

GEOLOGY OF THE BUCHANS–ROBERTS ARM VOLCANIC BELT, NEAR GREAT GULL LAKE

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ABSTRACT

In the eastern part of the Dawes Pond map area, Ordovician stratified rocks of the Buchans–Roberts Arm belt have been separated into four, regionally extensive, lithotectonic tracts. Although similar volcanic and sedimentary rock types are present in most tracts, each has a characteristic lithodemic association or a unique regional metamorphic assemblage. Particular mineralized volcanosedimentary horizons are present in the Gullbridge, Baker Brook and Powderhorn Lake tracts.

INTRODUCTION

The Buchans–Roberts Arm volcanic belt of north-central Newfoundland extends along strike some 300 km from Red Indian Lake to Notre Dame Bay (Dean, 1978). It is host to numerous volcanogenic massive sulphide deposits thought to have formed in a mature volcanic island-arc complex that developed in the northern part of the Cambro-Ordovician Iapetus Ocean (e.g., Evans *et al.*, 1992). Recent paleotectonic interpretations of the Buchans–Roberts Arm magmatic arc have it situated outboard of, and proximal to, an underplated peri-Laurentian ribboned microcontinent (Swinden *et al.*, 1997; Waldron and van Staal, 2001; Zagorevski *et al.*, 2006). Part of a larger tectonic entity known as the Notre Dame Arc (cf., Swinden *et al.*, 1997; see also van Staal *et al.*, 1998), the Buchans–Roberts Arm volcanic arc has been postulated to have been accreted to older Dunnage Zone oceanic rocks on the Laurentian continental margin during the late stages of the Taconic Orogeny (Cawood *et al.*, 1995; Kusky *et al.*, 1997; Draut and Clift, 2002; Lissenburg *et al.*, 2005).

Terminology. The Buchans–Roberts Arm belt is an informal term previously employed to distinguish it, geographically, from other lithotectonic belts in the Notre Dame Subzone of the Dunnage Zone (e.g., Swinden *et al.*, 1997). The name is also useful for general correlation purposes as several, though not all, lithostratigraphic units in the easternmost part of this Subzone share a common Ordovician and Silurian geological history, and are thus constituents of the same tectonic terrane. As initially defined, the Early-Middle Ordovician Buchans, Roberts Arm, Cottrells Cove and Chanceport groups were deemed to comprise the Buchans–Roberts Arm belt; however, it has been recently expanded to include newly recognized units such as the

Early-Middle Ordovician Red Indian Lake Group (Rogers *et al.*, 2005).

PREVIOUS REGIONAL GEOLOGICAL MAPPING

Strata traditionally assigned to the Buchans–Roberts Arm belt (e.g., Kalliokoski, 1954; Dickson, 2001) crop out in the eastern half of the Dawes Pond map area (NTS 12H/1 in Figure 1). Exposures of variably metamorphosed volcanic and sedimentary rocks near Great Gull Lake, Baker Brook,

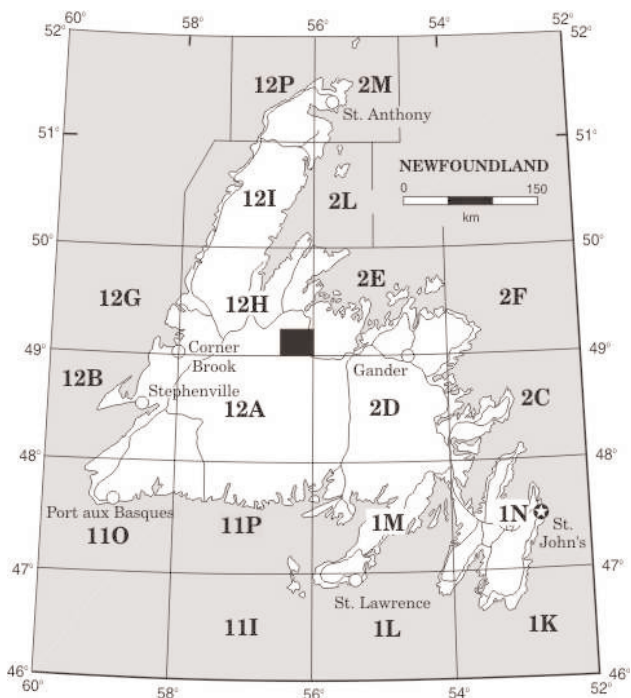


Figure 1. Geographic location of the NTS 12H/1 map area within the Island of Newfoundland.

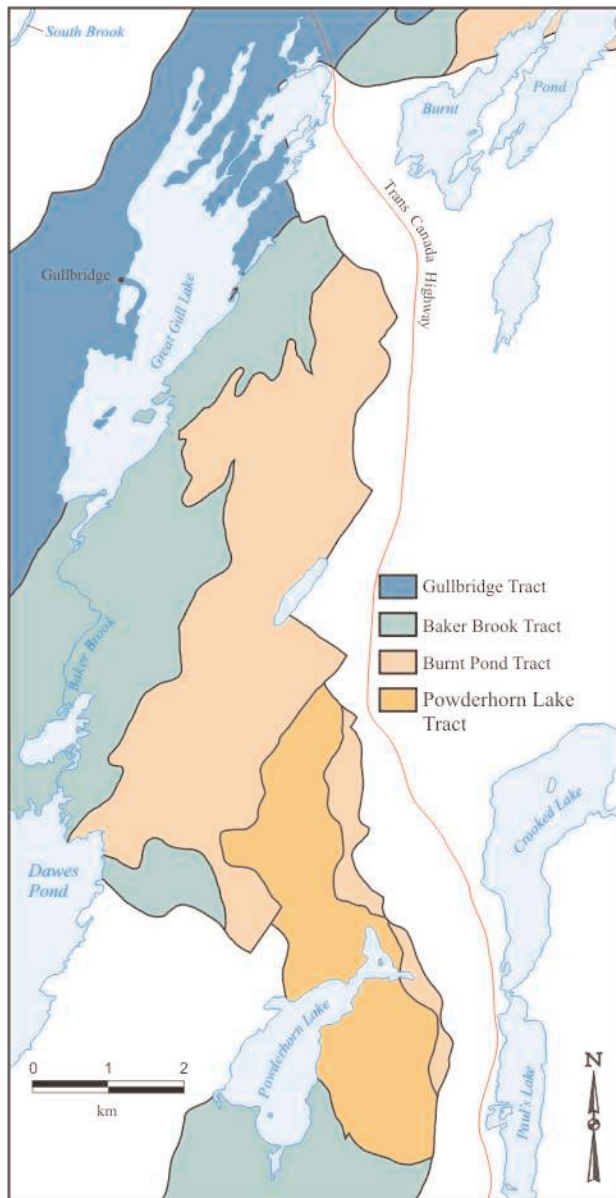


Figure 2. Simplified tectonic map highlighting the lower Paleozoic stratified rocks of the Buchans–Roberts Arm belt in the Dawes Pond map area (NTS 12H/1) of central Newfoundland. The regional disposition of the principal tracts of Ordovician volcanic and sedimentary rocks is illustrated. The Gullbridge, Baker Brook, Burnt Pond and Powderhorn Lake tracts share, for the most part, Early Silurian or older fault boundaries. They are informal terms used in this paper solely for descriptive purposes.

Powderhorn Lake and Burnt Pond are particularly informative (Figure 2) and are easily accessible from the Trans-Canada Highway.

Kalliokoski (1954) believed that the majority of the stratified rocks in the eastern part of the Dawes Pond map

area could be correlated with lithological units previously identified by Espenshade (1937) near Badger Bay on the west coast of Notre Dame Bay. He recognized divisions of dominantly mafic volcanic and dominantly felsic volcanic rocks within the along-strike correlative of the Roberts Arm Volcanics. Moreover, a division of predominantly ferruginous volcanoclastic sedimentary rocks, generally lying immediately east of these volcanic rocks, was assigned to the Crescent Lake Formation. It is significant that Kalliokoski (*ibid*) thought that the Ordovician 'Roberts Arm Formation' pyroclastic rocks he had mapped southwest of Great Gull Lake, particularly the felsic tuffaceous varieties, were very similar to strata grouped in his older 'Crescent Lake Formation'. Williams (1964, 1972) later proposed the name Roberts Arm Group to include all strata previously placed in these two formations.

Kalliokoski (1954) stated that the oldest rocks in the Dawes Pond map area were found in the easternmost part of the area surveyed and implied that these hornfelsed sedimentary and subordinate volcanic rocks did not belong to the younger Crescent Lake–Roberts Arm succession. Dean (1977) modified the distribution of Kalliokoski's subdivisions of Roberts Arm and Crescent Lake strata but concurred with his stratigraphical interpretation. In fact, Dean (*ibid*) correlated the older hornfelsed sedimentary strata with the Upper Ordovician–Lower Silurian Sansom greywacke of Badger Bay and locally assigned such strata to the basal sequence of the Roberts Arm Group.

In contrast, subsequent workers have generally shown the contact of the hornfelsed wacke sequence in the easternmost part of the Dawes Pond map area as a structural feature and variously depicted it as the Red Indian Line sole thrust (Pudifin, 1993), a fault or faults of unspecified type and age (Swinden and Sacks, 1996) or a folded regional overthrust (Dickson, 2001). Recent workers have placed these variably metamorphosed sedimentary rocks structurally below the 'Crescent Lake–Roberts Arm' succession (described earlier by Dean (1977) and Kalliokoski (1954)) and have collectively concluded that the immediately overlying, hanging-wall sequence does indeed represent a part of the Early–Middle Ordovician Roberts Arm Group. However, near the eastern shore of Great Gull Lake, Pope *et al.* (1990) purported that the structurally lowest portion of the hanging-wall sequence preserved the stratigraphically highest rocks in this section of the Roberts Arm Group.

Within the regional footwall sequence lying below the overthrust delimiting the southeast margin of the Roberts Arm Group, Swinden and Sacks (1996) identified a northern and southern belt of sandy wacke of generally low metamorphic grade. Both of them were designated, lithostratigraphically, to the Sansom Formation of the Badger Group.

In the vicinity of Powderhorn Lake, they mapped an intermediate wacke belt, at a similar regional structural position that also contained higher grade metaquartzite, pelitic schist and feldspathic gneiss. However, Swinden and Sacks (*ibid*) assigned the latter belt to a more generic Early Ordovician–Late Silurian unit of metamorphic rocks. For reasons unstated, they chose not to portray the volcanic rock units that had been originally mapped within the metasedimentary sequence lying below their redefined Roberts Arm Group.

Most recently, Dickson (2001) included most of the metasedimentary rocks in Swinden and Sack's intermediate belt and all of the sedimentary strata in the northern belt within the same lithostratigraphic unit, which he correlated with the type Badger Group (Sansom formation?) located some 5 km to the southeast. He also recognized a distinctive black sulphidic pelite and a black nodular meta-chert in a high-grade part of the intermediate belt and interpreted such strata as belonging to a more complexly deformed and metamorphosed equivalent of the Late Ordovician Shoal Arm Formation. Expanding on Kalliokoski's (1954) mapping, Dickson (*ibid*) depicted the relatively small metavolcanic units of mafic and felsic pyroclastic rocks lying within the easternmost metasedimentary rocks as fault-bounded inliers of the Roberts Arm Group, structurally detached from the main part of the unit farther west. The presence of highly tectonized Caradoc shale underlain by older peri-Laurentian volcanic rocks has obvious ramifications for the position of the Red Indian Line in the Dawes Pond map area.

REGIONAL LITHOTECTONIC UNITS

In the area surveyed, Ordovician stratified rocks of the Buchans–Roberts Arm belt have been provisionally subdivided into four fault-bounded tracts (Figure 2), some of which belong to the Roberts Arm Group as presently defined. Informally named after areas where the characteristic rock types of each tract are relatively well exposed, these lithotectonic units are herein referred to as the Gullbridge, Baker Brook, Burnt Pond and Powderhorn Lake tracts. The oldest posttectonic intrusion known to crosscut each of the bounding fault zones, and thus tectonically stitch all four tracts of the Buchans–Roberts Arm belt, is a gabbro body previously assigned to the Early–Late Silurian Hodges Hill Intrusive Suite (Dickson, 2001).

The volcanosedimentary rock units of the Gullbridge tract are generally represented by altered greenschists, mineralized mafic flow and/or felsic pyroclastic rocks, a variably developed oxide-facies iron formation, and proximal and distal volcanoclastic turbidites. The volcanosedimentary rock units of the southeasterly adjacent Baker Brook tract are typified by thinning-upward and fining-upward epiclastic turbidites that structurally overlie, and underlie gossanif-

erous basalt and associated felsic pyroclastic rocks. Farther southeast, the metamorphic rock units of the Burnt Pond tract characteristically contain regionally metamorphosed metasedimentary schist together with higher grade migmatite and intrusive gneiss. In contrast, the metamorphic rock units of the Powderhorn Lake tract are relatively lithologically distinct, and comprise a sequence of variably altered metavolcanic and overlying metapelitic rocks, regionally metamorphosed in the upper-amphibolite facies.

In the past, drilling campaigns in search of base metals have been mainly carried out in the altered volcanic and intrusive rocks of the Gullbridge, Baker Brook and Powderhorn Lake tracts. The site of the former Gullbridge copper mine is located on the western shore of Great Gull Lake (Figure 2).

REGIONAL SETTING OF THE MAP AREA

The regional setting of rocks in this part of the Buchans–Roberts Arm belt is best appreciated by viewing a 35-km-long cross section, looking northwestward along the tectonic strike, drawn from the eastern shore of Great Gull Lake to the vicinity of Kippens Pond, southwest of Badger Bay (Figure 3). Here, the Baker Brook, Burnt Pond and Powderhorn Lake tracts occur on the southwest flank of a regional antiformal thrust stack cored by the Middle Ordovician and older Sops Head Complex. Relatively low-grade Middle Ordovician volcanosedimentary rocks of the Exploits Subzone of the Dunnage Zone, together with unseparated tracts of an Upper Ordovician cover sequence, lie on the back-thrusted northeastern flank of this antiform. In the valley of South Brook (Figure 2), some 5 km southwest of the end of the section line, a post-metamorphic Carboniferous molasse is interpreted to have originally covered the altered and veined schist belts of the Gullbridge tract.

Within the Dawes Pond map area, particularly in the area of Great Gull Lake, Powderhorn Lake and Burnt Pond, all four lithotectonic tracts are stacked in a complex arrangement on a much smaller scale. The Gullbridge tract is structurally overlain by the Baker Brook tract directly at their mutual boundary, although the former is thought to have originally been thrust faulted above the latter. For the most part, the Baker Brook tract structurally overlies the southeasterly, adjacent Burnt Pond tract; however, there are some areas where the opposite relationship is mapped (Figure 3). The Powderhorn Lake tract is directly structurally overlain by both the Burnt Pond tract and the Baker Brook tract in a domal antiform located near Powderhorn Lake (Dickson, 2001; Figure 2). In antiforms that created structures like the Burnt Pond window (Figure 3), imbricated slivers of the Baker Brook tract may intervene between the underlying Powderhorn Lake tract and the overlying Burnt Pond tract.

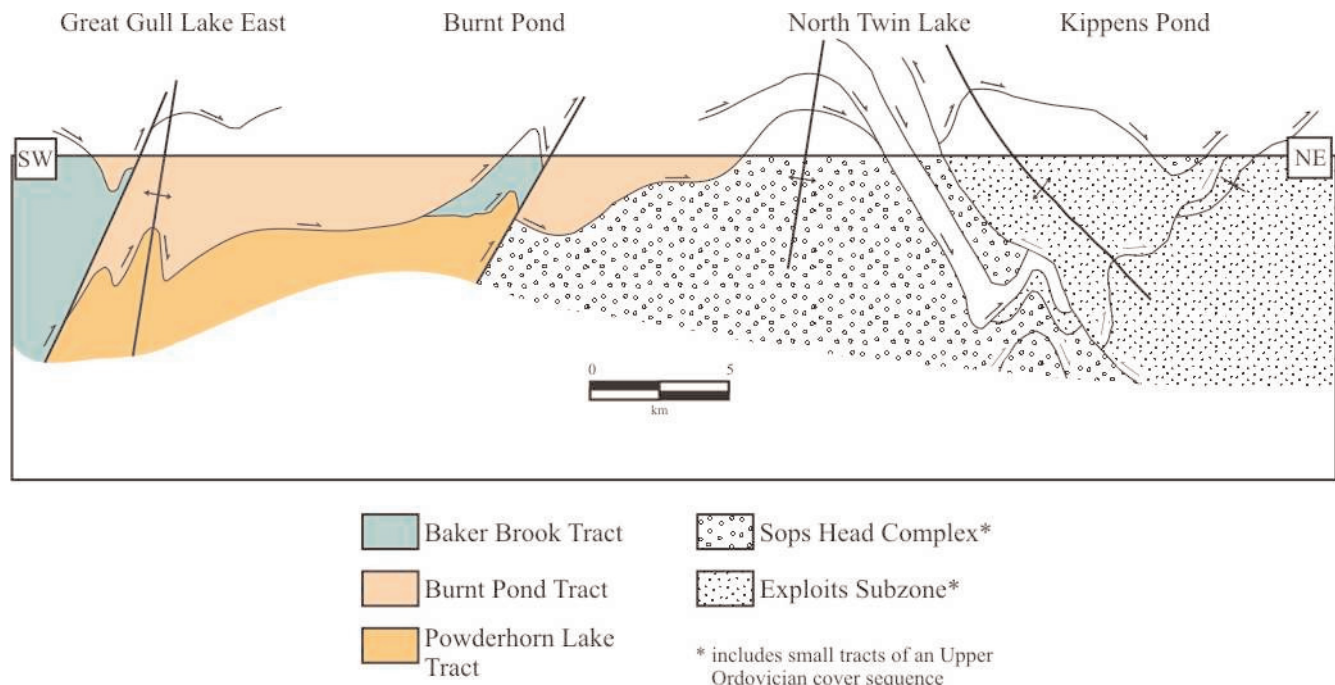


Figure 3. Simplified cross section, viewed looking northwest, showing the regional structural setting of the Baker Brook, Burnt Pond and Powderhorn Lake tracts. They are interpreted to overthrust the Sops Head Complex at the northeast margin of the Buchans–Roberts Arm belt. The unpatterned unit near North Twin Lake is the Crescent Lake Formation of the Roberts Arm Group. Vertical scale is exaggerated.

LITHOLOGICAL SUBDIVISIONS AND STRATIGRAPHICAL RELATIONSHIPS

The Ordovician stratified rocks of the Buchans–Roberts Arm belt display a variety of external relationships with younger rock units (Figure 4). Some internal stratigraphical relationships are preserved between the lithological subdivisions that make up each lithotectonic tract.

GULLBRIDGE TRACT

Rocks of the Gullbridge tract are intruded, posttectonically, by isotropic granodiorite, granite and syenite of the South Brook pluton, an Early–Late Silurian (?) constituent of the Topsails Intrusive Suite (Figure 4). In places, these plutonic rocks are cataclastically fractured, hydrothermally altered and intruded by diabase and quartz-feldspar porphyry dyke swarms, which are also present in Gullbridge tract country rocks. The pluton and its host rocks are postulated to have originally been unconformably overlain by Carboniferous polymictic boulder conglomerate and brownish-red cross-stratified sandstone displaying green reduction spots (Figure 4). Though very poorly exposed, such strata are seen to be devoid of minor intrusions in drill core. Immediately west of the map area, Carboniferous rocks are faulted against mineralized mafic and felsic schists belonging to the Gullbridge tract, as well as volcanic and sedimentary strata assigned to the Silurian Springdale Group.

As a result of field investigations, the lithostratigraphical order of rock units within the Gullbridge tract is only partially understood. The most widespread rock unit (Unit Gb) is generally composed of massive and pillowed basalt, porphyritic andesite, basaltic breccia and mafic tuff (Figure 4). Where regionally metamorphosed and deformed, the unit is made up of cordierite-biotite-actinolite schist, platey-foliated greenschist, sucrose mafic granofels and mafic mylonite. Where altered, such rocks host narrow zones of anthophyllite–cordierite schist, deformed stringer stockworks, pyritic gabbro sill complexes and pretectonic intrusions of quartz-phyric porphyry. Grouping all basalts and andesites together, which may or may not be valid, it seems that Unit Gb occurs in the lowest exposed part of the Gullbridge stratigraphical succession.

A variably thick unit of bimodal pyroclastic rocks (Unit Gp), which has been traditionally thought to have potential for exhalative base metals, contains the most commonly drilled sequence in the Gullbridge tract (*e.g.*, Pudifin, 1993). Where the unit is relatively thin and constituent mafic–felsic tuff successions are mesoscopically interstratified, they form a good marker horizon. In places, the bimodal pyroclastic strata of Unit Gp are observed to be overlain by purplish-red chert and jasperitized basalt. In other localities, interbedded mafic and felsic tuffs are seen to be underlain by a thin interval of felsic volcanic-derived graded wacke, itself situated directly above silicified chloritic basalt. How-

ever, because the basal mafic volcanic strata of Unit Gp are not lithologically distinctive, it has not been possible to confirm that Unit Gp stratigraphically overlies the adjacent non-jasperitized basalts of Unit Gb.

Gullbridge tract bimodal pyroclastic rocks contain intervals of thick-bedded basaltic hyaloclastite that passes upward into slump-folded felsic breccia. The rhyolitic agglomerates display blocks made of fragmented pillow selvages and are crosscut by peperitic gabbro. Unit Gp consists mainly of felsic lithic breccia gradational to laminated felsic ash tuff, banded siliceous argillite and thin-bedded amorphous chert. Where regionally metamorphosed and deformed, pyritic chlorite schist and quartz-sericite schist are common. Where altered and mineralized, widespread gossans cap semi-massive, disseminated and stringer sulphide zones developed in mafic and felsic rock types.

One of the more distinctive rock units in the Gullbridge tract is represented by a unique lithodemic assemblage of interbedded volcanic and sedimentary strata (Unit Gh). Rocks in this map unit are interpreted to stratigraphically overlie the purplish-red replacement chert at the top of the bimodal pyroclastic sequence. Well developed in the southern part of Great Gull Lake and also near the Trans-Canada Highway, Unit Gh is composed of interstratified red and green flows of porphyritic andesite and silicified basalt, hematitic pillow breccia, jasperitized tuffaceous sandstone, and red- and black-ribboned chert. Where this unit is most altered, hematized pyritic basalt and silicified quartz-feldspar tuff are associated with a locally developed oxide-facies iron formation.

A dominantly sedimentary rock unit (Unit Gc) is thought to stratigraphically overlie the variably oxidized, sulphide-bearing volcanosedimentary rocks of Unit Gh. A fine-grained, thin-bedded ferruginous sedimentary sequence constitutes the lower part of Unit Gc and includes maroon-banded argillite, black-laminated chert, interlayered red and green siltstone, and parallel-laminated sandstone turbidite. The upper part of the unit contains felsic volcanic breccia gradational to lithic-crystal tuff interstratified with a sequence of thick-bedded, poorly sorted volcanoclastic turbidites. Debrites are observed to be scoured into red-ribboned chert, maroon siliceous argillite and bedded jasper.

A dominantly felsic volcanic rock unit (Unit Gr) is mainly developed in the southwest part of the Gullbridge tract (Figure 4). Its lithostratigraphic position relative to the other four subdivisions of the Gullbridge tract is uncertain, as Unit Gr is mapped to be fault-bounded in most places. Best exposed south of the former Gullbridge mine, this map unit is mostly made up of pink flow-banded rhyolite, perlitic rhyolite breccia, quartz-phyrlic felsic lithic tuff, and second-

ary maroon chert. Felsic pyroclastic rocks in Unit Gr are coarsest in the southwest and finest in the northeast of the outcrop belt.

A locally preserved stratigraphical boundary with underlying bimodal pyroclastic rocks (Unit Gp) possibly occurs east of a small pond at the western boundary of the map area, although the actual contact between Unit Gr and Unit Gp is not observable (Figure 4). Unit Gh basalt, which is exposed farther northeast on the shore of Great Gull Lake above Unit Gp felsic and mafic tuff, is not present at this location below Unit Gr rhyolite breccia. It is possible that the felsic tuffs and epiclastic strata within Unit Gp, or even those of Unit Gc, represent a lateral facies variant of the more proximal strata found in Unit Gr.

Large pre-tectonic bodies of quartz-feldspar porphyry and gabbro are hosted by altered rhyolite, and may be similar to that intruded into Unit Gb basalt. Where hydrothermally altered, regionally metamorphosed and strongly deformed, felsic volcanic rocks in Unit Gr are represented by porphyroblastic quartz-sericite-pyrite schist and, more rarely, by anthophyllite-cordierite schist (Upadhyay and Smitheringale, 1972).

BAKER BROOK TRACT

Based on relationships observed to the south of the map area in the region of Catamaran Brook, a basalt-dominant volcanic division (Unit BBv) is inferred to have originally underlain the sedimentary rocks of the Baker Brook tract. The stratigraphical relationship of the mafic volcanic rocks in the Baker Brook tract to those of the Gullbridge tract is unknown, although they are directly tectonically juxtaposed in several localities (Figure 4).

Unit BBv is composed generally of pillowed basalt, graded pillow breccia, porphyritic tholeiite and minor mafic tuff. The assignment of all mafic volcanic rocks to one map unit of the Baker Brook tract is based on equivocal field relationships, and it may or may not be valid. Subunit BBvf is poorly exposed and confined to the northernmost part of this division. It contains felsic lithic breccia, marked by conspicuous flow-banded rhyolite fragments, interstratified with graded beds of crystal-rich felsic tuff. In subcrop, volcanoclastic wacke displaying detrital quartz-feldspar porphyry clasts is seen to be interbedded with parallel-laminated siltstone and thin-bedded sandstone.

Where the mafic volcanic strata of Unit BBv are altered and regionally metamorphosed, schistose chloritic basalt is transitional to a pervasively silicified, locally platy-foliated pyritic basalt or to a net-veined sericitic metabasite illustrating leached zones adjacent to the highly deformed stringers.

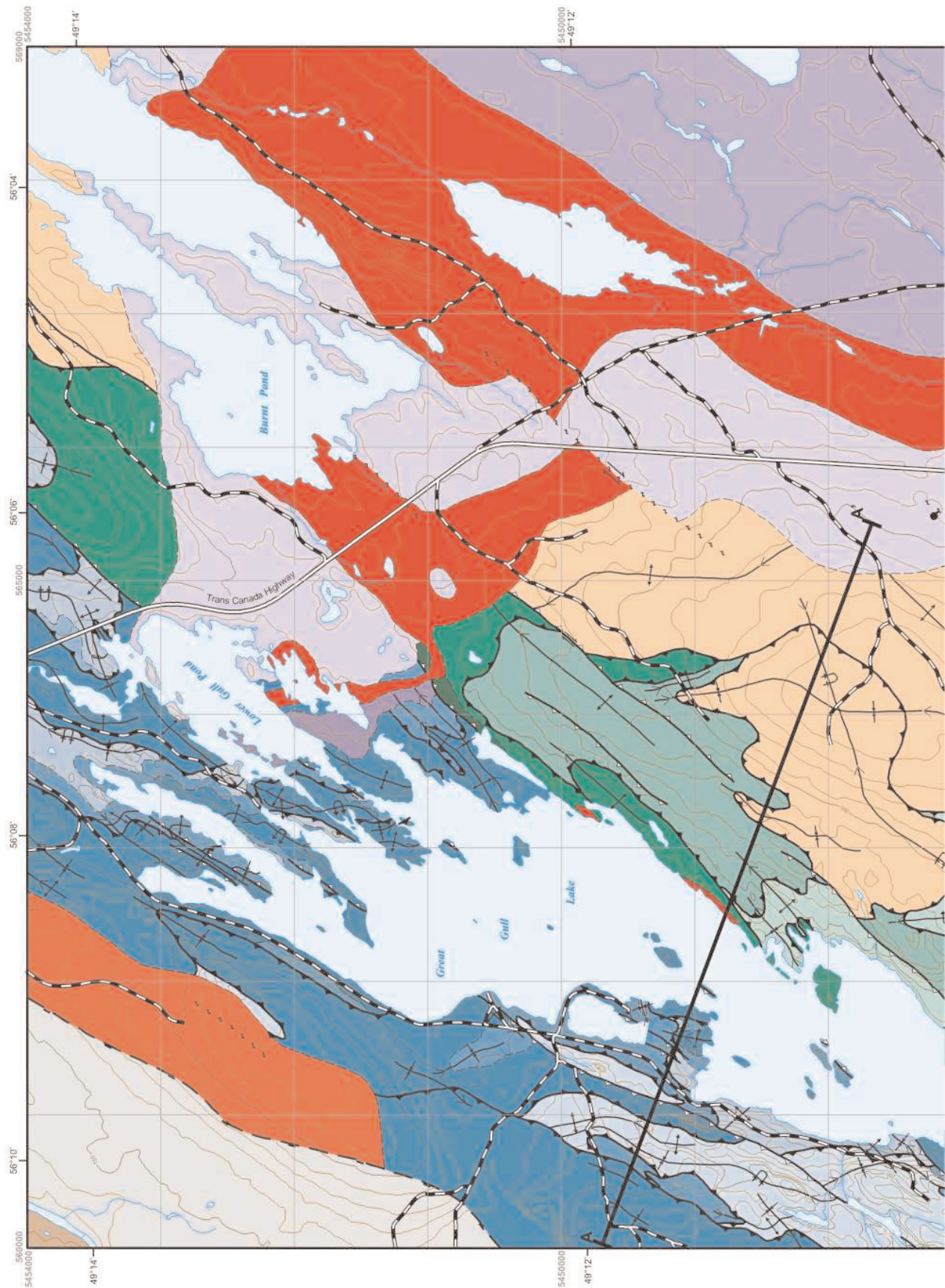


Figure 4.

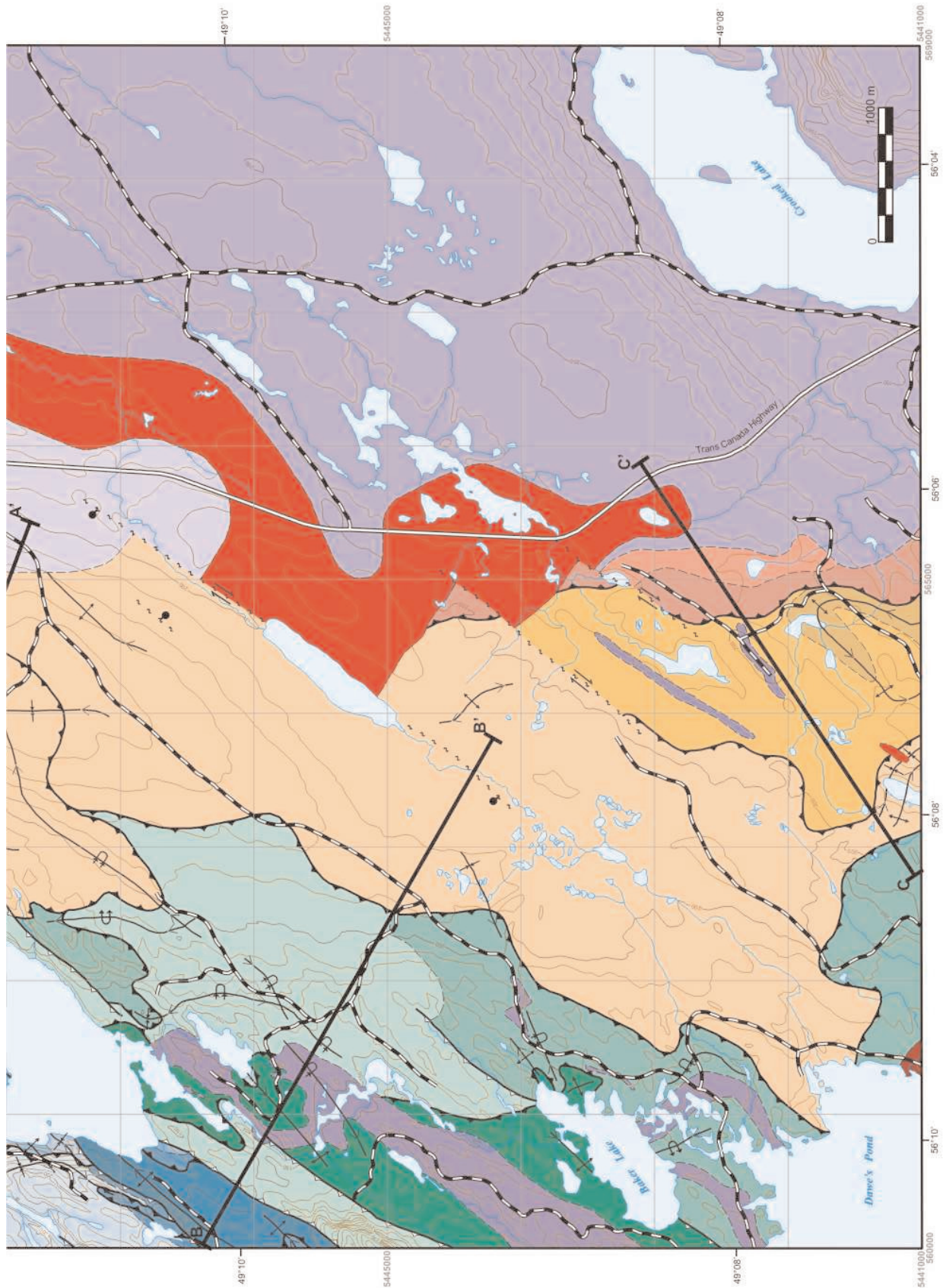


Figure 4. Bedrock geological map of the region around Great Gull Lake emphasizing distinctive lithological units and rock structures found within the four Ordovician tracts of the Buchans–Roberts Arm belt in the area surveyed. Adjacent rocks are mainly represented by various Silurian intrusive bodies, although Carboniferous and Silurian sedimentary strata are present near South Brook.

LEGEND

POST-METAMORPHIC COVER		SILURIAN STRATIFIED ROCKS	
Early Carboniferous (?)		Terrestrial Overlap Sequence	
Cc	<i>Massive to poorly stratified, clast-supported, brownish-red polymictic conglomerate showing rounded cobbles and boulders of red syenite, marble breccia, mafic and felsic schist, and foliated quartz-carbonate veins; minor, highly friable beds of dark-red cross-stratified sandstone displaying green reduction spots; graphitic and chloritic cataclastite</i>	Early to Late Silurian	
POST-TECTONIC INTRUSIVE ROCKS		Springdale Group	
Topsails Intrusive Suite		Ss	<i>Mainly medium-bedded, light-red arkosic sandstone; minor, cleaved, dark-red siltstone</i>
Early to Late Silurian (?)		DUNNAGE ZONE	
South Brook pluton		Roberts Arm Belt	
Ts	<i>Mainly light-grey, isotropic, hornblende-biotite granodiorite; minor; unseparated pink granite and red syenite; abundant swarms of fresh diabase and quartz-feldspar porphyry dykes near faults and fractures</i>	Gullbridge Tract volcanosedimentary rock units are generally represented by altered and mineralized mafic flow and/or felsic pyroclastic rocks, a variably developed oxide-facies iron formation, and proximal and distal volcaniclastic turbidites.	
Early Silurian (?)		Gr <i>A dominantly felsic volcanic rock unit of unknown lithostratigraphic position, is made up of light grey to pink, flow-banded rhyolite, coarse-grained perlitic rhyolite breccia, quartz-phyric felsic lithic tuff, and maroon replacement chert; subordinate, rhyolite-hosted quartz-feldspar porphyry bodies intruded by pre-tectonic gabbro; minor, spotted quartz-sericite-pyrite schist; rare, anthophyllite-cordierite schist</i>	
Dawes Pond pluton		Gc <i>A dominantly sedimentary rock unit is composed of a fine-grained, thin-bedded ferruginous sequence including maroon banded argillite, black laminated chert, interlayered red and green siltstone, parallel-laminated sandstone turbidite and minor hematitic basalt; a coarse-grained, thickly stratified sequence of felsic volcanic breccia gradational to fine-grained, lithic-crystal tuff interstratified with volcaniclastic turbidites and rare debrites; massive to thick-bedded, poorly sorted to graded, quartzofeldspathic wackes scoured into red ribboned chert, maroon siliceous argillite and bedded jasper</i>	
Td	<i>Mainly light-grey, isotropic, hornblende-biotite granodiorite intruded by multiple diabase dykes; unseparated gabbro</i>	Gh <i>A volcanosedimentary rock unit containing pyritized and hematized mafic volcanic rocks and minor reworked felsic pyroclastic strata associated with a locally developed oxide facies iron formation; massive, red, hematitic basalt and subordinate pillow breccia; interstratified red and green, silicified basalt and andesite flows; minor, jasperitized tuffaceous sandstone, hematized and silicified beds of felsic ash tuff, and red and black replacement cherts</i>	
Hodges Hill Intrusive Suite		Gp <i>A bimodal pyroclastic rock unit consisting mainly of buff, medium-grained, felsic lithic breccia gradational to laminated felsic lapilli tuff; light-grey, banded, siliceous argillite and thin-bedded amorphous chert interstratified with the coarser felsic pyroclastic rocks; thick-bedded basaltic hyaloclastite grading into slump-folded felsic breccia (displaying clasts of glassy pillow selvages) and crosscut by peperitic gabbro. Bimodal pyroclastic strata are overlain by purplish-red chert and jasperitized basalt and underlain by a coarse grained, well graded, felsic volcanic-derived wacke, itself directly situated above a dark-grey or green, silicified, chloritic basalt; disseminated, semi-massive and stringer sulphide zones capped by widespread gossans; subordinate, pyritic chlorite schist and quartz-sericite schist</i>	
Early to Late Silurian		Gb <i>A dominantly mafic volcanic rock unit generally composed of dark-grey, massive basalt and porphyritic andesite, pillowed basalt, basalt breccia and mafic tuff; light-green, epidotized basalt, hosting a deformed stringer stockwork, passing into dark-green, pervasively silicified, chloritic basalt; abundant basalt-hosted quartz-feldspar porphyry bodies and silicified, pyritic gabbro sills. Volcanic rocks preserving primary textures transitional to cordierite-biotite-actinolite schist, platy-foliated metabasite, pyritic mafic mylonite, and sucrose mafic granofels; rare, anthophyllite-cordierite schist</i>	
Burnt Pond Brook granodiorite			
Hb	<i>Light-grey to pink, equigranular, hornblende-biotite granodiorite; minor, isotropic, quartz porphyritic granodiorite crosscut by aplite and diabase dykes; rare pegmatite</i>		
Lower Gull Pond gabbro			
Hg	<i>Mainly dark-grey, medium-grained gabbro; minor, dark-grey, fine-grained, equigranular diorite; less common, light-grey, coarse grained leucogabbro having much finer cognate xenoliths; local pegmatitic gabbro developed at the margin of country rock enclaves; pyritic intrusion breccia having gabbroic blocks set in a granodiorite matrix; small granodiorite dykes displaying sharp intrusive contacts as well as diffuse marginal boundaries</i>		
Crooked Lake gabbro			
Hc	<i>Dark-grey, medium- to coarse-grained, equigranular, pyroxene gabbro; locally, later phases of fine- to medium-grained quartz diorite; satellite dykes of isotropic gabbro displaying chilled margins; later minor intrusions of pegmatitic syenite, porphyritic diabase, quartz-feldspar porphyry and granophyre</i>		
SYN-TECTONIC INTRUSIVE ROCKS			
Middle Ordovician to Early Silurian (?)			
Baker Lake gabbro			
BLg	<i>Dark-green, medium- to coarse-grained, chloritized and epidotized, pyroxene porphyritic and equigranular gabbro; black, fine-grained, sucrose metagabbro displaying folded quartz-chlorite-pyrite stringers; minor, cumulate-layered pyroxenite and associated leucogabbro sheets; multiple minor intrusions of dark-grey hornblende diorite and plagioclase porphyritic diabase having xenoliths of metasedimentary schist and schistose gabbro; rare, actinolite schist and amphibolite</i>		

Figure 4. Legend to Figure 4.

Baker Brook tract volcanosedimentary rock units are generally represented by thinning-upward and fining-upward epiclastic turbidites that structurally overlie, and underlie, basalt and associated felsic pyroclastic rocks.

BBc An upper sedimentary division is dominated by thin-bedded siltstone, replacement chert and volcanoclastic sandstone turbidites with subordinate felsic lapilli tuff. Interbedded maroon chert, red and grey siliceous siltstone, and parallel-laminated jasperitized sandstone; buff, thin-bedded, graded siltstone and fine-grained felsic lithic tuff interstratified with light-grey banded argillite; felsic ash tuff layers within concretionary siltstone displaying compacted lamination; light-pink, graded, quartz-feldspar crystal tuff interlayered with red siltstone. Subordinate, medium-bedded sandy wacke and local tuffaceous wacke illustrating sandstone dykelets and small argillite rip-up clasts. Minor, felsic spotted tuff and reverse-graded spotted sandstone; rare, porphyroblast-rich andalusite schist near folded gabbro sill

BBg A lower sedimentary division is dominated by thick-bedded proximal turbidites and reworked felsic pyroclastic ejecta with subordinate rhyolitic breccia. Dark-grey, thickly stratified tuffaceous wacke displaying coarse detrital grains of angular, variably sericitized, pink feldspar prisms, partially resorbed or rounded grey quartz crystals, and outsized oblong clasts of felsic volcanic rock; orange-weathered, light-pink, blue quartz-bearing arkosic wacke locally showing slump-folded and partially disaggregated argillaceous rip-up clasts; minor size-graded beds of felsic volcanic breccia. Subordinate, light-grey, parallel-laminated sandstone interbedded with medium-bedded sandy wacke and graded microconglomerate (having well-rounded rhyolite pebbles). Rare, thinly-bedded siliceous siltstone, dark-green banded argillite and black slate partings. Fine-grained, sucrose metasedimentary schist and porphyroblast-rich granoblastic schist are widespread

BBv A lower volcanic division is dominantly made up of mafic volcanic flows with subordinate felsic pyroclastic rocks and rare volcanoclastic sedimentary rocks. Dark-grey pillowed basalt and graded pillow breccia; dark-green porphyritic basalt and minor mafic tuff transitional to schistose chloritic basalt; light-grey, netveined or pervasively silicified, locally platey-foliated pyritic basalt (having leached zones adjacent to deformed stringers); black sucrose basalt gradational to mafic granofels (locally crosscut by chlorite-epidote-chalcopyrite-quartz veinlets); vuggy epidote-chlorite-carbonate-clinozoisite-quartz veins hosted by light-green actinolite schist and epidotized pillowed basalt. In subunit (BBvI), in the northernmost part of this division, massive lithic breccia displaying flow-banded rhyolite fragments; well-bedded, graded, crystal-rich felsic tuff; light-grey, parallel-laminated siltstone and thin-bedded sandstone interstratified with wacke displaying detrital quartz-feldspar porphyry clasts

Burnt Pond tract metamorphic rock units generally contain regionally metamorphosed metasedimentary schist together with higher grade migmatite and intrusive gneiss.

BPo An upper orthogneiss division is typically composed of light-grey to pink, medium-grained, fine-banded, hornblende-bearing granodiorite gneiss. Granodioritic injection gneiss and schistose leucogranite sheets transgressing host migmatite, restite and metagabbroic intrusions; dip-lineated, quartz-ribbed granodiorite with ellipsoidal enclaves of amphibolite schist transitional to wispy-foliated granodiorite displaying partially assimilated trains of accidental mafic xenoliths; zones of aligned plagioclase phenocrysts in hornblende granodiorite intruded by unfoliated swarms of mafic dykes

BPp An intermediate paragneiss division is mostly made up of intercalated light-grey and dark-grey, porphyroblast-rich metasedimentary gneiss. Intrastratal folds of transposition fabric in fine-grained psammitic and semipelitic bands crosscut by deformed sheets of dark-green amphibolite gneiss; tectonically straightened lit-par-lit migmatite gneiss; platey sucrose gneiss overprinted by euhedral plagioclase porphyroblasts near metagabbro sheets; boudinaged garnet amphibolite dykes displaying boudin necks filled with granitic gneiss; rotated amphibolite pods (with oblique internal foliation) augened by gneissosity in host metasedimentary rocks; variably reworked amphibolite gneiss and migmatite crosscut by schistose metadiorite dykes

BPss A lower striped schist division is represented by medium- to thin-bedded, coarsely porphyroblastic metasedimentary schist locally transitional to schistose spotted turbidite. Thinly intercalated psammitic and semipelitic schist illustrating complexly folded and lineated, quartz-plagioclase-chlorite veins and lits; light-grey and buff, fine-grained andalusite-cordierite-biotite psammitic; dark-grey, thin-bedded, staurolite-garnet-cordierite-hornblende-biotite semipelitic; sucrose granofelsic semipelitic containing disseminated pyrite and acicular hornblende gradational to siliceous sericite schist; tectonically straightened hornfelsic schist intruded by foliated tourmaline-muscovite pegmatite; minor, mafic tuffaceous schist, mafic amphibolite gneiss and mafic mylonite

Powderhorn Lake tract metamorphic rock units generally comprise a regionally metamorphosed sequence of variably altered metavolcanic and overlying metasedimentary rocks.

PLs An upper sedimentary division is principally composed of carbonaceous iron-rich pelitic schist. Dark grey, thin-bedded to laminated, andalusite-garnet-hornblende-biotite pelite, sulphidic black graphitic schist and cordierite-lineated pelitic schist; subordinate, light-grey, thin-bedded, fine-grained, siliceous psammitic schist interlayered with semipelitic schist containing unoriented porphyroblasts of cordierite, andalusite and hornblende; minor, sucrose sericite-chlorite schist; rare, black chert and laminated pelite illustrating disseminated and porphyroblastic pyrite

PLv A lower felsic volcanic division mainly consists of locally mineralized, schistose tuff and breccia. Felsic quartz-sericite-pyrite schist displaying coarse andalusite and cordierite porphyroblasts; gossan-bearing, biotite-lineated, platey-foliated felsic breccia preserving quartz-phyric rhyolite fragments; light-grey, fine-grained, well-banded lithic tuff displaying finely disseminated sphalerite and coarsely recrystallized chalcopyrite; thin-bedded, graded, felsic crystal tuff illustrating crosscutting folded and boudinaged quartz veins; altered quartz-feldspar porphyry dykes

SYMBOLS

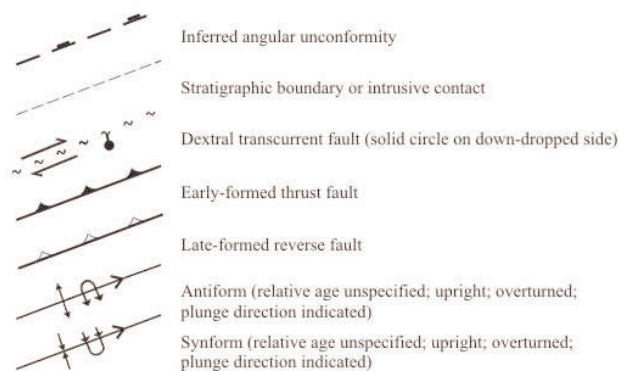


Figure 4. Legend to Figure 4.

In other locations, black sucrose basalt is gradational to an isotropic mafic granofels, which is seen to be locally cross-cut by chlorite–epidote–chalcopyrite–quartz veinlets. Where the inhomogeneously deformed basalt sequences are regionally metamorphosed and then altered, vuggy epidote–chlorite–carbonate–clinozoisite–pyrite–quartz veins are observed to be hosted by actinolite schist and epidotized pillow lava (*see also* Hudson and Swinden, 1990).

The lower sedimentary division (Unit BBg) of the Baker Brook tract is dominated by thick-bedded proximal turbidites and subordinate thin-bedded felsic tuffs. Size-graded beds of rhyolitic breccia are present in the lower part of the map unit. The most common sedimentary rock is a tuffaceous wacke having coarse detrital grains of partially resorbed or rounded quartz crystals, angular prisms of fresh and altered feldspar, and outsized clasts of felsic volcanic rock. Blue quartz-bearing arkosic wacke, locally illustrates slump-folded and partially disaggregated argillaceous rip-up clasts and is interstratified with parallel-laminated sandstone and graded sandy wacke. Less common beds of microconglomeratic wacke have scoured bases and display well-rounded rhyolite pebbles.

Rare, black slate partings in ferruginous-banded argillite are observed in the lowest preserved part of the map unit, where such strata lie tectonically adjacent to Unit BBv tholeiitic basalt. Black silicified mudstone, which forms the matrix of chaotically folded slump sheets in a thinly bedded siltstone sequence, are also present in the lower part of this division. Sucrose metasedimentary schist and porphyroblast-rich granoblastic schist are widespread within Unit BBg, especially near its boundary with the Burnt Pond tract.

The upper sedimentary division (Unit BBc) of the Baker Brook tract is dominated by thin-bedded siltstone turbidite, variegated chert, banded argillite and minor felsic lapilli tuff. Typically, red and grey siliceous siltstone, jasper-bearing laminated sandstone and maroon chert are observed to be rhythmically interbedded. Felsic ash tuff layers within nodular siltstone intervals show draping around zoned concretions and other evidence of compacted lamination. Coarser grained felsic lithic tuff is most commonly associated with finely banded grey argillite; whereas, red siltstone is interlayered with the graded beds of quartz-feldspar crystal tuff. Subordinate intervals of volcanoclastic sandstone illustrate the argillite rip-up clasts and intrusive sandstone dykes typical of compacted turbidite flows.

Where the Unit BBc multilayer is polyphase deformed, the strata display striated bed-parallel quartz veins as well as folded and boudinaged quartz veinlets that cut across the sedimentary section. Some folded quartz reefs are intruded by quartz-cemented breccias and diabase dykes emplaced

along the fold axial surface. Similar quartz breccias seal faults in secondary fold hinge zones and occupy the same conduit as a satellite suite of posttectonic granodiorite dykes.

Where Unit BBc is regionally metamorphosed, the sandstone and siltstone metaturbidites typically show reverse grading that is defined by the distribution of cordierite porphyroblasts. Very coarse-grained andalusite schist is locally developed in Unit BBc near the folded sills of Unit BLg gabbro (Figure 4) and, there, only relicts of the primary bedforms and stratification are preserved. In certain locations, altered felsic tuffs are spotted with ferroan carbonate–pyrite aggregates, especially near the syntectonic quartz veins.

BURNT POND TRACT

In terms of areal distribution, the most extensive subdivision of the Burnt Pond tract is a map unit (Unit BPss) of thinly striped schist of metasedimentary origin (Figure 4). Interpreted as the structurally lowest of the three divisions of constituent metamorphic rocks, it is disposed about a large northwest-plunging antiform and lies up-plunge of the Powderhorn Lake tract. Unit BPss crops out to the northeast and southeast of the Baker Lake tract (Figure 4), as the regional antiform is refolded and cross faulted in the ground east of Dawes Pond. Many of the northeast-trending dextral transcurrent faults offsetting Unit BPss also displace posttectonic gabbro and granodiorite bodies in the Hodges Hill Intrusive Suite.

The striped schist division of the Burnt Pond tract is generally made up of thin- to medium-bedded, coarsely porphyroblastic, amphibolite-facies metasedimentary schist. In a few exposures, such schists are locally transitional to a rock that could be described as a schistose, spotted, graded quartz wacke. More commonly, thinly intercalated psammitic and semipelitic schist illustrate complexly folded and lineated, quartz–plagioclase–chlorite veins and, in places, garnet-bearing lit-par-lit metamorphic segregations.

Unit BPss is mainly composed of sulphidic, andalusite–cordierite–biotite psammite, preserving relicts of laminated or graded beds, tectonically interleaved with thinly striped intervals of staurolite–garnet–cordierite–hornblende–biotite semipelite. Near Burnt Pond, the map unit also contains minor amounts of mafic tuffaceous schist, mafic amphibolite gneiss, platey metagabbro and localized mafic mylonite. Where highly deformed, subordinate semipelitic and pelitic schist in Unit BPss display augened porphyroblasts and sheared nests of quartz stringers. Tectonically straightened hornfelsic schist assigned to this map-unit is observed to be intruded by foliated tourmaline–muscovite

pegmatite. In contrast, isotropic granodiorite dykes and granite veinlets crosscut the hinge zones of minor secondary folds and are intruded along small reverse shear zones. Where altered and metamorphosed, siliceous sericite schist in Unit BPss passes gradationally into a sucrose granofelsic semipelite that contains disseminated pyrite and acicular hornblende needles.

In some rare localities, situated along the northwestern margin of the striped schist division, andalusite-bearing psammitic schist is seen to be interlayered with black sulphidic cordierite pelite. More significantly, thin beds of both rock types are scoured by metamorphosed sandy and pebbly wackes. For Unit BPss, this could possibly provide an important stratigraphic linkage to black sulphidic cordierite pelites found in the lower part of the Burnt Pond tract or the upper part of the Powderhorn Lake tract.

The paragneiss division (Unit BPp) of the Burnt Pond tract is thought to be faulted along the length of its south-western boundary and to be terminated northwestward by the intrusion of the Burnt Pond Brook granodiorite (Figure 4). The map unit occurs on the northeastern flank of the aforementioned northwest-plunging regional antiform (part of the larger Powderhorn Dome; *see* Pennell, 2004), where it is cross folded by later northeast-trending fold structures. Unit BPp is mapped to lie directly above the striped schist unit at the base of the Burnt Pond tract as well as both divisions of the underlying Powderhorn Lake tract (Figure 4; Pennell, 2004).

Intercalated light-grey and dark-grey, compositionally banded, porphyroblast-rich metasedimentary gneiss, complexly folded lit-par-lit migmatite gneiss and lesser dark-green amphibolite gneiss generally comprise the paragneiss division. Unit BPp metasedimentary gneiss has psammitic and semipelitic layers that preserve a transposed banded foliation that is tightly to isoclinally folded and then intruded by several generations and types of amphibolite-facies mafic dykes. Folded intrusive sheets of early amphibolite gneiss are crosscut by deformed and metamorphosed bodies of gabbro, diorite and diabase. In places, boudinaged amphibolite dykes preserving relict igneous texture display boudin necks filled with granitic gneiss injected from the host migmatite.

Where the paragneiss division of the Burnt Pond tract is most deformed and metamorphosed, discoidal lenses of folded lit-par-lit migmatite are bounded by zones of tectonically straightened metasedimentary gneiss showing trains of rectilinear amphibolite boudins. Folded amphibolite pods, preserving an oblique internal foliation, are augened by gneissosity in Unit BPp metasedimentary host rocks. Here, a platy sucrose psammitic gneiss is overprinted by

euhedral plagioclase porphyroblasts in the thermal aureole of small metagabbro intrusions. Subsequently, schistose metadiorite dykes and later diabase crosscut the variably reworked migmatitic paragneiss, which is very rarely seen to be transitional with interlayered psammitic and semipelitic schist.

A gradationally overlying orthogneiss division (Unit BPo) represents the structurally highest component of the Burnt Pond tract. Within the area surveyed, this lithologically distinctive map unit is partially engulfed by the post-tectonic Crooked Lake gabbro (Figure 4). However, orthogneiss has been traced along the northeast flank of the Powderhorn Dome for at least 4 km southeast of the boundary of the map area (Pennell, 2004).

Unit BPo is mostly composed of finely banded hornblende-bearing granodiorite gneiss that locally has xenoliths and small enclaves of migmatitic paragneiss, amphibolite and metagabbro. In places where granodioritic injection gneiss is sharply bounded, it is seen to transgress metric-scale bands of restite and migmatite. In other localities, banded granodiorite and folded *lit-par-lit* vein complexes crosscut migmatite zone rocks as young as the foliated metadiorite dykes. The metagabbro suite and associated high-temperature hornfels are also observed to host schistose and gneissose leucogranite sheets.

Where strongly deformed, Unit BPo contains quartz-ribboned, dip-lineated granodiorite gneiss that has ellipsoidal enclaves of amphibolite schist. Where this unit is less deformed, banded or platy granodiorite is transitional to wispy-foliated granodiorite, which displays partially assimilated trains of accidental mafic xenoliths. Where unaffected by crystal plastic deformation, the granodiorite hosts narrow shear zones, which are defined by flow-aligned plagioclase phenocrysts and intruded by unfoliated swarms of mafic dykes. In some parts of Unit BPo, the hornblende granodiorite is isotropic and difficult to distinguish from the Burnt Pond Brook granodiorite (Unit Hb).

POWDERHORN LAKE TRACT

Stratified rocks of the Powderhorn Lake tract have been assigned to an older metavolcanic unit and a younger metasedimentary unit (*cf.*, Dickson, 2001; Pennell, 2004). These two divisions of regionally metamorphosed amphibolite-facies rocks are interpreted to outline a regional fold interference pattern in the southernmost part of the map area (Figure 4). They have been subsequently intruded by several northeast-trending, altered and metamorphosed gabbro bodies that have been correlated with the syntectonic Baker Lake gabbro (Unit BLg) to the west. Rocks within the Powderhorn Lake tract occur in the core of the regional north-

west-plunging antiform previously discussed and represent the deepest exposed level of the Buchans–Roberts Arm belt in the Dawes Pond map area.

The lower felsic volcanic division (Unit PLv) of the Powderhorn Lake tract mainly consists of crystal-lithic tuff, thin-bedded breccia and altered felsic schist. Recumbently folded and boudinaged quartz veins crosscut schistose size-graded crystal tuffs. Felsic volcanic rocks showing relict primary textures are locally intruded by altered quartz-feldspar porphyry dykes.

Where strongly deformed, regionally metamorphosed and extensively altered, felsic quartz–sericite–pyrite schist displays very coarse andalusite and cordierite porphyroblasts and is commonly seen to be flat-lying. Where Unit PLv is mineralized, compositional layers in metamorphically banded lithic tuff illustrate finely disseminated sphalerite and coarsely recrystallized chalcopyrite. Numerous gossan zones are seen to be developed in a biotite-lineated, platy-foliated felsic breccia that is observed to locally preserve volcanic fragments of a quartz–pyritic rhyolite.

The upper sedimentary division (Unit PLs) of the Powderhorn Lake tract is mainly represented by a coarse, porphyroblastic, thin-bedded, iron-rich pelitic schist. A black graphitic schist, which acts as a good electromagnetic conductor, is closely spatially associated with the ferruginous pelitic schist. Unit PLs also has a subordinate amount of porphyroblast-rich, thin-bedded semipelitic schist interlayered with minor siliceous psammitic schist. More rarely, black-laminated pelite is seen to be interbedded with dark-green-banded argillite and dark-grey cryptocrystalline chert.

Where strongly deformed and regionally metamorphosed, andalusite–garnet–hornblende–biotite pelite is tectonically intercalated with carbonaceous and sulphidic, cordierite-lineated pelitic schist. The latter displays structurally detached boudinaged folds of quartz–biotite–pyrite segregation lites.

Altered metasedimentary strata in Unit PLs illustrate matrix-disseminated pyrite and porphyroblastic pyrite. They are present together in the same beds along with small randomly oriented cordierite porphyroblasts. A sucrose sericite–chlorite schist is observed to be bedded and to host quartz–pyrite stringers having a folded alteration envelope.

REGIONAL STRUCTURAL SECTIONS

Three cross sections have been constructed in an attempt to illustrate the regional structural style of the Buchans–Roberts Arm belt in the eastern part of the Dawes Pond map area (Figure 5). For descriptive purposes, these

are herein called the Great Gull Lake section, the Baker Brook Valley section and the Dawes Pond East section.

The northwest-southeast line of section for the Great Gull Lake cross section is located near the latitude of the past-producing copper mine at Gullbridge (AA' in Figure 4). The geological section across the Baker Brook Valley is located 3 km farther southwest along the tectonic strike and has a section line that is similarly oriented (BB' in Figure 4). The northeast–southwest line of section for the Dawes Pond East cross section is drawn to the north of Powderhorn Lake (Figure 2, CC' in Figure 4). By choosing two section lines in the northeast-trending part of the belt and one section line in the northwest-trending part of the belt, it is possible to show typical geometrical relationships amongst most map units within the Gullbridge, Baker Brook, Burnt Pond and Powderhorn Lake tracts.

The early formed major structures depicted in sections AA', BB' and CC' (and identified in the symbol key for Figure 5) are not primary structures. Moreover, they may not have the same absolute age in every lithotectonic tract. Similarly, late-formed structures shown in section CC' are known to be relatively older than some of the young structural features depicted in sections AA' and BB'.

DAWES POND EAST SECTION

When viewed looking northwestward, regionally metamorphosed schistose and gneissose rocks of the Powderhorn Lake and Burnt Pond tracts are seen to be disposed about a secondary upright antiform (CC' in Figure 5). This structure refolds earlier subrecumbent folds defined by the contact between the lower volcanic and upper sedimentary divisions of the Powderhorn Lake tract. These sub-recumbent folds are also outlined by the bedding-parallel schistosity in rocks of Unit PLv and Unit PLs.

In the overlying thrust sheet carrying the striped schist division of the Burnt Pond tract, moderately inclined, Z-shaped minor folds of the bedding-parallel schistosity are consistent with its position on the southwest limb of the regional antiform (CC' in Figure 5). The basal southwest-dipping thrust of Unit BPss is interpreted to be folded over the hinge zone of the antiform, as the hanging-wall semipelitic schist is observed to dip 15° northwestward immediately north of the section line.

The paragneiss and orthogneiss divisions of the Burnt Pond tract occur on the northeast limb of the antiform, where the gneissosity lies parallel to the moderate northeast dip of the Unit BPP–Unit BPo contact. In section CC', the striped schist division (Unit BPss) does not occur at surface on this fold limb. Instead, the Burnt Pond paragneiss unit lies directly above black graphite-bearing pelitic schist in

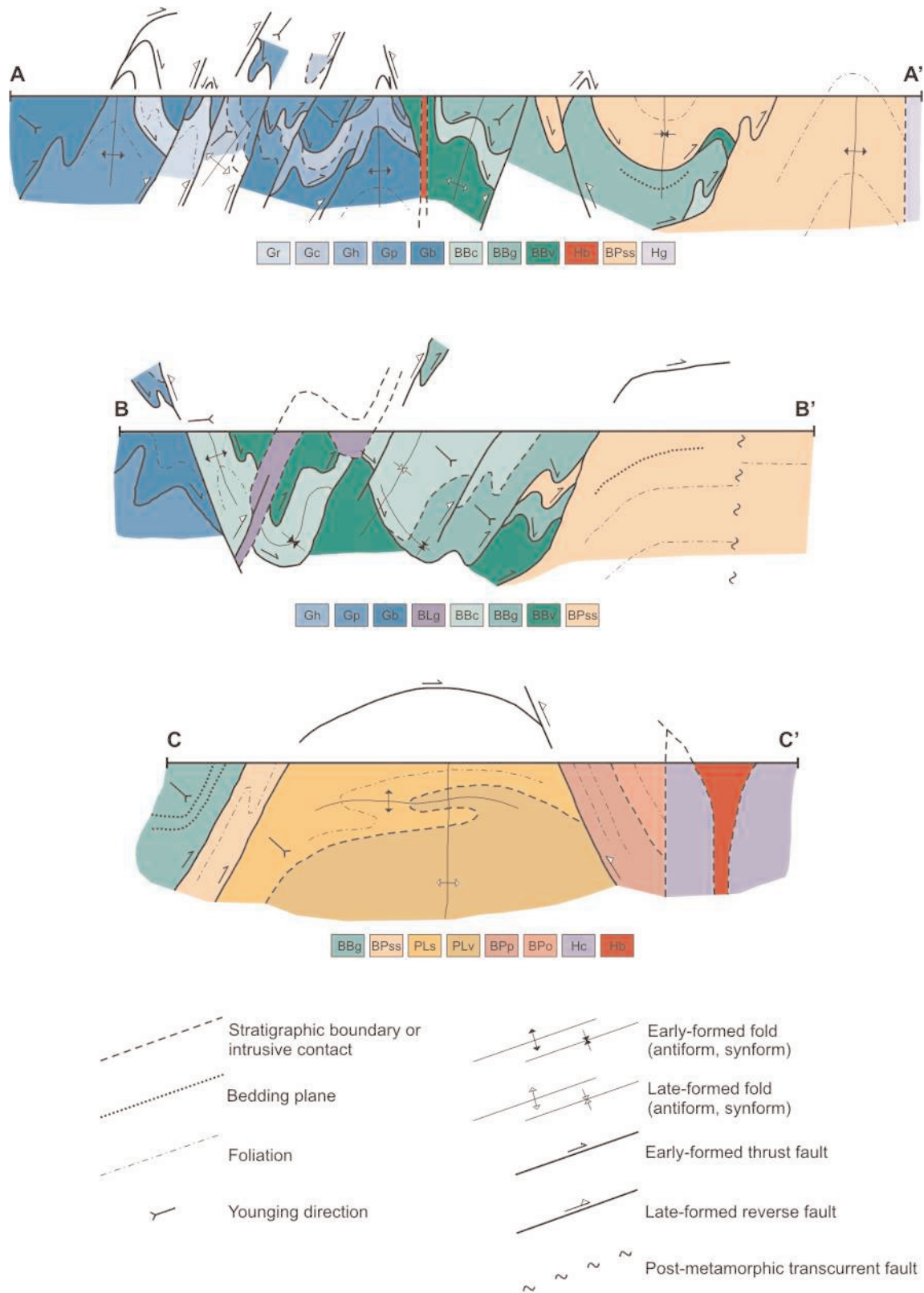


Figure 5. Regional cross sections AA', BB' and CC' illustrating the typical structure of the map units comprising the Gull-bridge, Baker Brook, Burnt Lake and Powderhorn Lake tracts near Great Gull Lake. Vertical scale is exaggerated. Lines of section for AA', BB' and CC' are shown in Figure 4. Lithological units are identified and described in the Legend for Figure 4.

the younger sedimentary division of the Powderhorn Lake tract.

Based on local minor structures, and supported by the work of Pennell (2004), the lower boundary of the straightened migmatitic paragneiss in Unit BPp is thought to be a late-formed northeast-dipping overthrust. This structure, which extends southeastward about 10 km to the outflow of Catamaran Brook, is postulated to have locally displaced the basal thrust of Unit BPss beneath the erosion surface. Alternatively, prior to this event, the striped schist division may have been tectonically excised at the tip of a southwest-dipping thrust wedge, theoretically situated below the paragneiss division and above the footwall sequence of the Powderhorn Lake tract.

BAKER BROOK VALLEY SECTION

In the southeastern part of section BB', the striped schist division of the Burnt Pond tract is exposed in the hinge zone of the aforementioned regional antiform (Figure 5). The open folds of the bedding-parallel schistosity, illustrated in BB', belong to a late-formed group of overprinting structures, which trend northeasterly and are seen here in true section. When viewed looking northeastward, the transcurrent fault in the hinge zone of the antiform is interpreted to down drop the striped schist division toward the northwest. It also dextrally offsets the intrusive contact of the Burnt Pond Brook granodiorite with Unit BPss of the Burnt Pond tract (Figure 4).

These late-formed, northeast-trending folds increase their amplitude and decrease their wavelength toward the northwest and, as shown in section BB', they commonly vary in inclination from upright to southeasterly overturned. Such fold structures deform the major thrust fault at the upper boundary of Unit BPss (Figure 4) and are responsible for the change in its orientation from the overall southwest dip, observed east of Dawes Pond to the northwest dip seen in section BB' in the Baker Brook Valley. Smaller imbricate slices of Unit BPss within the immediate hanging-wall sequence of the Baker Brook tract (Figure 5) are similarly affected. Here, however, the overfolding results in the early formed thrust sheets displaying both northwestward and southeastward dip directions.

In the vicinity of section line BB', the fault-bounded Baker Brook tract is exposed in a regional structural basin (a large W-shaped synclinorium) situated between the Gullbridge tract and the Burnt Pond tract (Figure 5). A major synform–antiform pair in the central and eastern part of the Baker Brook tract is responsible for the disposition of most map units. The sedimentary divisions of the Baker Brook tract mainly occur in the synform and the structurally under-

lying volcanic division crops out at surface within the antiform.

The secondary S-shaped fold outlined by the gently southwest-plunging Baker Lake gabbro (Unit BLg in Figure 4) is consistent with the fold vergence of the above synform–antiform pair. It opposes, however, the dextral vergence of most earlier formed mesoscopic folds in the Baker Brook tract. This syntectonic gabbroic intrusion is emplaced into northwest- and southeast-dipping thrust sheets carrying Unit BBv and Unit BBg strata and, in doing so, it crosscuts several early formed thrusts and associated fold nappes (Figure 5). The two sedimentary divisions of the Baker Brook tract contain a synformal nappe lying above their thrust-faulted contact with underlying massive volcanic rocks. Immediately east of Baker Brook, a sub-recumbent northeasterly overturned major fold defined by the bedding-parallel schistosity in Unit BBg and Unit BBc is seen to be refolded by northeast-trending inclined folds (Figure 4), most of which are overturned toward the southeast (Figure 5).

In section BB', northwest-dipping, high-angle reverse faults are shown to displace regionally fault-imbricated or stratigraphically inverted parts of several map units within the Baker Brook tract. Yet, large parts of the stratigraphical succession remain northwest-younging and right-side-up (Figure 5; *see also* Pope *et al.*, 1990; Pudifin, 1993). However, near the northwest margin of the Baker Brook tract, a northwesterly overturned tight antiform occurs within Unit BBc immediately above a southeast-dipping back thrust. This antivergent secondary structure defines the unit's tectonic boundary with the underlying rocks of the Gullbridge tract (Figure 5). The presence of both northwest- and southeast-dipping thrust sheets in the Gullbridge footwall sequence is an important consideration when choosing the azimuth of exploration drillholes.

GREAT GULL LAKE SECTION

An approximately 5-km-long cross section has been constructed across the northwest and southeast sides of Great Gull Lake (AA' in Figure 5). It depicts the structural relationships of Gullbridge tract rocks to the rest of those in the Buchans–Roberts Arm belt at a surface location where the Baker Brook tract is narrowest and the Burnt Pond tract is widest (Figure 4). This section also illustrates the regional disposition of the map units that comprise the Gullbridge tract near the past-producing Gullbridge mine.

Burnt Pond and Baker Brook Tracts

The gently northeast-plunging antiform depicted in the striped schist division of the Burnt Pond tract in the southeast end of section line AA' (Figure 5) has a strong aero-

magnetic expression but is very poorly exposed. Crudely defined by the varying dip direction of the bedding-parallel schistosity, this late-formed, open to close, generally upright structure might belong to the regional northeast-trending group of folds. Alternatively, it could be the same antiform displayed in section CC', albeit locally reorientated from its northwest trend and possibly tightened by further shortening. Regardless, the antiform contains the structurally lowest tectonic panel of the Burnt Pond tract in the Great Gull Lake section. Here, and at Burnt Pond, it may expose some of the younger parts of the Unit BPss sequence.

The upper part of the northwesterly adjacent thrust sheet in section AA' carries an early formed tectonic slice of the Burnt Pond tract measuring about 5 km² in outcrop area (Figure 4). Significantly, it lies above the northwest-dipping thrust fault located at the top of the Unit BPss sequence within the core of the regional antiform (Figure 5). Near the eastern shore of Great Gull Lake, form line mapping of the bedding-parallel schistosity in the striped schist division outlines a doubly plunging, upright synclinorium (Figure 4). Based on the overall trend of the synclinorium, it is probable that the rocks in this slice formed part of an originally southwest-dipping thrust sheet.

In the southern part of this particular Burnt Pond slice, a large southeasterly overturned synform overprints part of the northwest-trending synclinorium. To the west and north, the flanks of the early formed fold structure are offset by northwest-dipping and southeast-dipping faults, respectively (Figure 4). Consequently, the bedding-parallel schistosity of Unit BPss is presently observed to be mostly southeast-dipping in section AA' in the northwestern part of the map unit and mainly inclined in the opposite direction toward the southeastern boundary of the thrust sheet (Figure 5). As opposed to the main part of the Burnt Pond tract, this 5 km² belt of striped schist structurally overlies the Baker Brook tract.

The lower sedimentary division of the Baker Brook tract makes up most of the folded wedge-shaped thrust sheet lying below the Burnt Pond tract. However, at the southeast margin of the Baker Brook tract, the basal thrust is overlain by a relatively tightly folded assemblage of small, structurally detached thrust sheets in which parts of all of the constituent divisions are present (Figure 5). Together with the sole thrust, these early formed imbricate faults are folded by several northeast-trending structures, including the overturned synform mentioned above. In section AA', the lower sedimentary division of the Baker Brook tract is also shown to be displaced by discrete northwest- and southeast-dipping reverse faults, much like those developed in the tectonically overlying slice of the striped schist division.

Farther northwest along section line AA', the older sedimentary division of the Baker Brook tract (Unit BBg) is thought to structurally overlie the younger sedimentary division (Unit BBc) in a stack of generally southeast-dipping thrust sheets (Figure 5). The underlying Baker Brook volcanic division (Unit BBv) is postulated to be bounded by a folded southeast-dipping, early formed thrust fault along its upper contact and by a southeast-dipping, high-angle reverse fault along its lower contact. The lower structural boundary of Unit BBv is an along-strike continuation of the late-formed back thrust illustrated in section BB' at the top of the Gullbridge tract (Figure 5).

A northeast-trending satellite body of granodiorite from the Hodges Hill Intrusive Suite is emplaced into Unit BBv mafic volcanic rocks along the eastern shore of Great Gull Lake (Dickson, 2001; Unit Hb in Figure 4). This subvertical isotropic intrusion has randomly oriented xenoliths of schistose basalt and displays partially digested enclaves of mafic mylonite. It is thus possible that the plutonic rocks in Unit Hb may have ascended along the Baker Brook–Gullbridge boundary and crosscut the southeast-dipping back thrust at depth (Figure 5).

As illustrated in the central part of cross section AA', the regionally northeast-striking set of bivergent reverse faults are closely spaced in the narrowest exposed part of the Baker Brook tract. The vergence of the southeasterly overturned folds that deform the tripartite thrust stack are consistent with the presence of a regional structural basin to the southeast. The inclination of said folds is compatible with the northwest dip of the southeasterly adjacent, high-angle reverse fault. Such late-formed faults are, therefore, deemed to have been broadly consanguineous with the development of the northeast-trending group of upright to asymmetrical folds.

Gullbridge Tract

The dominant stratified rocks of the Gullbridge tract make up the northwestern half of the Buchans–Roberts Arm belt in cross section AA' (Figure 5). In the area surveyed, this tract contains two antiformal thrust stacks separated by the complexly faulted limb and hinge zone of an intervening synform.

One of these originally northwest-trending antiforms is located west of the former base-metal mine at Gullbridge. Culminating to form a doubly plunging ellipsoidal fold (Figure 4), this structure was subsequently tightly refolded about northeast-trending fold axes. As such, the domal antiform creates a tectonic window through the structurally highest

unit of mafic volcanic rocks in the Gullbridge tract (Unit Gb in Figure 4). A major thrust fault and mylonite zone located at the base of this thrust sheet is crosscut by an isotropic granodiorite within Unit Ts; whereas, the hanging-wall sequence of basalt and andesite is probably separated from Unit Cc strata by a sub-Carboniferous angular unconformity.

When viewed in cross section AA', and placed in its regional context, the previously described northwest-dipping thrust fault is tightly folded and thus dips southeastward near the end of the section line. The structural footwall sequence of this early formed fault is exposed in the core of the antiform and is represented by Unit Gp bimodal pyroclastic strata. An upside-down sequence of Unit Gr rhyolite breccia and graded lapilli tuff occur in the immediate hanging-wall plate. These rocks are structurally capped by a southeast-dipping imbricate slice of Unit Gb basalt that resides higher in the hanging-wall plate (Figure 5).

The other antiformal thrust stack found in the Gullbridge tract is best exposed near Lower Gull Pond, where it is tightly refolded about northeast-trending fold axes and displaced by northwest- and southeast-dipping, high-angle reverse faults (Figure 4). This regional structural feature is also partially displayed west of the outflow of Baker Brook and on islands in Great Gull Lake. Situated immediately beneath the Baker Brook tract, the carapace of this structural dome is composed of alternating right-side-up and inverted successions of Unit Gh basalt and Unit Gc argillite overlain, in places, by Unit Gp bimodal pyroclastic strata. In the northeast corner of Great Gull Lake, where the intervening Gh-Gc sequence is completely tectonically excised, Unit Gp locally forms the basal map unit of the hanging-wall plate (Figure 4). The antiform creates a tectonic window into a structurally underlying fault-bounded sequence of regionally altered basalts. Lacking petrochemical data, these mafic volcanic rocks have been provisionally assigned to Unit Gb (Figure 4).

In the middle part of section AA', near the southeastern boundary of the Gullbridge tract, a mainly right-side-up pillowed basalt sequence (Unit Gb; the Burnt Island basalt of Swinden and Sacks, 1996) occurs on the northwest flank of the antiform in question and lies above a folded thrust fault (Figure 5). The lowest imbricate slice of basalt depicted in the core of this antiform sits in a similar structural position as the altered basalt in the core of the dome at Lower Gull Pond. On islands southeast of Gullbridge, the thrust sheet carrying the structurally highest basalt is seen to be tectonically underlain by an upside-down sequence of bimodal pyroclastic strata. In contrast, the thrust sheet that contains the structurally lowest basalt is tectonically overlain by a right-side-up sequence of hematized basalt succeeded by

maroon argillite, red chert and volcanoclastic wacke (Figure 5). In this way, Unit Gp comes in direct structural contact with Unit Gh along section line AA'. On a regional scale, they occur within a ductile imbricate fault zone sandwiched between openly folded tectonic panels of massive volcanic rocks.

Volcanosedimentary strata that crop out in the ground separating the two antiformal thrust stacks are well exposed near the former Gullbridge mine (Figure 4). This part of the Gullbridge tract has been previously described in much greater detail by Pope *et al.* (1990) and Pudifin (1993). In the general vicinity of Gullbridge, the regional deformation is inhomogeneous and partitioned into low-strain and high-strain belts. The northeast-trending major folds are variably plunging and separated by narrow zones of mylonite or very platy strata. Attendant minor folds commonly possess a strong dip-lineated, northwesterly inclined, axial-planar crenulation cleavage.

The dominant S- and W-shaped folds are mainly southeasterly overturned and the intervening high-angle reverse faults dip toward the northwest (Figure 5). Such close to isoclinal folds overprint right-side-up and inverted stratigraphical sequences preserved within the numerous thrust sheets of this region. For the most part, these southeast- and northwest-dipping imbricate fault slices contain well-stratified rocks. Parts of Unit Gp, Unit Gr, Unit Gh and Unit Gc are observed to be structurally repeated to the northwest and southeast of the former Gullbridge mine.

CONCLUSIONS

The various lithotectonic tracts may contain strata that are simply lithofacies variants of each other and represent rocks that originally formed within different paleogeographic regions of a volcanic island arc. Alternatively, these tracts might include strata that were deposited at different stages of the Ordovician and accumulated in several, tectonically unrelated, magmatic arc complexes. Two logical choices for the position of the Red Indian Line are the structural base of the Baker Brook tract or the structural top of the Powderhorn Lake tract. The origin of rocks in the Burnt Pond tract remains enigmatic.

ACKNOWLEDGMENTS

Jeremy Squires is thanked for his geological assistance with this regional bedrock-mapping project during the summer of 2006. Terry Sears of the Geological Survey's Cartographic Unit prepared digital versions of the maps and line diagrams. Logistical support of the field operation by Gerry

Hickey is gratefully acknowledged. The manuscript was scientifically reviewed by Lawson Dickson.

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