabogamo Gabbro. Locally, S_1 and F_1 are overprinted by an east-northeast- to southeast-striking foliation defined as S_2. Bedding and F_1 structures are locally folded about S_2 producing F_2 folds. The superposition of F_2 folds on F_1 has produced Type II and III interference patterns, which occur as map-scale structures near the outlet of the McKay River into Gabbro Lake. There are several occurrences of a north-striking S_3 crenulation cleavage, which overprints S_2 in Blueberry Lake group sedimentary rocks.

Mylonite and porphyroclastic gneiss occur around the margin of the megacrystic granite (Unit 14) intrusion. Based on examinations in the field, formation of the high-strain fabrics was attendant with greenschist- to amphibolite-facies metamorphism. Kinematic indicators were not mapped. The fact that dykes of Shabogamo Gabbro crosscut the high-strain structures demonstrates that the structures are not Grenvillian. Instead, these high-strain structures are thought to be Labradorian. This model is based on the assumption that Unit 14 is correlative with the Trans-Labrador batholith.

ECONOMIC POTENTIAL

Several occurrences of grey-weathering phyllite from Unit 10 (e.g., 347342E, 5952340N, and 348478E, 5950883N UTM coordinates) contain several percent of disseminated pyrite and very minor amounts copper-bearing sulphides. These occurrences suggest that the fine-grained clastic rocks in Units 9 and 10 have potential to host SEDEX base-metal sulphide mineralization, although samples from these locations do not contain significant amounts of base metals. The average copper content in sulphide-bearing rocks from the two outcrops noted above is less than 50 ppm.

The Blueberry Lake group felsic volcanic rocks may have some potential for volcanic-hosted massive sulphide mineralization, although occurrences of sulphide mineralization were not observed during the mapping. Moderate lake-sediment geochemical anomalies in As, Zn, Ni and Pb are present over the Blueberry Lake group (Swinden *et al.*, 1991).

DEPOSITIONAL MODEL, BLUEBERRY LAKE GROUP

The sedimentary rocks of the Blueberry Lake group were deposited unconformably along the southern margin of pre-Labradorian Laurentia consisting of Knob Lake Group rocks and sub-Knob Lake Group gneisses of the Superior and Rae provinces. The deposition of the Blueberry Lake group probably occurred in a back-arc basin floored by pre-Labradorian Laurentian crust. This is suggested by the association of the Blueberry Lake group with the Trans-Labrador batholith, interpreted to be a subduction-related continental magmatic arc (see James, 1994).

The Blueberry Lake group succession, although not studied in detail, consists of three principal elements, namely: 1) a local basal conglomerate, 2) a middle sequence that is dominated by quartz wacke, conglomeratic quartz wacke and shale, and minor amounts of felsic pyroclastic and epiclastic rocks, and 3) an upper sequence of dominantly felsic pyroclastic to epiclastic rocks, and lesser amounts of mafic to intermediate volcanic flows, and some sedimentary rocks similar to the middle sequence. This tripartite sequence suggests a marine basin fill of mixed provenance. The quartz wacke and conglomerates containing clasts of granitoid gneiss and granite, support a source in the Archean basement complexes of the Superior and Rae provinces. This is in marked contrast to the felsic volcanic rocks of the upper part of the group. Intercalation of sedimentary and volcanic rocks throughout the group indicates that the two source areas are penecontemporaneous with each other.

The basal and middle sequences are essentially derived from the Archean basement to the west and north. The localized basal conglomerate is interpreted as a submarine canyon fill. The well-bedded nature of the quartz wacke and shale, and the types of sedimentary structures, support gravity-driven turbiditic sedimentation along a rifted margin. Tuffaceous sandstone interbedded throughout the middle sequence suggests contemporaneous epiclastic sedimentation of tuffaceous volcanic rocks into the basin.

There is insufficient data to allow further interpretation of the depositional environments of the turbidites. However, the fining upward nature of the middle sequence and the distribution of map Units 9 and 10, which overstep the canyon fill (Unit 8) and onlap the basement, suggest that the basin foundered with rifting. Relative sea-level rise drowned the Laurentian margin cutting off the Archean source. This consequently allowed the volcanic arc to supply most of the detritus for the youngest part of the basin fill.

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