GEOLOGY OF THE WEST HALF OF THE BURNT POND MAP AREA (12A/3), SOUTH-CENTRAL NEWFOUNDLAND

by

S.J. O'Brien and S.L. Tomlin

ABSTRACT

The map area lies within the Dunnage Zone of the Newfoundland Appalachians, and is located in the north-central part of the Hermitage Flexure. The oldest of the area's components are the mid-Ordovician polyphase deformed and metamorphosed sedimentary rocks of the Bay du Nord Group and migmatites of enigmatic origin. Both are intruded by the polyphase, Siluro-Devonian North Bay Granite. A major aeromagnetic linear separates the equigranular and earlier porphyritic phases of the granite. It is thought that the Bay du Nord Group was deformed and metamorphosed under upper greenschist to amphibolite facies conditions prior to and during the earliest magmatism of the North Bay Granite. Subsequent phases are late tectonic. The youngest equigranular granite phases are quartz rich and muscovite bearing, and have the potential of hosting Sn-W-Mo-U-F mineralization.

INTRODUCTION

The western half of the Burnt Pond map area is located in south-central Newfoundland and is bounded by 57°15' and 57°30' west longitudes and 48°00' and 48°15' north latitudes (Figure 1). From mid summer and autumn, the area is accessible by the private roads of Newfoundland and Labrador Hydro and Abitibi-Price Newfoundland Limited; access beyond the Granite Lake west dam requires the prior approval of Newfoundland and Labrador Hydro.

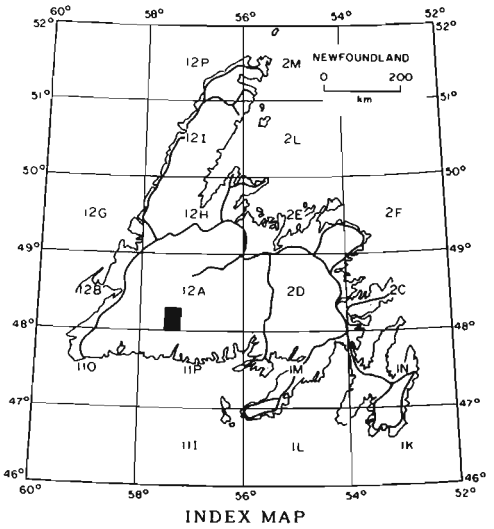

Figure 1: *Location of the study area.*

The area contains little bedrock exposure and is physiographically characterized by a boggy, flat to gently rolling topography (ca. 300-350 m), broken by widely scattered monadnocks (ca 450 m. asl.). The southern part of the area is topographically higher (350-450 m) and more irregular than the north. Original drainage patterns have been drastically altered during flooding by Newfoundland and Labrador Hydro in the late 1960's.

Previous geological investigations in the area include reconnaissance mapping by the Buchans Mining Company (Scott and Conn, 1950) and 1:250,000 scale mapping by the Geological Survey of Canada (Riley, 1957). A project of limited geological reconnaissance together with map compilation was carried out by Smyth (1979). The area was covered by the regional lake bottom sediment sampling program of the Newfoundland Department of Mines and Energy (Butler and Davenport, 1980). The eastern half of the Burnt Pond map area was mapped at a scale of 1:50,000 by Dickson (1982) and 1:50,000 scale mapping of the westerly adjacent King George IV map area was completed by Kean (1983).

GENERAL GEOLOGY

The area forms part of the north-central Hermitage Flexure of the Dunnage Zone of the Newfoundland Appalachians, and is underlain by granitoid rocks of the North Bay Granite (Jewell, 1939) and metasedimentary rocks of the Bay du Nord Group (Dorf and Cooper, 1943; Cooper, 1954). The area can be divided into three components which form separate northeast to east trending belts (Figure 2). The southernmost component comprises mainly polydeformed, upper greenschist to amphibolite facies schists and metasediments (Units 1 and 2), which are intruded posttectonically by an equigranular granite stock (Unit 7). The central component comprises foliated, coarse grained, porphyritic granodiorite and granite (Unit 4) that intrude or are faulted against the metasedimentary rocks. In the contact zone, granites and metasediments are both affected by the regional foliation. A major aeromagnetic lineament separates the granitoids of the central

This project is a contribution to the Canada-Newfoundland Mineral Development Agreement.

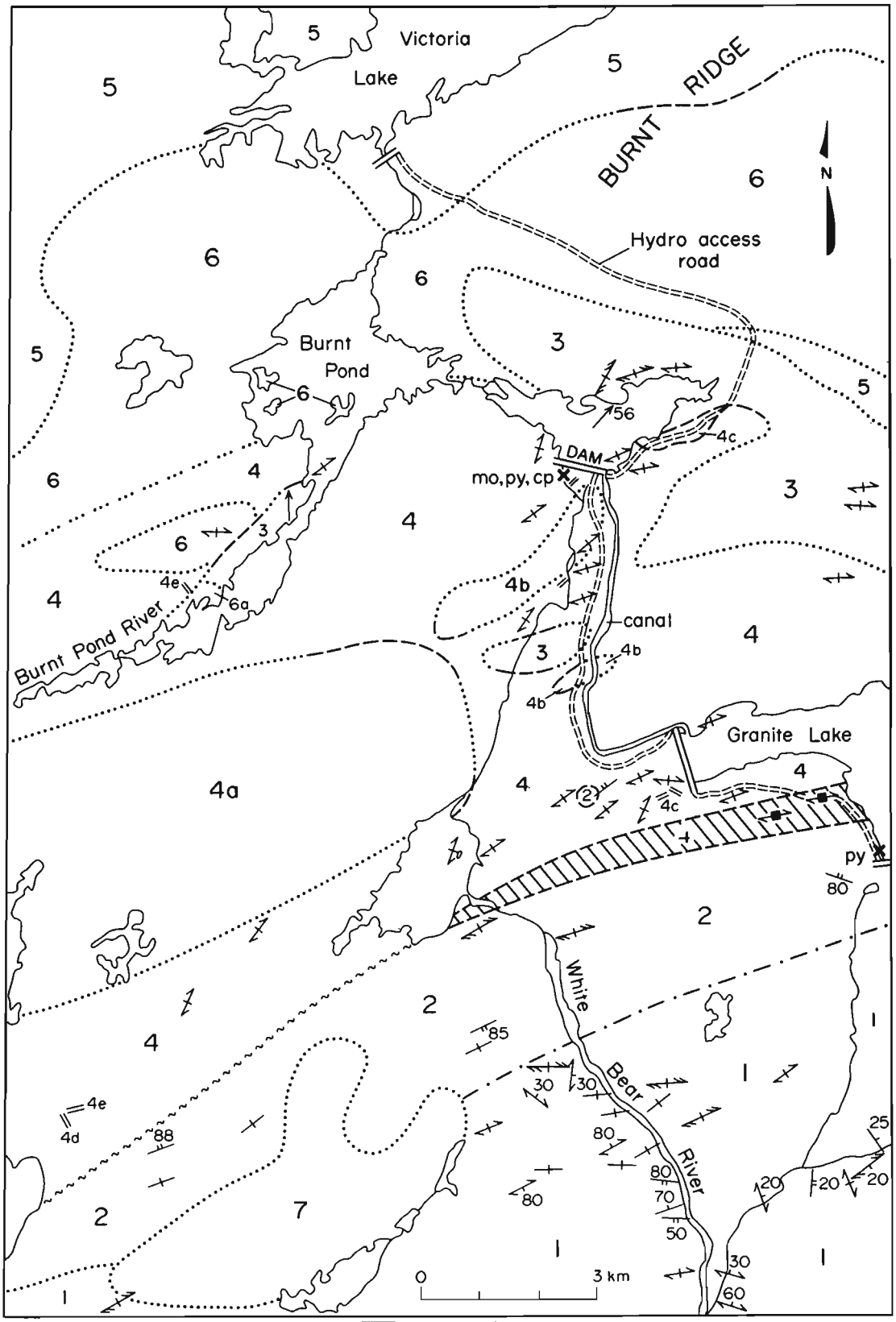

Figure 2: *Geological map of the western half of the Burnt Pond (12A/3) map area, Newfoundland.*

LEGEND

DEVONIAN OR EARLIER

NORTH BAY GRANITE (Units 4 to 7)

7 *Buff to pink essentially massive, fine to medium grained, equigranular to quartz porphyritic, biotite ± muscovite granite.*

6 *Buff to pale pink massive to weakly foliated, fine to medium grained, equigranular, biotite ± muscovite granite; hornblende and tourmaline-muscovite-garnet bearing pegmatite;* **6a**, *dark gray, fine to medium grained, equigranular, biotite-rich granite.*

5 *Buff to white, weakly foliated, medium to coarse grained, equigranular to sparsely porphyritic, biotite granite.*

4 *Gray and pale pink, foliated, coarse grained, K-feldspar porphyritic to megacrystic, biotite granite and granodiorite;* **4a**, *unseparated, coarse grained porphyritic and equigranular biotite granite;* **4b**, *coarse grained, K-feldspar porphyritic, biotite granodiorite containing cognate xenoliths of diorite;* **4c**, *coarse grained, porphyritic, biotite granite with screens of paragneiss and metasedimentary rocks;* **4d**, *fine to medium grained diabase;* **4e**, *pink and gray aplite.*

ORDOVICIAN OR EARLIER

3 *Migmatite, psammite, paragneiss and granitoid.*

LOWER TO MIDDLE ORDOVICIAN

BAY DU NORD GROUP

2 *Gray to green shale, siltstone, sandstone, phyllite and psammite; minor thin tuff beds.*

1 *Pelite, semi-pelite and biotite schist with granitoid and quartz segregations.*

component from a northernmost component of porphyritic and equigranular granite and migmatite. In the northern zone, the migmatite and associated equigranular granitoids (Unit 3) are intruded by foliated porphyritic granodiorite and granite (Unit 4) and by foliated to massive equigranular to variably porphyritic granite and pegmatite (Units 5 and 6).

Bay du Nord Group (Units 1 and 2)

The Bay du Nord Group was defined by Dorf and Cooper (1943) and Cooper (1954) as the dominantly metasedimentary rocks exposed between La Poile Bay and Garia Bay on the southwest coast of Newfoundland. As originally defined, the group contained a fossiliferous sedimentary succession of Devonian age. Chorlton (1980) redefined the Bay du Nord Group, removing from it the fossiliferous section; the remaining metasedimentary and metavolcanic rocks were reassigned to the Ordovician. Subsequent mapping by Kean (1983), O'Brien (1983) and O'Brien and Tomlin (1984) has extended the group northeastwards into the present map area.

In the western half of the Burnt Pond area, the group is comprised mainly of pelitic to semi-pelitic, upper greenschist to amphibolite facies metasediments. On the basis of relative metamorphic grade, the group can be divided into two units.

Unit 1

Unit 1 consists mainly of highly contorted phyllites, semi-pelite, pelite and biotite schist, with minor siltstone and shale; quartz veining and incipient migmatization is widespread throughout. The metasediments are dark gray, black or green, locally rusty weathering, and either laminated, thinly bedded or massive. Quartzofeldspathic beds may be locally granoblastic. A fine penetrative foliation, often coplanar to bedding, is essentially ubiquitous. Locally, the fabric is parallel to the axes of early small scale folds. Refolding is widespread and accompanied locally by the transposition of S_1 by second generation cleavage. In places, granitic veins and quartz rich segregations impart a migmatitic appearance to Unit 1.

Unit 2

Unit 2 consists mainly of black, gray or locally buff, mainly fine grained clastic sedimentary rocks of lower to upper greenschist facies metamorphic grade. Shale, siltstone, sandstone, phyllite and psammite are diagnostic rock types; these occur together with rare coarse grained sandstone and conglomerate. Quartzofeldspathic arenite and lithic tuff in beds up to 20 cm thick are present, but uncommon. The sedimentary rocks are characteristically either black, gray or locally buff,

and fine grained. In most areas, the sediments form thin parallel beds and laminae; only rarely are they massive and thickly bedded (Plate 1). Sandy beds are locally cross-stratified. Adjacent to the granitoids, the sedimentary rocks are either massive, featureless hornfels or staurolite bearing schist. Unit 2 lacks the pervasive quartz veining and incipient migmatization diagnostic of Unit 1. Unit 2 is variably deformed, with an early fabric refolded on steep, upright, axial planes. The second deformation also produced a variety of kinks, crenulations and brittle structures within both Units 1 and 2.

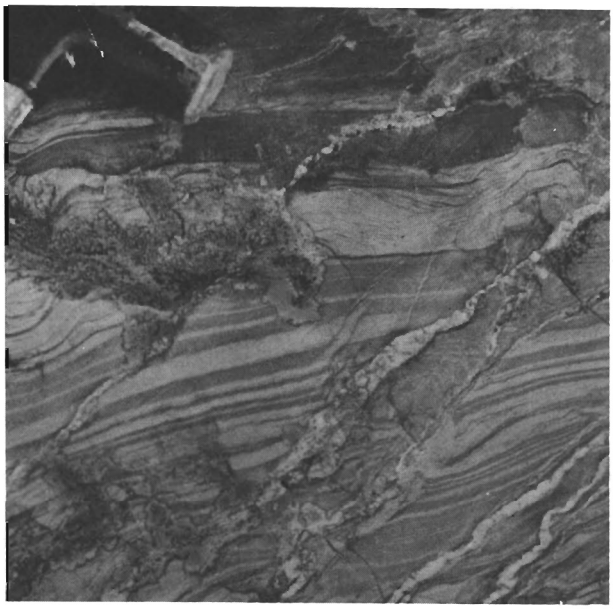

Plate 1: *Thinly bedded sandstone and shale, Bay du Nord Group.*

The contact of Units 1 and 2 is gradational over a distance of several hundred metres, marked by a gradual decrease in metamorphic grade and the degree of metamorphic remobilization from Unit 1 into Unit 2.

Unit 3

Unit 3 denotes a zone of migmatite and associated granitoid rocks which is intruded by younger phases of the North Bay Granite. The zone is poorly exposed, and inferred to underlie approximately 20 km^2 north and east of Burnt Pond. Equivalent rocks underlie a narrow area immediately northwest of the steadies on Burnt Pond River.

The migmatites have irregularly developed stromatic and schlieren structures (Plate 2). Layering of biotite-rich, sillimanite-bearing bands and equigranular granitoid is of variable width, but is commonly between 2 and 5 mm. The proportion of

Plate 2: *Migmatized metasedimentary rocks, Unit 3.*

paleosome is variable, and the migmatites, in places, are comprised almost entirely of nebulitic granitoid leucosome. The migmatites contain psammitic xenoliths that display various degrees of assimilation with the leucosome. In places the xenoliths have polydeformed internal foliations (Plate ?); elsewhere they form indistinct zones within the migmatite, and have a fabric which is roughly concordant with that in the leucosome. The migmatites are intruded by the younger porphyritic and equigranular phases of the North Bay Granite.

Plate 3: *Refolded structures in psammitic xenolith, Unit 3.*

North Bay Granite (Units 4 to 7)

The name North Bay Granite (Jewell, 1939) denotes the large composite granitoid batholith which lies to the north of and intrudes the Bay du Nord Group along the central and eastern parts of the Hermitage Flexure. In the western half of the Burnt Pond area, the granite can be divided into four distinctive units, based on texture, mineralogy, degree of deformation and field relationships. These include: foliated porphyritic biotite granite and granodiorite (Unit 4); foliated coarse grained equigranular to variably porphyritic biotite granite (Unit 5); foliated to massive equigranular biotite ± muscovite granite (Unit 6), and massive, quartz-porphyritic to equigranular biotite ± muscovite granite (Unit 7).

Unit 4

Unit 4 comprises the foliated, coarse grained porphyritic, biotite granite and granodiorite that underlies much of the central part of the map area. Locally, it is divisible into subunits that are characterized by either: (a) their association with small amounts of equigranular granitoid (Unit 4a), (b) the presence of numerous diorite xenoliths (Unit 4b), or (c) the presence of screens of either metasediment or paragneiss (Unit 4c). Another diagnostic feature of Unit 4 is the presence of dikes of diabase (Unit 4d) and aplite (Unit 4e).

Unit 4 granite and granodiorite is either gray or very pale pink with pink or white K-feldspar phenocrysts and megacrysts (Plate 4). It is characteristically phenocryst rich, but may locally contain diffuse bands with relatively few phenocrysts. Grain size is characteristically coarse. Locally, two phenocryst size populations are developed: 1-2 cm and 4-5 cm. In places, megacrysts up to 8 cm were noted. Phenocrysts are either equant or subhedral to anhedral, and are zoned in places (Plate 5).

Diorite, metasediment and paragneiss are present as inclusions in the granite and granodiorite. The diorite xenoliths, presumably of cognate origin, vary from a few centimeters to 1.5 meters in maximum dimension (Plate 6). Their boundaries may be either sharp or diffuse, and the xenoliths have an internal foliation parallel to that in the enclosing granite. The metasedimentary inclusions are variable in size, and contain the regional foliation seen in the adjacent granite. The paragneiss has a previously deformed biotite rich banding and has undergone a different style of deformation than the surrounding granite.

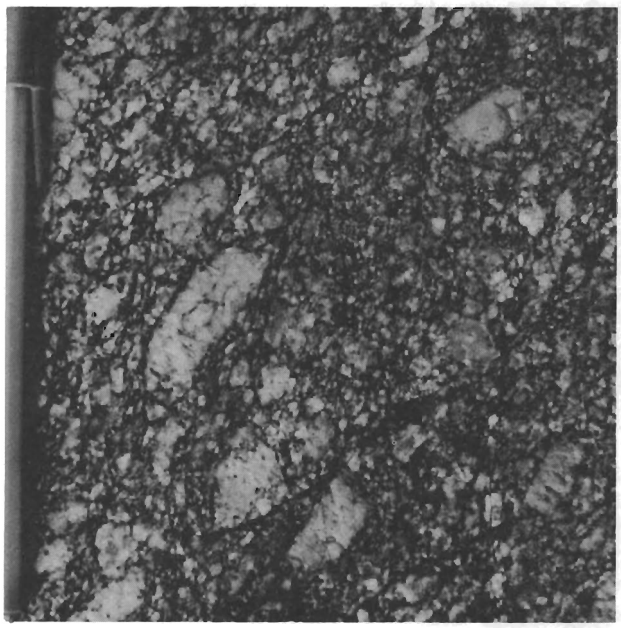

Plate 4: *K-feldspar porphyritic, biotite granite, North Bay Granite (Unit 4).*

Plate 5: *Zoned K-feldspar megacryst in porphyritic, biotite granite, North Bay Granite (Unit 4).*

Unit 4 has a variably developed foliation which, although seen in most areas, is not everywhere penetrative. The regional foliation in the unit increases in intensity southwards, where it has a strong cataclastic component. Adjacent to the contact with the Bay du Nord Group, a protomylonite zone is developed in the granite. At the Granite Lake (west) Dam, the porphyritic granite and aplites which intrude

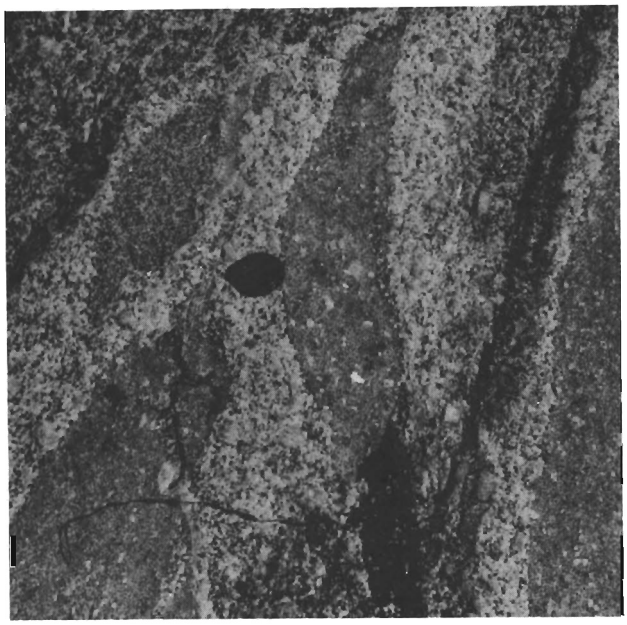

Plate 6: *Diorite xenoliths with K-feldspar porphyroblasts, North Bay Granite (Unit 4b).*

it are affected by brittle structures, and brecciation accompanied by extensive chlorite and hematite alteration is widespread.

Unit 4 posttectonically intrudes the migmatites of Unit 3. Although much of the contact between Units 2 and 4 is either faulted or unexposed, the presence of large xenoliths of metasediment in the granite immediately north of the assumed contact indicates an originally intrusive relationship. In the contact area, both granite and metasediment are affected by the regional deformation.

Unit 5

Unit 5 comprises the weakly foliated, medium to coarse grained, equigranular and medium grained, variably porphyritic biotite granite, which underlies the northernmost parts of the map area. Due to poor exposure, the unit cannot be further subdivided.

On the northern part of Burnt Ridge, the unit consists of weakly foliated, buff, medium grained, equigranular biotite granite. In places this granite contains 1-2 percent K-feldspar phenocrysts. A similar rock type forms the only exposure of this unit found west of Burnt Pond. Buff to white, medium grained, porphyritic, biotite-poor granite is exposed in the central part of the area underlain by Unit 5. Here, the granite is spatially associated with medium grained, sparsely porphyritic biotite granite. Coarse grained equigranular to sparsely porphyritic, biotite granite, exposed approximately 1 km northeast of the eastern end of Burnt Pond, is tentatively included with Unit 5.

The contact of Unit 5 with adjacent units is unexposed, thus the nature of its relationship to other phases of the North Bay Granite is uncertain. Its granitic composition and its spatial association with Unit 6 may indicate a genetic link with that phase.

Unit 6

Unit 6 is a fine to medium grained equigranular granite, which lies to the north of Units 3 and 4 and which is bounded to the north by Unit 5. It is exposed only on the southern part of Burnt Ridge and on the Victoria Dam access road. A distinctive aeromagnetic low over much of the area west of Burnt Pond is taken as evidence that Unit 6 underlies much of this drift and swamp covered area.

The typical rock type of this unit is a massive to weakly foliated, buff to pale pink, equigranular biotite ± muscovite granite. It is usually massive in outcrop but is locally foliated. In places it is cut by rare hornblende-bearing appinitic sweats and pegmatite dikes. Tourmaline-muscovite-garnet pegmatites are spatially associated with dikes of Unit 6 which intrude Units 3 and 4, near the eastern end of Burnt Pond (Plate 7). It is assumed that these latter pegmatites are also genetically related to Unit 6.

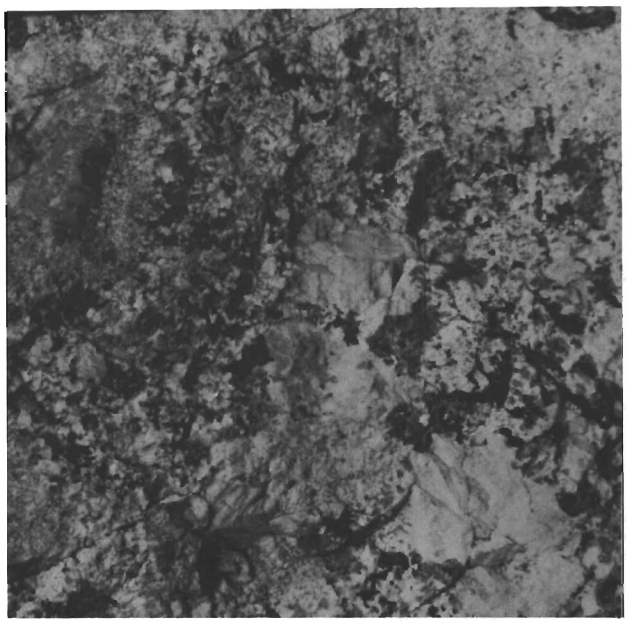

Plate 7: *Garnet-muscovite-tourmaline bearing granite pegmatite associated with Unit 6 of the North Bay Granite.*

Dikes of medium grained equigranular, biotite ± muscovite granite intrude the migmatites of Unit 3. These dikes are post-tectonic with respect to the deformation seen in the migmatites. Dikes of the same composition intrude porphyritic granodiorite of Unit 4. Locally, both dike and host rock share the same regional foliation. The contact of Unit 6 with Unit 5 is unexposed and their relationship is unknown.

Unit 7

Unit 7 is a small granite plug, separate from the main body of the North Bay Granite, which intrudes the Bay du Nord Group. Its lithology is fine to medium grained buff to pink equigranular to quartz porphyritic leucocratic biotite ± muscovite granite. The granite lacks a pervasive foliation but is affected by narrow shear zones along which a cleavage is locally developed.

The unit has intruded the Bay du Nord Group after the first and main deformation. Dikes of this granite in the metasediments are affected only by the second phase folds of cleavage.

MINERAL POTENTIAL

The map area has potential for both sediment hosted and granitoid related mineralization. Within the Bay du Nord Group (Units 1 and 2), pyrite mineralization is widespread, and a potentially significant pyritiferous gossan is developed over black slate and pelitic schist at Goodyears Dam on the south side of Granite Lake.

Uranium mineralization occurs in Bay du Nord Group sediments approximately 3 km south of the Burnt Pond map area (O'Brien and Tomlin, 1984, this volume). The uranium occurs in both pelitic schist and tuffaceous metasediments. Both rock types occur within Units 1 and 2 in the Burnt Pond area, and these units have potential of hosting similar mineralization.

The North Bay Granite in the Burnt Pond area contains small showings of pyrite, chalcopyrite and molybdenite, and has a potential for tin, tungsten, fluorine and uranium mineralization. In the hydro canal immediately south of the dam on Burnt Pond, Unit 4 porphyritic granite is cut by dikes of Unit 6 equigranular granite. There, fractures in the porphyritic granite are partially coated by pyrite, chalcopyrite and molybdenite mineralization.

Significant Mo-W mineralization occurs in the North Bay Granite near the eastern end of Granite Lake, approximately 40 km to the east (Dickson, 1982). There sparse, disseminated molybdenite occurs in granite dikes, quartz veins and pegmatites, which cut altered muscovite-biotite granite. Wolframite and scheelite (0.1 to 2 percent WO_3) occur in quartz veins near the contact between muscovite-biotite granite and biotite granodiorite. Immediately east of the western half of the Burnt Pond map area, lake sediment molybdenum anomalies occur over the equivalents of Unit 5 (Butler and Davenport, 1980). Boulders of equigranular granite with tourmaline and minor molybdenite disseminations were found in the easternmost part of the area, and suboutcrop of Unit 5 with minor tourmaline and molybdenite-coated fractures was seen approximately 500 m east of the map area. Tourmaline-muscovite-garnet pegmatites and quartz-rich segregations occur in Units 3 and 4 close to the contact with Unit 5 near the east end of Burnt Pond. These dikes are presumed to be related to Unit 5, and have good potential for tungsten mineralization.

SUMMARY

The major geological components of the map area are the Ordovician Bay du Nord Group, the Siluro-Devonian(?) North Bay Granite, and migmatites of equivocal age and origin. The Bay du Nord Group represents a period of Middle Ordovician distal marine sedimentation accompanied by limited volcanism. These rocks were first deformed and metamorphosed under upper greenschist to amphibolite facies conditions prior to and in part during the intrusion of the early porphyritic phases of the North Bay Granite. Subsequent equigranular phases of the granite are late synkinematic to post-tectonic with respect to the major tectonothermal event affecting the sedimentary rocks. The youngest phase of the granite cross cuts S_1 in the metasediments; dikes of this phase are affected by open upright F_2 folds.

The protolith of the migmatites in the North Bay Granite is uncertain. In the adjacent King George IV map area, Kean (1983) demonstrated that migmatites there were related to high grade metamorphism of the Bay du Nord Group. It is thought that the migmatites represent higher metamorphic equivalents of the Bay du Nord Group rocks to the south, although there is no evidence in the map area which rules out another source for these rocks.

In light of the known occurrences of molybdenite, scheelite and wolframite showings elsewhere in the North Bay Granite (e.g. Dickson, 1982), the area can be considered to have good potential for granite hosted mineralization.

ACKNOWLEDGEMENTS

The authors thank Messrs. Jacob Lushman, Richard Lushman and Brian Wheaton for the excellent assistance they provided in the field. Thanks also go to Gerard Hartery and Hubert Rodway of Universal Helicopters Limited and to Newfoundland Air Transport Limited; all provided excellent service. Thanks also go to the Administrative Section of Mineral Development Division for their logistical support. The cooperation of Newfoundland and Labrador Hydro regarding access to the Burnt Pond region is recognized; the hospitality of the Hydro staff at Burnt Dam was particularly appreciated.

An early version of this manuscript was improved by the critical reviews of W.L. Dickson and B.F. Kean.

REFERENCES

Butler, A.J., and Davenport, P.H.
1980: Lake Sediment Geochemical Survey of Southwestern Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Open File Nfld. 1150.

Chorlton, L.B.
1980: Geology of the La Poile River map area (110/9), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-3, 85 pages.

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

Dickson, W.L.
1982: Geology of the Wolf Mountain (12A/2W) and Burnt Pond (12A/3E) Map Area, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-5, 43 pages.

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

Jewell, W.B.
1939: Geology and Mineral Deposits of the Bay d'Espoir area. Newfoundland Geological Survey, Bulletin 17, 29 pages.

Kean, B.F.
1983: Geology of the King George IV Lake Map Area (12A/4). Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-4, 67 pages.

O'Brien, S.J.
1983: Geology of the eastern half of the Peter Snout map area (11P/13E), Newfoundland. *In* Current Research. *Edited by* M.J. Murray, P.D. Saunders, W.D. Boyce and R.V. Gibbons, Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 57-67.

O'Brien, S.J., and Tomlin, S.L.
1984: Geology of the White Bear River map area (11P/14), Newfoundland. *In* Current Research. *Edited by* M.J. Murray, J.G. Whelan and R.V. Gibbons, Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-1, pages 220-230.

Riley, G.C.
1957: Red Indian Lake (west half). Geological Survey of Canada, Map 8-1957.

Scott, H.S., and Conn, H.K.
1950: Preliminary report of the geology of the Buchans Mining Company concessions in central and south-central Newfoundland. Photographic Survey Corporation Limited, Geological Division, unpublished report, 12 pages.

Smyth, W.R.
1979: Burnt Pond (12A/3), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 7955.