GEOLOGY OF THE SOUTHEASTERN LABRADOR TROUGH

by R.J. Wardle

INTRODUCTION

The project involved mapping of Aphebian, Archean and Helikian rocks which form a southerly extension of areas of the eastern margin of the Labrador Trough mapped in 1977 (Wardle and Doherty, 1978). Work centered on 1:100,000 scale mapping of Aphebian sedimentary and felsic volcanic rocks in the Gabbro Lake area and was supplemented by helicopter reconnaissance of the surrounding, poorly exposed terrain. The geology of the Helikian Sims Formation formed the subject of a separate project (see Ware, this volume).

Parts of the area, particularly those underlain by iron formation, have been mapped on 1 inch = 1000 feet and 1 inch = 1/2 mile scale for the Labrador Mining and Exploration Company and the Iron Ore Company of Canada (I.O.C.C.) by Beland (1949), Baird (1950) and Goodwin (1951). The only regional compilation of the area is that of Wynne-Edwards (1961), who mapped the area on 1 inch = 4 mile scale for the Geological Survey of Canada.

Apart from the Sims Formation, which forms high well exposed hills, the area is flat, extensively covered by muskeg and boulder fields, and affords good exposure only around the shorelines of Gabbro and Ossokmanuan Lakes.

Ossokmanuan, Gabbro and Sandgirt Lakes form part of the Smallwood Reservoir system and have been extensively flooded to depths of about 15 m. The accompanying map has not been corrected for this flooding, which has considerably altered topography in low lying areas.

REGIONAL SETTING AND GENERAL GEOLOGY

The area lies at the southeastern extremity of the Labrador Trough, where the Aphebian sedimentary and volcanic rocks that are characteristic of the Trough along most of its length terminate against gneisses of the Churchill Province to the east and gneisses of the Grenville Province to the south.

The oldest rocks in the area are the gneisses of Unit 1, which are believed to be Archean on structural grounds, and which extend in a crescentic shape around the eastern and southern margins of the map area and partially enclose the Aphebian rocks of the Labrador Trough.

The Aphebian rocks in this part of the Trough comprise the Blueberry Lake group, a new term informally proposed for a unique sequence of sedimentary and felsic volcanic rocks which occur in the area around Gabbro and Blueberry Lakes, and the Knob Lake Group, consisting of the well defined sedimentary lithologies characteristic of this group in the rest of the Trough.

To the north of the area the Knob Lake Group stratigraphy consists, from base to top, of the Seward, Attikamagen, Denault, Dolly, Wishart, Sokoman and Menihek Formations. A sequence of mafic volcanics locally associated with the Wishart and Sokoman Formations is termed the Nimish Subgroup. The Knob Lake Group extends south through the map area but, due to poor exposure and the degree of structural complication, it has not been possible to recognize all the component formations of the group.

A suite of granites of possible Aphebian or Archean age has intruded the basement gneisses, and possibly

also the Knob Lake Group, in the eastern part of the area.

In the northern part of the area the Knob Lake Group is overlain unconformably by Helikian clastic rocks of the Sims Formation. Following deposition of the Sims Formation the area was intruded by the voluminous Shabogamo Gabbro.

The Aphebian rocks, together with the basement gneisses in the eastern part of the map area, were strongly deformed in the Hudsonian Orogeny circa 1735 Ma. Structural trends produced during this event swing from northwest-southeast in the northern to east-west in the southern part of the area.

The Aphebian, Archean and Helikian rocks in the southern part of the area were subsequently deformed into east-west structural trends during the Grenville Orogeny circa 1000 Ma. Since Hudsonian and Grenvillian fabrics are coplanar over much of the area, Grenvillian fabrics can only be positively identified in the Helikian Shabogamo Gabbro. Penetrative Grenvillian fabrics are restricted to the area south of Way Bay; north of the bay Grenvillian deformation is restricted to thin shear zones and dies out to the north.

ARCHEAN

Unit 1- Granite gneiss, migmatite, minor amphibolite

White weathering, granodiorite-tonalite gneisses form a poorly exposed belt between MacLean and north Gabbro Lake, and represent a southerly extension of the Eastern Basement Complex gneisses described by Wardle and Doherty (1978) to the north.

Lithologies encountered are usually migmatitic, contain abundant pods and sheets of amphibolite and have frequently been severely mylonitized during later deformation. Similar gneisses, but usually more completely mylonitized and retrogressed, occur as screens in the Shabogamo Gabbro, as a large inlier west of Gabbro Lake and as a small inlier at the mouth of the McKay River. The leucosome component of the granite gneiss migmatites in these areas commonly has a bluish hue which may be a relict feature of granulite grade metamorphism.

Migmatitic, granodiorite-tonalite gneisses also occur south of Ossokmanuan Lake where they have been zonally reworked in east-west trending mylonite zones. These gneisses usually give K-Ar ages in the range of 950-1000 Ma and have generally been considered part of the Grenville Province (*e.g.* Greene, 1972). Since they are very similar to those elsewhere in the area, it is likely that they are also of Archean age and have been locally reworked in mylonite zones during the Grenvillian Orogeny.

Unit 1a is a body of foliated plagioclase amphibolite, locally identifiable as metagabbro, which is located at the north end of Sandgirt Lake and forms the tip of a more extensive body mapped to the north (Wardle and Doherty, 1978). Since the contacts of the amphibolite with the granitic gneisses are not exposed, it has not been possible to determine whether the unit is an original part of the Archean gneiss assemblage, or a later gabbro sill of the Aphebian Montagnais Group (see Wardle and Doherty, 1978) which was highly metamorphosed during the Hudsonian Orogeny.

APHEBIAN

Blueberry Lake group

This is a new term provisionally proposed for a sequence of felsic volcanics and associated sediments found around the Blueberry Lake and Gabbro Lake areas.

Rocks of this type in the area were first noted by Béland (1949), who recognized a series of "graywackes" around the McKay River which he referred to as the McKay River formation, and a sequence of felsic rocks east of Gabbro Lake which he described as intrusive feldspar porphyries and granites. Wynne-Edwards (1961) recognized these felsic rocks to be silicic volcanics and albite porphyries and also extended the sequence of "graywackes" north from McKay River to MacLean Lake.

Work during the past summer has confirmed the existence of a suite of sediments, including conglomerates, west of Gabbro Lake and also a heterogeneous assemblage of felsic volcanics and associated volcanogenic sediments east of the lake. The sedimentary sequence contains graywackes, feldspathic sandstones and tuffs very similar to those intercalated in the felsic volcanic suite and it is believed that the two rock suites are contemporaneous.

The outcrop extent of these rocks has been considerably modified from the map produced by Wynne-Edwards (1961). The area between Gabbro Lake and MacLean Lake, for instance, is not underlain by graywackes but rather by basement gneiss (Unit 1) and granite (unit 8).

The eastern part of the Blueberry Lake group (Unit 2a) is composed dominantly of white and pink colored felsic crystal tuffs and rhyolites (possibly ranging to dacite). The rhyolites are locally flow banded but usually massive, and may be of extrusive or intrusive origin. Intercalated within the tuffs and rhyolites are thin units

of rhyolite breccia, tuffaceous sandstone, one occurrence of lapilli tuff, volcanogenic conglomerate, graywacke, vesicular mafic flows, mafic tuffs and various highly contorted felsic and mafic volcanic breccias which appear to be of slump origin. A prominent unit, provisionally identified as andesite prophyry, has also been traced for 6 km along the southern side of Blueberry Lake (not shown on map). Due to poor exposure, however, it has not been possible to map out other subdivisions of the group.

The sedimentary sequence (Unit 2b) of the Blueberry Lake group lies west of Gabbro Lake and consists of isolated outcrops of polymictic conglomerate, feldspathic (tuffaceous) sandstone, sericitic phyllite, slate, graywacke with well developed graded bedding, and thin units of felsic tuff.

On the islands at the mouth of the McKay River small outcrops of basement gneiss are interspersed with outcrops of conglomerate. The conglomerate is polymictic and in addition to clasts of black slate and felsic tuff contains numerous clasts of foliated leucogranite with blue quartz identical to that seen in the leucosome fraction of the adjacent gneisses. Both gneisses and conglomerate are highly deformed but there appears little doubt that in this area the Blueberry Lake group rests directly on basement.

Outcrops of felsic volcanics also occur in very close proximity to gneisses at the north end of Gabbro Lake and may also rest unconformably on basement.

These relationships indicate that the Blueberry Lake group lies at the base of the Aphebian sequence in the area and led Wynne-Edwards (1961) to suggest a correlation with the Seward Formation, which forms the base of the Trough succession to the north. The two units are not connected but the Seward Formation in the Timmins Lake area (Wardle and Doherty, 1978) contains polymictic conglomerates very similar, albeit lacking in felsic volcanic clasts, to those in the Blueberry Lake group. The sedimentary part of the Blueberry Lake group also contains slates and phyllites similar to those found in the Attikamagen Formation to the north, and it is possible that the Blueberry Lake group is equivalent to the combined Seward and Attikamagen Formations.

Knob Lake Group

The Knob Lake Group is generally very poorly exposed in the area and to date it has only been possible to correlate highly characteristic units such as the Sokoman iron Formation and Denault dolomite with their equivalents in the Knob Lake Group to the north.

By extension of a unit recognized in 1977 mapping to the north (Wardle and Doherty, 1978), rocks of the Seward Formation (Unit 3) should be present under the drift cover at the north end of MacLean Lake. The only exposure of Seward Formation in the map area is a rather dubious outcrop of white orthoquartzite and sericite schist on the east side of MacLean Lake which probably belongs to the Upper Seward Formation (Wardle and Doherty, 1978). The outcrop is surrounded by granite but no contacts were seen to confirm that the relationship is intrusive or, indeed, that the outcrop is in place.

Numerous bodies of undifferentiated shale, slate and phyllite (Unit 4) occur throughout the eastern part of the area and probably include representatives of the Attikamagen, Dolly and Menihek Formations, which are the usual shale formations present in the Knob Lake Group to the north. With further work it will probably be possible to differentiate some of these units within the area.

The Denault Formation (Unit 5) outcrops in a series of small exposures near the Attikonak River, the south end of Gabbro Lake and in the Dave Lake area. The lithology is usually a massive gray or cream dolomite heavily veined by quartz or chert and containing talc and tremolite in its more southerly exposures.

The Sokoman Formation (Unit 6) is exposed as a unit of jasper-hematite bearing cherty iron formation north of Sims Lake. A similar oxide iron formation lithology, but also containing magnetite, probably underlies the well defined magnetic anomaly that extends through McKay Lake. The presence of iron formation under the anomaly has been confirmed by I.O.C.C. drilling to the northwest. In the southern part of the area, near Way Bay and Dave Lake, the iron formation is more highly metamorphosed and is present as quartz-grunerite-magnetite and carbonate-grunerite schists.

A series of vesicular metabasalts, actinolite schists and thin volcanogenic conglomerates (Unit 7) occurs in association with the Sokoman Formation in the Dave Lake area. Their lithologies and the intimate association with iron formation suggests they are correlatives of the Nimish Subgroup, which outcrops extensively to the north of the map area (Evans, 1978; Wardle and Doherty, 1978).

The distribution of these various formations of the Knob Lake Group over much of the area is not known and it is not possible yet to determined the nature of the contact between the Knob Lake Group and Blueberry Lake group. The facts that the Blueberry Lake group rests on basement and that the Seward Formation is not seen in the central or southern part of the area suggests that the Blueberry Lake group underlies the Knob Lake group. The nature of the contact between the two groups is, however, unknown.

Unit 8 - Granites

The area between the north end of MacLean Lake and the Attikonak River is underlain by an extensive suite of granites which includes megacrystic microcline granite, medium grained pink granite and pink microgranite. The state of these rocks varies from altered but nondeformed to strongly deformed near the contact with Unit 1 gneisses. This contact is seen in the Attikonak River, where screens of megacrystic granite and porphyroblasts of microcline (often converted to augen schist by later mylonitic deformation) overprint the earlier gneissic fabrics, and at the north end of MacLean Lake, where dikes of pink granite crosscut the gneissic foliation of the Unit 1 gneisses. In the eastern part of the area the granites grade into microgranite towards the Blueberry Lake group felsic volcanics. The contact, however, was not seen.

The age of the granites is uncertain, but the manner in which they grade towards microgranite in the vicinity of the volcanics suggests that they may be subvolcanic equivalents and, therefore, Aphebian in age. An alternative possibility, however, is that they are late, posttectonic Archean granites.

HELIKIAN

Sims Formation - Unit 9

The Sims Formation forms hill cappings of conglomerate, arkose and quartzite in the northwestern part of the area which have been warped into broad, northwest trending folds during subsequent deformation. The geology of the formation is more fully described by Ware (this volume).

Shabogamo Gabbro - Unit 10

The Archean, Aphebian and Helikian rocks of the area have been intruded by a voluminous suite of olivine gabbro and diabase collectively referred to as the Shabogamo Gabbro. The form of these intrusions varies from sills and discordant sheets in the sedimentary-volcanic rocks to discordant stocks in the basement lithologies.

In the northern part of the area the gabbro varies from diabase to microgabbro, has a brown weathering color and a well preserved ophitic texture defined by long delicate laths of plagioclase enclosed in olivine and pyroxene. In the southern exposures of the unit the gabbro has the same general appearance but is coarser grained, contains frequent diffuse zones of coarse pyroxene-plagioclase pegmatite, and occasionally displays a weak cumulate layering. A characteristic feature of the gabbro in this area is a coarse pitted weathering surface produced by preferential weathering of large poikilitic pyroxene grains, and a tendency towards spheroidal weathering.

The age of the gabbro, since it intrudes the Sims Formation, is believed to be Helikian. Gabbro samples have been collected for radiometric dating in order to further define the ages of the Shabogamo Gabbro and Sims Formation.

Unit 11 - Granodiorite, granite

A small unit of granodiorite, intruded by thick veins of pink granite, outcrops on islands in south Gabbro Lake. The state of these rocks varies from moderately cleaved on the northern islands to fresh and pristine on the southern island. Contacts between the main mass of the granodiorite and the Shabogamo Gabbro are not seen but, since gabbro in the vicinity of the granodiorite is intruded by thin dikes of a similar granodiorite, it is assumed that Unit 11 is intrusive into the Shabogamo Gabbro.

STRUCTURE AND METAMORPHISM

The migmatite and gneissic fabrics of Unit 1 formed under an upper amphibolite facies metamorphism that was presumably part of an Archean event. The gneissic fabrics have subsequently been folded, locally mylonitized, and retrogressed during later Hudsonian and Grenvillian deformations.

The Aphebian rocks of the Knob Lake and Blueberry Lake groups are invariably highly folded, strongly cleaved and zonally sheared. Fold axes generally have moderate plunge values and cleavage trends swing from northwest-southeast in the northern part of the area to east-west in the central and southern parts of the area. Metamorphism during this deformation increased from north to south. In the north only slaty cleavages are present whereas in the central and southern parts of the area typical lower to middle greenschist facies chlorite (or biotite) - actinolite-epidote-sericite assemblages define the S_1 schistosity.

In the northern part of the area the deformed Aphebian strata are overlain unconformably by shallowly dipping Helikian rocks and it is known that their deformation must be Hudsonian. In the central part of the area, however, the Hudsonian fabrics swing to east-west trends and it is difficult to distinguish them from possible coplanar Grenvillian fabrics.

The only unit in which solely Grenvillian fabrics may be recognized is the Shabogamo Gabbro. In the area of south Gabbro Lake and south of Ossokmanuan Lake the gabbro displays occasional east-west penetrative

cleavages, defined by actinolite, which are presumably the effect of the Grenvillian Orogeny. A major fault which brings up basement against Aphebian rocks and Shabogamo Gabbro east of Ossokmanuan Lake is a high angle overthrust developed at this time.

North of Ossokmanuan Lake the gabbro is usually deformed in thin (10 cm - 1 m) east-west shear zones defined by actinolite schistosities. Otherwise, the frequency of shearing within the gabbro dies out to the north. An exception is a major shear zone, approximately 250 m wide, developed in a gabbro sheet at the northeast end of Gabbro Lake near the Churchill Falls Road. Outside the shear zones the gabbro may be locally altered to actinolite-albite assemblages, but it is usually fairly fresh and preserves an igneous mineralogy of olivine-pyroxene-calcic plagioclase.

Since the gabbro is largely undeformed over most of the central and northern parts of the area, it should postdate the homogeneous development of cleavage and low grade metamorphism seen in the Aphebian rocks. S_1 fabrics in the Knob Lake and Blueberry Lake groups north of Way Bay are therefore believed to be Hudsonian. In the southern part of the area around Dave Lake, however, the S_1 schistosity in the Knob Lake Group rocks is locally crenulated and megascopically refolded by coplanar east-west F_2 folds. Since the gabbro in this area is also locally penetratively deformed, sheared and altered, it is not possible to determine whether deformation in this area is solely of Grenvillian age or is a composite Hudsonian/Grenvillian effect.

In summary the northern limit of Grenvillian penetrative deformation and metamorphism appears to be an east-west line located just to the north of Way Bay. Fabrics north of this are largely Hudsonian. The frequency of east-west Grenvillian shearing dies out to the north and does not appear to extend beyond the Attikonak River.

The gabbro sheet of the Shabogamo Gabbro that intrudes the Sims Formation in its eastern outlier, however, has been locally sheared along the fault contact with the basement gneisses. The Sims Formation has also been deformed into broad folds with parallel northwest trends. Both deformations are probably the result of reactivation of an earlier Hudsonian shear zone along the Knob Lake Group - basement contact. Whether this was a pre-Grenvillian or syn-Grenvillian period of deformation is not known.

ECONOMIC GEOLOGY

Several small pyrite-pyrrhotite showings with minor galena have been recorded in the slates of Unit 4 and the Shabogamo Gabbro near Ossokmanuan Lake (Breau, 1957).

The iron formation in the area, which is predominantly silicate-carbonate facies, has low total iron contents and does not appear to form a suitable host for large secondary hematite deposits.

The most significant potential for mineralization appears to be in the volcanic rocks of the Blueberry Lake group. These rocks are a well differentiated felsic-intermediate-mafic suite that formed under subaqueous conditions and seem to offer a likely environment for massive sulfide mineralization.

Since Aphebian felsic volcanic rocks elsewhere in Labrador are known hosts for uranium mineralization (*e.g.* Aillik Group; Bailey, 1978), the Blueberry Lake group should also be worth investigation for similar mineralization. Scintillometer readings on available exposures did not reveal any anomalous values but, since outcrop is less than one percent, this does not reflect a representative sampling.

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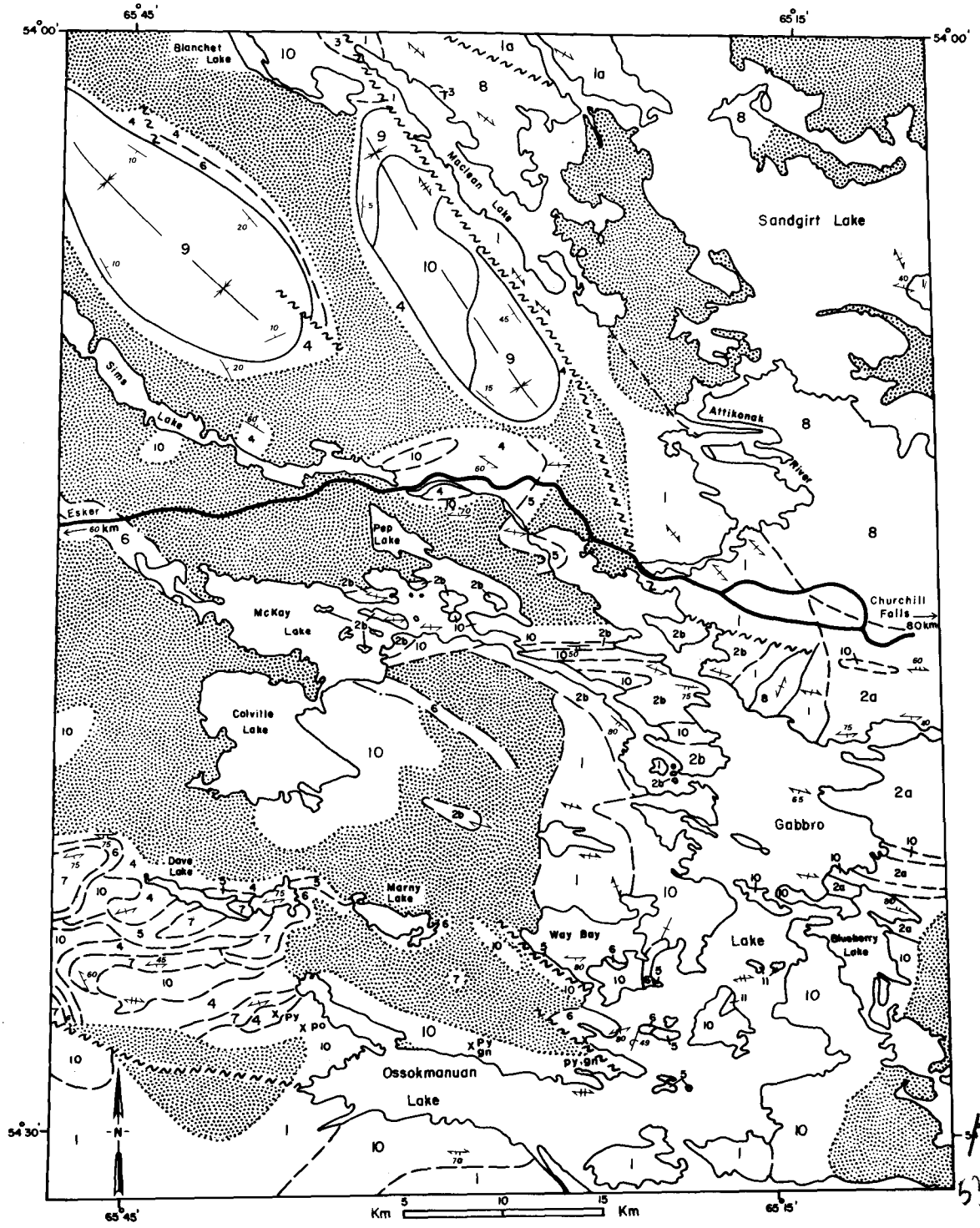

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LEGEND

HELIKIAN

11 *Granodiorite, granite.*

10 **Shabogamo Gabbro:** *Gabbro, diabase.*

9 **Sims Formation:** *Conglomerate, arkose, orthoquartzite.*

APHEBIAN

8 **Granites:** *Includes megacrystic granite, granodiorite, and microgranite. May in part be Archean.*

Knob Lake Group

7 **Nimish Subgroup:** *Metabasalt flows, metadiabase, volcanogenic conglomerate.*

6 **Sokoman Formation:** *Silicate and carbonate iron formation, quartz-grunerite schist, minor oxide iron formation.*

5 **Denault Formation:** *Dolomite.*

4 *Shale, slate, phyllite; undifferentiated.*

3 **Seward Formation:** *Feldspathic sandstone, arkose, orthoquartzite.*

Blueberry Lake Group

2 **2a,** *Felsic volcanics; includes flow banded rhyolite, rhyolite breccia, dacite, andesite porphyry, felsic crystal tuff, mafic tuff, basalt, minor volcanogenic conglomerate, tuffaceous sandstone, volcanic breccias;* **2b,** *polymictic conglomerate, tuffaceous sandstone, graywacke, phyllite and slate.*

ARCHEAN

1 *Granite gneiss, migmatite, minor amphibolite;* **1a,** *plagioclase amphibolite (metagabbro).*