GEOLOGY OF THE WHITE BEAR RIVER MAP AREA (11P/14), SOUTHERN NEWFOUNDLAND

by

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Abstract

The White Bear River map area is situated along the northernmost part of the Hermitage Flexure of the Newfoundland Appalachians, and has components characteristic of both the Dunnage and Gander Zones of the orogen. The area's salient geological elements include a suite of ophiolitic meta-igneous rocks, with an apparently overlying metasedimentary and metavolcanic succession of presumed Ordovician age, and a post-Ordovician suite of syn-kinematic and late kinematic biotite granites. The stratified rocks comprise the Bay du Nord and La Poile Groups and the granitoid rocks comprise parts of the North Bay Granite and the Burgeo batholith. Younger muscovite-bearing granitoids include the Cochrane Pond granite, which intrudes the Bay du Nord Group and contains uranium, molybdenum and tungsten mineralization. The area was affected by regional post-Ordovician deformation accompanied by mid-greenschist to upper amphibolite facies metamorphism.

Introduction

The White Bear River map area (Figure 1), bounded by north latitudes 47°45' and 48°00' and west longitudes 57°00' and 57°30', is centered approximately 45 km east of the community of Burgeo, in southwestern Newfoundland. Although portions of the southern part of the area can be reached from White Bear Bay, the remainder is readily accessible only by air.

The area was extensively glaciated during the Late Wisconsinian, and evidence of this glaciation is widespread. Much of the area underlain by the Burgeo Batholith is characterized by an irregular, rugged topography with many roches moutonnees. With the exception of the resistant ophiolitic ridges near Top Pond, much of the remainder of the area forms a rolling peneplain broken by several prominent roches moutonnees.

Previous geological surveys in the area include the 1:250,000 scale mapping of Riley (1959), the reconnaissance mapping and compilation of Smyth (1979) and unpublished mapping carried out in conjunction with the exploration programs of Buchans Mining Co. (Scott and Conn, 1950) and Falconbridge Nickel Co. (Barry, 1980).

General Geology

The White Bear River area lies on the northern reentrant of the Hermitage Flexure (Williams et al., 1970) and contains geological elements of the Gander and Dunnage Zones (Williams, 1976) of the Newfoundland Appalachians. The northern segment of the area is underlain mainly by an east to east-southeast trending belt of polydeformed metasedimentary, metavolcanic and ophiolitic meta-igneous rocks, which is continuous westward with, and in part correlative to, the Ordovician La Poile and Bay du Nord Groups (Cooper, 1954; Chorlton, 1980; O'Brien, 1983). These rocks are also considered to be in part correlative with the Baie d'Espoir Group (Jewell, 1939; Colman-Sadd, 1976) to the east. The Bay du Nord and La Poile Groups in the White Bear River area, together with underlying ophiolitic rocks, are intruded in the south by syn- to late tectonic granitoids of the Burgeo batholith (Williams, 1978; O'Brien, 1983). The Bay du Nord Group is also intruded by the North Bay Granite in the northeast and by several smaller syn- to late tectonic granites that are geographically separate from the larger plutons and confined to the volcano-sedimentary belt.

Although the absolute ages of rocks in the White Bear River map area are unknown, limited isotopic data is available for some equivalent units elsewhere in southern and south-central Newfoundland. The Bay du Nord Group to the southwest has been dated isotopically at 449 ± 20 Ma (U/Pb zircon, reported in Chorlton, 1980). In the same area, the La Poile Group has been dated at 459 ± 18 Ma (Rb/Sr isochron, reported in Chorlton, 1980). Ophiolitic rocks of the Annieopsquotch Complex, possible equivalents of ophiolitic rocks in the White Bear River area, have been dated isotopically at 477 +1.3,-1.0 Ma and 481 +4.0,-1.9 Ma (U-Pb zircon) (Dunning and Krogh, 1983). The only fossil control in equivalent units elsewhere is in the Baie d'Espoir Group which contains Middle Ordovician fossils (Baird et al., 1951; Colman-Sadd, 1976).

Unit 1

The inferred base of the stratigraphic succession within the map area is an assemblage of gabbro, pyroxenite, diabase and

peridotite (Unit 1), here interpreted to be of ophiolitic origin. These rocks are exposed in an elongate, 15 km^2 roof pendant in the Burgeo batholith southeast of Top Pond. The unit, disrupted by faults, consists of peridotite, pyroxenite and gabbro in the southeast, succeeded to the northwest by massive and layered gabbro and pyroxenite, and further northwestward by layered gabbro cut by rare diabase dikes. The dominant rock type of the unit is layered to locally massive, dark gray and green, medium grained equigranular gabbro. The nature of the layering within the gabbro is variable. Cumulate layering may be either coarse (ca. 10 cm), fine (1 to 10 mm), well developed or ill-defined. Locally, the layering was remobilized during metamorphism and in places the gabbros were cut by plagioclase veins and sweats. Medium to coarse grained pyroxenite occurs in association with the gabbros. The pyroxenite may occur either in separate exposures or together with gabbro; however, no clear contact relations were discernible. Brown weathering, dark green to black peridotite is in fault contact with massive gabbro to the southeast. The peridotite has either tectonic or igneous banding and is serpentinized. Fine grained diabase is rare and occurs as narrow dikes intruded parallel to the layering in gabbro (Plate 1).

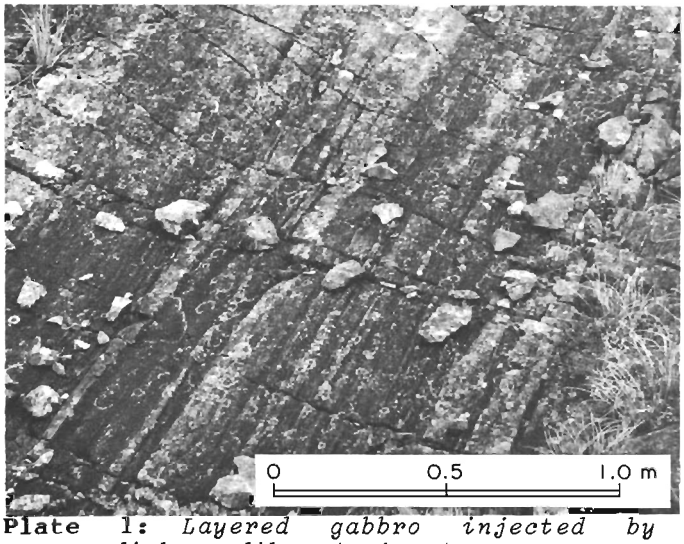

Plate 1: *Layered gabbro injected by narrow diabase dikes (Unit 1).*

BAY DU NORD GROUP (UNITS 2-6)

The name Bay du Nord Group was originally used by Dorf and Cooper (1943) and subsequently by Cooper (1954) to designate a succession of predominantly metasedimentary rocks exposed in two belts in La Poile and Garia Bays of southwestern Newfoundland. Included in the group was a sequence of clastic sediments containing Devonian plant fossils (Dorf and Cooper, 1943). Chorlton (1980) redefined the group, separating the fossiliferous succession from the remaining metavolcanics, metasediments, migmatites and amphibolites. O'Brien (1983) extended the group northeastwards, including within it the metavolcanics and metasediments that lay between the Bay d'Est and Gunflap Hills faults in the Peter Snout map area. The volcanic and sedimentary rocks exposed north of the Burgeo batholith in the White Bear River area represent the eastward continuation of the Bay du Nord Group.

In the White Bear River area, the group is tentatively divided into five lithologic units, including a lower succession of mafic and felsic volcanics (Units 2 and 3 respectively) and an upper clastic sedimentary succession of sandstone and conglomerate (Unit 4), black slate, shale and phyllite (Unit 5) and sandstone, siltstone and shale, and their metamorphic equivalents (Unit 6).

Unit 2

Unit 2 is a narrow, and laterally discontinuous, fault-bounded and repeated succession of mafic tuff, mafic tuffaceous siltstone and sandstone, and amphibolite, here tentatively included within the Bay du Nord Group. The unit is intruded by syn- to late tectonic porphyritic granite of the Burgeo batholith and is faulted against the upper metasedimentary sequences of the Bay du Nord Group. Unit 2 is not in contact with ophiolitic rocks of Unit 1 and its relationship with the felsic volcanics of the Bay du Nord Group is enigmatic.

Unit 2 is dominated by tuffaceous volcanic and volcanogenic sedimentary rocks and their metamorphic equivalents. They are either massive or schistose, and banded, laminated or without primary structure. Amphibolitized bands within the laminated tuffs may represent basic dikes or flows; more massive amphibolite is exposed in the northern parts of this unit in White Bear River.

Unit 2 may represent either the distal facies of an early, distinct episode of mafic volcanicity, or a local period of mafic volcanicity that was essentially contemporaneous with the felsic volcanism characteristic of the group.

Unit 3

A variety of massive volcanic and volcaniclastic rocks of felsic composition are included within Unit 3. These rocks are exposed in a discontinuous, folded, east-southeast trending belt that is succeeded

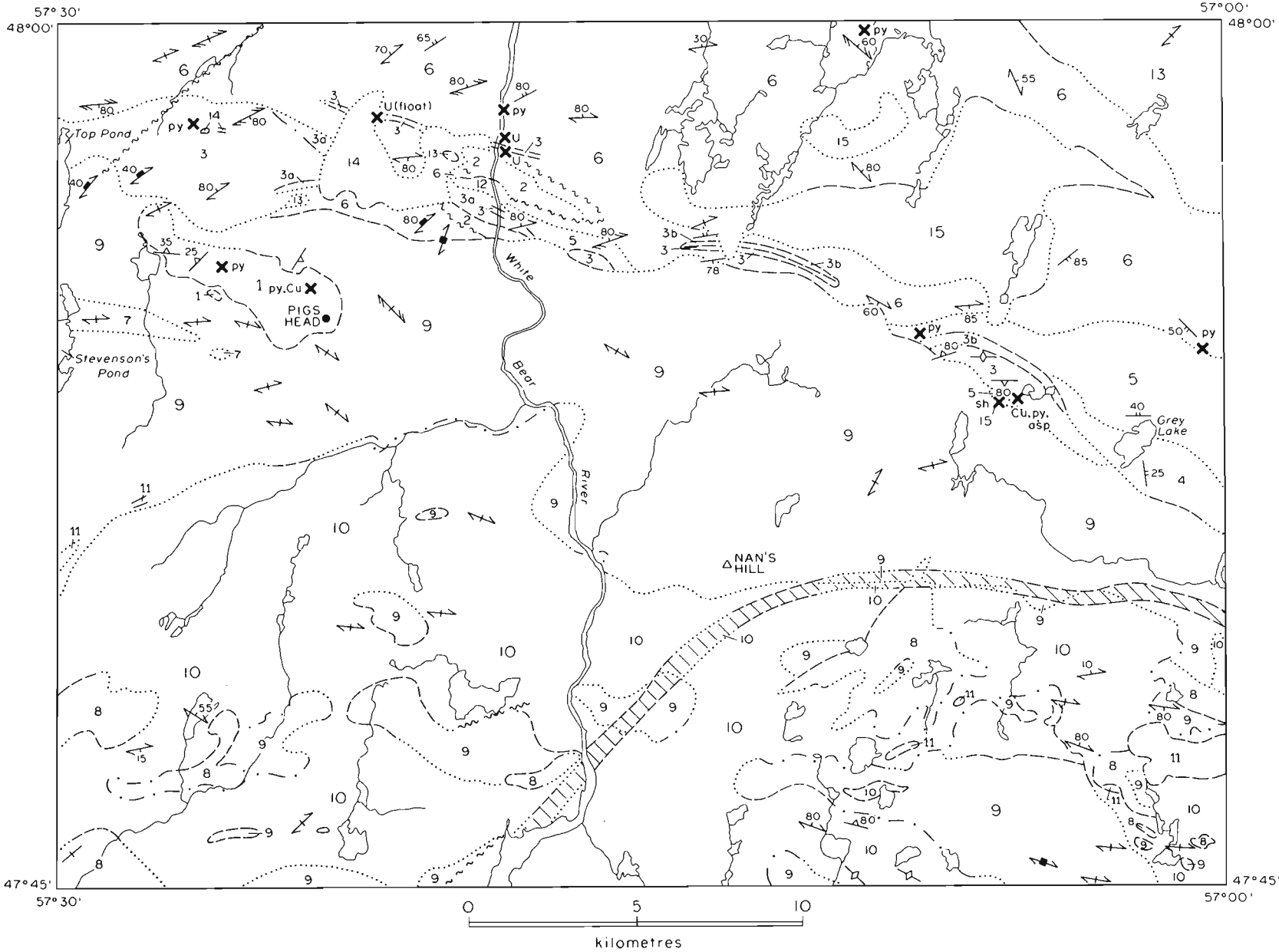

Figure 1: *Geological map of the White Bear River (11P/14) area, Newfoundland.*

LEGEND

DEVONIAN(?) or earlier

15 Fine to medium grained, equigranular muscovite-biotite granite; lepidolite-tourmaline-garnet-bearing aplite; rare porphyritic granite.

14 Pink felsite and fine grained granite; muscovite-tourmaline leucogranite.

North Bay Granite (Unit 13)

13 Coarse grained feldspar porphyritic biotite granite.

12 Fine to medium grained, equigranular to porphyritic granite.

Burgeo Batholith (Units 9-11)

11 Fine to medium grained, pink equigranular biotite granite.

10 Medium grained, mainly equigranular biotite granite.

9 Variably (feldspar) porphyritic, medium to coarse grained, biotite (± rare hornblende) granite and minor adamellite.

ORDOVICIAN(?)

8 Psammite, semipelite, migmatite and associated granitoids.

La Poile Group

7 Gray sandstone.

Ray du Nord Group (Units 2 - 6)

6 Thickly to thinly bedded, gray psammite, semipelite, phyllite, sandstone, siltstone and shale.

5 Black slate, graphitic schist, phyllite and minor semipelite.

4 Medium to coarse grained sandstone and granule to pebble conglomerate; psammite.

3 Rhyolite flows, massive and banded felsic tuff. **3a**, siliceous bedded tuff; **3b**, tuffaceous sediments.

2 Mafic tuff and tuffaceous sediment; amphibolite.

ORDOVICIAN or earlier

1 Massive and layered metagabbro; metadiabase; minor pyroxenite and peridotite.

to the north by the clastic sedimentary facies of the Bay du Nord Group; in the south it is intruded by syn- to late tectonic porphyritic granite of the Burgeo batholith.

The diagnostic rock types of the unit are massive or banded, pink to buff rhyolite flows and ash-flow tuffs. While the flows are characteristically massive in nature, the ash-flow tuffs are either streaky or well banded. Many of the ash flows are rich in quartz crystals and flattened biotite-rich lapilli. Between Top Pond and White Bear River, the rhyolitic flows and ash flows are replaced northwards and eastwards by a laterally equivalent succession of intercalated biotite-rich ash flows, psammite and silicic bedded tuff (subunit 3a). The latter rock type is more extensive east of White Bear River, where it forms a mappable unit (subunit 3b) that overlies massive rhyolite. Coarser grained pyroclastic rocks are atypical of the Bay du Nord Group in this area, occurring in a small roof pendant in the northern part of the Burgeo batholith.

The relationship of Unit 3 to the mafic rocks of Unit 2 is unclear. Unit 3 is not in contact with the ophiolitic rocks of Unit 1, but less than 10 km to the west, in the adjacent Peter Snout map area (11P/13E), conglomerate beds within stratigraphic equivalents of Unit 3 are rich in gabbroic detritus (O'Brien, 1983). If one can assume that this detritus is derived from ophiolitic gabbro of Unit 1, then the existence of these gabbro-boulder conglomerates together with the discovery of ophiolitic rocks in the White Bear River area can be regarded as evidence for the existence of ophiolitic basement to the Bay du Nord Group.

Unit 4

Unit 4 is a succession of sandstone and quartz-rich granule and pebble conglomerate that locally overlies felsic volcanics of Unit 3 on the south limb of a large scale F_2 syncline. The unit pinches out rapidly along strike to the west but outcrops again to the east, where it is folded around the hinge of the same west-plunging structure (Blackwood, *this volume*). Unit 4 is intruded to the south by porphyritic granite of the Burgeo batholith. The diagnostic rock types of the unit are green, siliceous, planar-bedded fine to coarse grained sandstones. Clastic quartz is readily visible in the coarser sandstones, which are interbedded with green, well rounded quartz granule and quartz-pebble conglomerate.

Unit 5

Unit 5 consists mainly of dark blue-gray and black, fine grained clastic sedimentary rocks that overlie volcanic rocks of Unit 3 and locally sedimentary rocks of Unit 4. It is exposed in a southeasterly trending belt east of White Bear River and is in places truncated by porphyritic granite of the Burgeo batholith. The characteristic rock type of the unit is a fine grained, thinly laminated black slate. The slate is typically highly contorted by folding and in many places is pyritic. Associated with the slate are black graphitic schist and phyllite, and thinly bedded black and gray semipelite.

Unit 6

Unit 6 is the most extensive subdivision of the Bay du Nord Group in this area. It is exposed in an arcuate belt up to 10 km wide, bounded to the north and south by the North Bay Granite and the Burgeo batholith, respectively, and also intruded along its length by late tectonic granitoids. Intensive folding precludes a meaningful estimate of the unit's thickness.

The unit's dominant and most typical rock types are variably deformed gray and green sandstone, siltstone and shale, and their metamorphic equivalents, psammite, pelite and phyllite. In the thermal aureole of the Burgeo batholith, Unit 6 clastics were metamorphosed to coarse grained staurolite-garnet schist (see below).

The sediments are characteristically well bedded and occur in planar beds of variable thicknesses, seldom in excess of 15 cm (Plate 2). Cross-stratification is rare; it occurs only in the cross-laminated layers where partial Bouma sequences are preserved. The latter are rarely well preserved; where recognizable, they indicate that much of the unit represents relatively distal turbidite facies. Nevertheless, the tuffaceous nature of some of the sediments, coupled with the presence of intercalated tuff beds indicates that the sedimentation was penecontemporaneous with volcanism.

La Poile Group (Unit 7)

The name La Poile Group was first used by Cooper (1954) to denote those volcanic and sedimentary rocks in the La Poile - Cinq Cerf area, which were exposed between the Bay d'Est Fault and the Chetwynd Granite. The group was later redefined by Chorlton (1978), who extended it towards

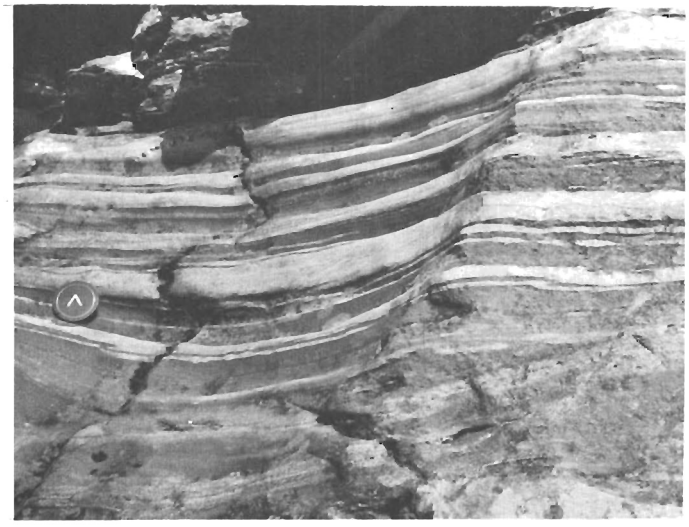

Plate 2: *Bedded sandstones of the Bay du Nord Group (Unit 6).*

the northeast and divided it into a sequence of volcanic and sedimentary rocks (Georges Brook Formation) and a subvolcanic pluton (Roti Granite). The group was extended further northwestwards across the Peter Snout area (O'Brien, 1983), where it is separated from the adjacent Bay du Nord Group by the Bay d'Est fault. The group is continuous eastwards from there into the present map area, where it is truncated by the Burgeo batholith.

Unit 7 forms a narrow, 1 by 5 km band within the Burgeo batholith north and northeast of Stephensons Pond. A smaller pod of partly migmatized metasediment lies less than 1 km east of the main body. The unit consists of fine to medium grained, massive and cross-stratified gray sandstone and cordierite hornfels.

Unit 8

Unit 8 consists of variably migmatized metasedimentary rocks and associated granitoids that occur as large inclusions within the Burgeo batholith. The unit is intruded by all phases of the batholith, but is restricted to its southern part, where it is in many places associated with equigranular granite. The protolith of the metasediments and migmatite is interpreted to be the Bay du Nord Group.

The dominant rock types of the unit are recrystallized psammite, semipelite and pelite. The metasediments are mainly dark gray or dark greenish brown, and are either massive or banded on scales varying from tens of millimetres to tens of centimetres. They have a prominent penetrative schistosity. In places they contain sillimanite, and underwent varying degrees of migmatization. The volume of granitoid within the migmatite varies from a small proportion of quartz, pegmatite and granitoid sweats cutting recrystallized metasediment to 10 to 20 percent metasediment, locally with amphibolite, in a porphyritic or equigranular granitoid host (Plate 3). The granitoids developed a local crude gneissic foliation. Such granitoids are particularly well exposed in the southwestern corner of the map area, in and around Kings Harbour Brook.

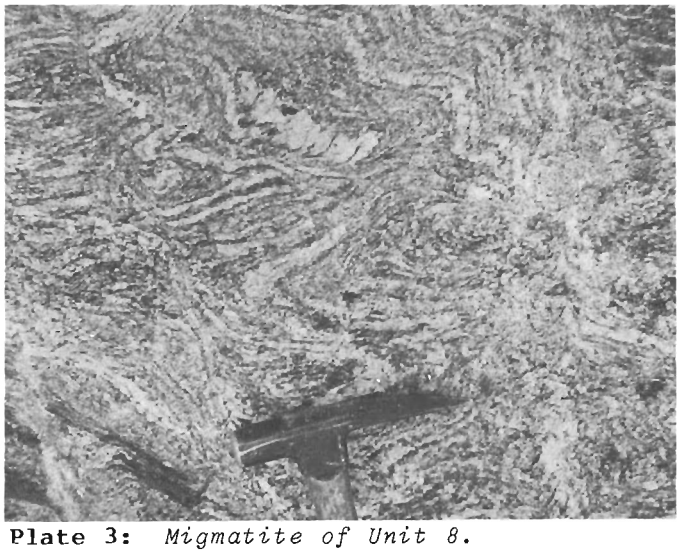

Plate 3: *Migmatite of Unit 8.*

BURGEO BATHOLITH (UNITS 9, 10 and 11)

The name Burgeo batholith is an informal name first used by Williams (1978). O'Brien (1983) retained the name in an informal way to denote the suite of granitoid rocks that intruded the La Poile Group in the southeastern part of the Peter Snout map area. The name is used here, in an informal fashion, to designate the granitoid rocks that lie to the south of, and intrude, the Bay du Nord Group in the White Bear map area. The batholith is tentatively subdivided into three distinctive intrusive phases which are interpreted to have a close genetic interrelationship. The batholith is presently interpreted to have intruded in several pulses throughout the main period of deformation.

Unit 9

Unit 9, the dominantly porphyritic phase of the Burgeo batholith, constitutes the northern part of the batholith and intrudes each of Units 1 to 8. The unit is also present in the south as separate massifs within the dominantly equigranular phase. The characteristic rock type of Unit 9 is medium to coarse grained porphyritic biotite granite. The granite is characterized by 1 to 1.5 cm microcline phenocrysts

that locally constitute 60% of the rock. Biotite is ubiquitous and characteristically chloritized; it locally constitutes up to 15% of the granite. Amphibole is present locally. Plagioclase is extensively saussuritized. Slightly porphyritic granite and rare equigranular granite are intimately associated with the porphyritic phase locally. Where present, these phases are subordinate with respect to the porphyritic phase, and cannot be readily separated from it. In many areas, the unit contains a variety of cognate mafic, biotite-rich, and other amphibolitized xenoliths; these range in area from a few millimetres to several tens of centimetres. Near its contact with the Bay du Nord Group, the granite hosts numerous large migmatized metasedimentary xenoliths. The granite is variably deformed and in places contains two recognizable foliations; in many places the foliation is cataclastic (Plate 4). A strong cataclastic fabric is particularly well developed along the trace of the Dragon Bay Fault (Blackwood, 1983) (see below). The northern contact of Unit 9 with the Bay du Nord Group and ophiolitic rocks is sharp but locally irregular in detail. The contact with the La Poile Group to the south is more gradational.

Plate 4: *Foliated porphyritic biotite granite of the Burgeo batholith.*

Unit 10

Unit 10 consists mainly of equigranular biotite granite (Plate 5). The granite may be either massive or variably foliated and locally displays a pronounced igneous banding. It underlies much of the southern half of the map area, and in places has gradational contacts with adjacent porphyritic granite of Unit 9; locally, the two phases cannot be readily separated. Mineralogically, the granite is characterized by up to 40% K-feldspar, 10 to 20% oligoclase and locally up to 5% biotite. Rare muscovite was noted. Average grain size is variable between 1.0 and 3.0 mm. Subordinate amounts of adamellites are also included in this unit. In the southeastern quadrant of the area, the unit is characterized by variably developed light and dark, biotite-rich and biotite-poor bands which vary in width from several millimetres to several centimetres. The granite contains a variety of mafic to intermediate xenoliths.

Plate 5: *Equigranular biotite granite of the Burgeo batholith.*

Unit 11

Unit 11 represents the latest intrusive activity of the Burgeo batholith in the map area. It forms several smaller plugs and dikes in the southeastern corner and the westernmost parts of the area, south of Stevenson's Pond. It intrudes both porphyritic and equigranular phases of the batholith and also the migmatites of Unit 8. The granite is only weakly foliated, and near Kings Harbour Brook, post-tectonic dikes of similar lithology intrude migmatite and deformed granite. The characteristic rock type of the unit is pale pink to red, fine grained, equigranular granite rich in K-feldspar with minor biotite. Locally the granite contains muscovite.

Unit 12

Unit 12 constitutes several small areas of deformed porphyritic granite that lie north of the Burgeo batholith in the vicinity of the White Bear River. The granites intruded various levels of the Bay du Nord Group syntectonically. It is likely that these granites are related to early Burgeo batholith plutonism. Unit 12 is not

unlike the porphyritic phase of the Burgeo batholith, as it is characterized by strongly deformed, coarse to medium grained, K-feldspar porphyritic biotite granite. The grain size was significantly reduced in areas of high strain.

North Bay Granite (Unit 13)

The name North Bay Granite was introduced by Jewell (1939) in order to designate the granitoids in the North Bay and East Bay areas of the south coast. The name has been retained by later workers who extended the boundaries of the granite northwards and westwards (eg. Dickson and Tomlin, 1982; Blackwood, 1983). The granitic rocks in the northeastern corner of the map area are an extension of the main body of North Bay Granite to the east.

In the White Bear River area, the North Bay Granite is dominantly medium to coarse grained, locally megacrystic biotite granite. The coarser grained varieties are typified by euhedral K-feldspar phenocrysts up to 12 cm in length. The granite is characteristically massive but locally does develop northwest trending narrow (<1 cm) shear zones. The North Bay Granite was intruded into Unit 6 of the Bay du Nord Group after the first main period of deformation.

Unit 14

Unit 14 is a poorly exposed granite pluton that is intrusive into volcanic and sedimentary rocks of the Bay du Nord Group and earlier granites of Unit 13. At least three rock types are included within the pluton: pink felsite, pink microgranite or aplite, and fine grained leucogranite. The felsite is an essentially structureless aphyric rock, locally containing small inclusions of Bay du Nord Group metasediments. The microgranite in places has a strong foliation and may be gradational into the fine grained leucogranite phase. The latter is deformed, contains muscovite, tourmaline and rare biotite, and is locally quartz porphyritic. Most of the area designated as this unit in the map area is drift-covered, and may thus include earlier granitoids.

Unit 15

Unit 15, informally referred to by explorationists as the Cochrane Pond granite, is the youngest plutonic rock in the area. The granite is late tectonic and is intrusive into metasediments of the Bay du Nord Group in the northeast quadrant of the map area. The most characteristic rock type of the granite is a quartz-rich, leucocratic, fine to medium grained, equigranular, muscovite-biotite granitoid. The granitoid is either undeformed or locally weakly foliated, and in places is extensively sericitized and/or saussuritized. The granite is cut locally by tourmaline-bearing quartz-rich pegmatite dikes. Associated with the leucogranitoid phase are dikes of lepidolite-tourmaline-garnet-bearing aplite. Locally, the equigranular phase is associated with slightly porphyritic granitoid. Unit 15 bears lithologic similarities to granites of Unit 14 and it is likely that both plutons are genetically closely related.

Structure and Metamorphism

All rocks within the map area display the variable effects of a medium to high grade regional, post-Ordovician tectonothermal event. Deformations associated with this event produced two regional foliations, first and second generation folds, and major faults and related mylonite zones. The regional metamorphism, associated with the first and main deformational episode, appears to have occurred under mid-greenschist to upper amphibolite facies conditions.

The first regional tectonic fabric (S_1) is recognizable, albeit variably developed, in all but the youngest plutonic rocks within the area. In the gabbros and affiliated rocks of Unit 1, it is well developed, although not everywhere is it penetrative. Where penetrative, however, the fabric can be shown to be approximately parallel to crude metamorphic banding in the gabbro. S_1 is pervasive throughout all units of the Bay du Nord Group. The tuffaceous metavolcanic and metasediment exposures of Unit 2 are characterized by a strong, closely spaced penetrative foliation. Likewise, the finer grained felsic tuffaceous deposits of Unit 3 are characterized by a penetrative fabric, defined by biotite and/or muscovite. The aphyric rhyolite flows, because of their more resistant nature, rarely display macroscopic flattening. However, in the coarser grained porphyritic flows, tails are developed on the feldspar phenocrysts. The clastic sedimentary facies of the group, particularly Units 4 and 5, are characterized by an essentially ubiquitous fine, penetrative foliation that is usually coplanar to bedding and that, in rare exposures, can be shown to be axial planar to F_1 isoclinal folds. The intensity of the fabric within the clastic facies of the group is variable and appears to increase generally with proximity to the Burgeo batholith. In the northern parts of the area, the first fabric is developed axial planar to upward facing folds that are overturned to the south.

The granitoid rocks within the Burgeo batholith are variably affected by a regional foliation that is, in a regional sense, parallel to or concordant with the S_1 regional foliation in the Bay du Nord Group. Within the granitoids, this fabric varies markedly in intensity. This is at least in part due to the apparent synkinematic nature of the batholith. In several areas, penetratively deformed granitoid phases were intruded by less intensely deformed granitoids of the same phase. In the adjacent Dolland Brook area, the synkinematic nature of this granite can be clearly demonstrated (see Blackwood, *this volume);* there, the granite both intrudes D_1 mylonite zones and is cataclastically deformed by the same D_1 structures.

In the northern contact zone of the Burgeo batholith, dikes of granite show variable relations with respect to the main foliation in Bay du Nord Group country rock. Typically, the granitoid contains a fabric parallel to that in the country rocks but less penetrative. In places the fabric, both in the granite dikes and the sediment, is overprinted by a S_2 crenulation cleavage. In the southeastern quadrant of the map area, coincident locally with the contact of Units 9 and 10, intense cataclastic fabrics are well developed within the batholith. Locally, the regional fabric can be traced into a mylonite zone with a narrow (<1 km) transition from foliated biotite granite, through protomylonite to ultramylonite; the latter is in places cut by pseudotachylite veins. This major D_1 mylonite zone may represent the westward extension of the Dragon Bay fault (Blackwood, 1983). The mylonite zone trends east-west for a distance of some 15 km, there trends west-southwest and southwest and continues towards the southern part of the area, where it may be sited along White Bear Bay. Another zone of extensive cataclastic deformation is developed in Unit 9 of the batholith immediately east of Top Pond. There, poor exposure precludes delineation of the mylonite zone to the northeast and much of the area along strike of the zone is underlain by Bay du Nord Group clastic rocks, in which cataclastic fabrics would unlikely be developed. This mylonite may form the northeastern extension of the Bay d'Est fault (Cooper, 1954; Chorlton, 1980; O'Brien, 1983). Narrower, less extensive northeast trending mylonites are exposed in the northern parts of the batholith between Top Pond and White Bear Bay.

The second foliation is also developed in the North Bay Granite. The fabric there is generally not as intense as that developed in the Burgeo batholith; nevertheless, narrow (<1 cm) northwest trending cataclastic zones, possibly related to syn-F_2 faulting, were noted in the northeasternmost part of the area.

The second deformation produced a regionally developed fabric (S_2) that varies from a weak crenulation through strain-slip cleavage to a strong composite foliation with transposition of the earlier fabric (S_1) (Plate 6). The strong second regional foliation is most readily identifiable, and presumably preferentially developed in the clastic facies of the Bay du Nord Group where it is axial planar to small scale, upright F_2 folds. Nevertheless, a second coarse strain-slip cleavage locally overprints the earlier fabric in Units 1, 2 and 3 and also in Unit 9 of the Burgeo batholith. Large scale F_2 structures are not definable in the map area. A large scale F_2 syncline, outlined by a felsic volcanic band in Bay du Nord Group, has been mapped in the adjacent Dolland Brook area (Blackwood, *this volume).* Presumably, Units 3, 4 and 5 in the easternmost part of the White Bear River area lie on the southern limb of this structure.

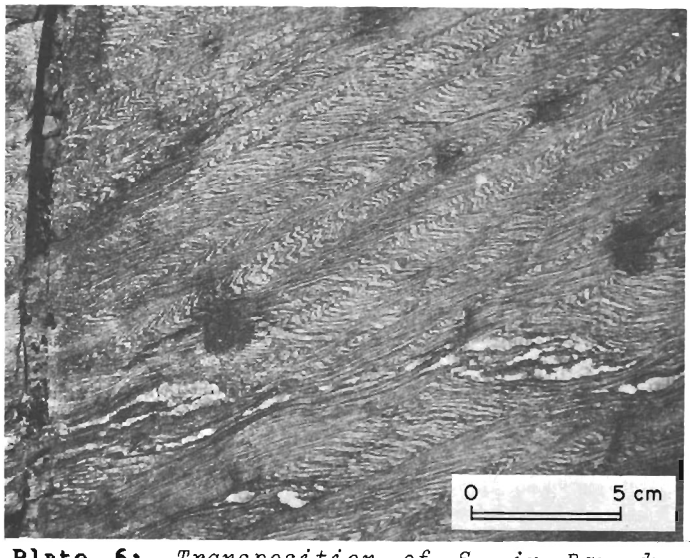

Plate 6: *Transposition of S_1 in Bay du Nord Group metasediment.*

In the southwest corner of the area, dikes of Unit 11 are intrusive into deformed porphyritic granite (Unit 9), truncating the first fabric in the granite. The dikes themselves locally have a weak fracture cleavage developed. Similar rocks in the southeastern quadrant of the area constitute the least deformed phase of the Burgeo batholith. Units 14 and 15 are the least deformed and also the youngest granitoids in the area, the latter containing only a single, weak, locally developed S_2 fabric.

Regional metamorphism accompanied the first main episode of deformation. Within the Bay du Nord Group it varies in grade from mid- to upper greenschist facies in the northern parts of the Bay du Nord belt to upper amphibolite facies adjacent to and within the Burgeo batholith. A progressive increase in grade from sandstone and phyllite in the north to porphyroblastic garnet-muscovite-biotite schist in the south is evident. Highest grade rocks are the migmatites (Unit 8) within the Burgeo batholith; it is probable that these rocks represent the higher grade metamorphic equivalents of the Bay du Nord Group to the north.

Mineralization and Exploration Potential

Mineralization of varying significance is found within Units 1, 3, 5, 6, 14 and 15. Mineralization within the ophiolitic rocks and overlying Bay du Nord Group includes pyrite, chalcopyrite and arsenopyrite; granitoid-related mineralization includes scheelite, molybdenite and uranium.

The layered and massive gabbros of Unit 1 are host to at least two minor base metal occurrences. Both are areally insignificant and consist mainly of pyrite occurring along fractures within the gabbro. A small showing north of Pigs Head contains minor malachite; arsenopyrite was reported from the same area (Scott and Conn, 1950).

Volcanic rocks of the Bay du Nord Group are host to a significant sulfide occurrence near Grey Lake, in the west-central part of the map area. There, altered massive rhyolite of Unit 3 contains disseminated chalcopyrite, pyrite and arsenopyrite. Rhyolite tuff approximately 500 m north of the above occurrence also contains traces of pyrite. These showings are significant in that they occur at the same stratigraphic level as the Strickland massive sulfide deposit to the southwest (Swinden, 1981), namely, within the uppermost part of the Bay du Nord volcanic succession, immediately below graphitic pelites and slates. Unit 3 also contains very minor pyrite occurrences along strike in White Bear River and northeast of Top Pond.

The Bay du Nord Group sedimentary rocks, especially the slates and pelitic schists of Unit 5, contain minor pyrite occurrences. Small pyrite occurrences have also been found in Unit 6 in the northern parts of the area. Pyrite, in association with scheelite and arsenopyrite, has been reported in quartz veins in sediments from the northern parts of the area (Scott and Conn, 1950; *see* Smyth, 1979).

The most significant mineralization in the map area is associated with the late tectonic granitoids that intrude the Bay du Nord volcano-sedimentary belt, namely Units 14 and 15. These units contain muscovite-biotite leucogranitoids and muscovite-tourmaline-garnet-bearing aplitic phases, and are anomalously radioactive with variable backgrounds of 200 to 400 c.p.s. (total counts, BGS-1 SCINTREX scintillometer).

Unit 15 has long been known to host significant scheelite showings and float in the vicinity of Cochrane Pond (Scott and Conn, 1950; Smyth, 1979). Other smaller fracture coatings of scheelite have been found in a dike or small plug of similar granitoid almost 2 km south of the main pluton about 3 km northwest of Grey Lake (Figure 1).

Three new uranium showings were discovered during the course of this mapping program. The showings occur in Bay du Nord Group volcanic and sedimentary rocks; two of the showings are areally associated with muscovite-garnet leucocratic aplite dikes and quartz veins presumably related to either Unit 14 or 15. One showing consists of several large ($\leq$ 10 to 20 kg) tabular radioactive boulders interpreted to be subcrop of Unit 3 biotite-rich metatuff. These boulders yield readings in excess of 10,000 c.p.s. (total counts, BGS-1) and have yellow uranophane staining; background radioactivity in rocks of similar lithology along strike to the west gives about 150 c.p.s. (total counts, BGS-1). Two other showings, several tens of metres distant from each other, occur in metavolcanic and metasedimentary rocks respectively. These showings lie approximately 3 km along strike to the east of the above radioactive subcrop. The sediment-hosted mineralization consists of radioactive, quartz-veined, staurolite porphyroblastic semi-pelitic schist (Unit 6) containing tuffaceous volcanic interbeds; total counts of 6,000 c.p.s. (BGS-1) were recorded at this showing. A third radioactive zone of approximately 2000 c.p.s (BGS-1) occurs within a felsic tuff layer of the metasediments.

In summary, the greatest potential for discovery of economic mineralization lies in the granitoid rocks of Units 13, 14 and 15. All should be treated as having high potential Sn-W-U mineralization. The earlier plutonic rocks of the Burgeo batholith also have anomalously radioactive areas of 3 to 4 times background and should not be overlooked in assessing the exploration potential of the area. The greatest potential for base metal mineralization lies within the upper levels of the volcanic part of the Bay du Nord Group.

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References

Note: Unpublished reports in the Mineral Development Division files are followed by file numbers in square brackets.

Baird, D.M., Scott, H.S., Moore, J.C.B. and Walker, W.
1951: Reconnaissance geology of east-central Newfoundland between Sir Charles Hamilton Sound and Baie d'Espoir. Photographic Survey Corporation Limited, unpublished report, 155 pages. [Nfld (73)]

Barry, J.M.
1980: Assessment report on the geological, geochemical and geophysical surveys performed during 1979 in the Cochrane Pond area on the south coast of Newfoundland. Falconbridge Nickel Co., unpublished confidential report. [11P/14 (67)]

Blackwood, R.F.
1983: Geology of the Facheux Bay (11P/9) map area, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 26-40.

1984 *(this volume)*: Geology of the west half of the Dolland Brook map area (11P/15), southern Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-1.

Chorlton, L.B.
1978: The geology of the La Poile map area (11O/9), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 78-5, 14 pages.

1980: Geology of the La Poile River map area (11O/16), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-3, 85 pages.

Colman-Sadd, S.P.
1976: Geology of the St. Alban's map area (1M/13), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 76-4, 19 pages.

Cooper, J.R.
1954: The La Poile - Cinq Cerf map area, Newfoundland. Geological Survey of Canada, Memoir 256, 62 pages.

Dickson, W.L. and Tomlin, S.L.
1983: Geology of the D'Espoir Brook map area and part of the Facheux Bay map area, south-central Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 51-56.

Dorf, E. and Cooper, J.R.
1943: Early Devonian plant fossils from Newfoundland. Journal of Paleontology, Volume 17, pages 264-270.

Dunning, G.R. and Krogh, T.E.
1983: Tightly clustered, precise U-Pb (zircon) age of ophiolites from the Newfoundland Appalachians. Geological Society of America (Northeastern Section), Program with abstracts, Volume 15.

Jewell, W.B.
1939: Geology and mineral deposits of the Baie d'Espoir area. Geological Survey of Newfoundland, Bulletin 17, 29 pages.

O'Brien, S.J.
1983: Geology of the eastern half of the Peter Snout map area (11P/13E), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 57-67.

Riley, G.C.
1959: Burgeo-Ramea, Newfoundland. Geological Survey of Canada, Map 22-1959.

Scott, H.S. and Conn, H.K.
1950: Preliminary report of the geology of Buchans Mining Company concessions in central and south-central Newfoundland. Photographic Survey Co. Ltd., Geological Division, unpublished report, 12 pages. [12A (7)]

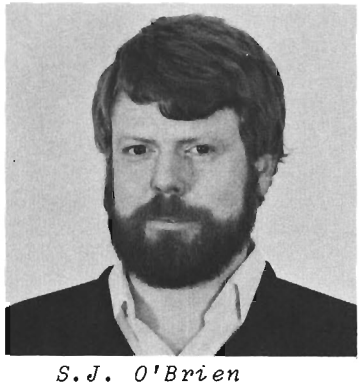
Smyth, W.R.
1979: Peter Snout (11P/13), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Open File Map 79-52.

Swinden, H.S.
1981: Economic geology of the western Hermitage Flexure, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 81-1, pages 80-95.

Williams, H.
1976: Tectonostratigraphic subdivision of the Appalachian orogen. Geological Society of America, Program with abstracts, Volume 8, Number 2, page 300.

1978: Tectonic lithofacies map of the Appalachians. Memorial University of Newfoundland, Map 1.

Williams, H., Kennedy, M.J. and Neale, E.R.W.
1970: The Hermitage Flexure, the Cabot Fault, and the disappearance of the Newfoundland Central Mobile Belt. Geological Society of America, Bulletin, Volume 81, pages 1563-1568.



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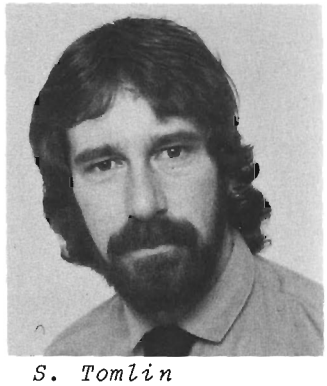

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