GEOLOGY OF WEST PART OF GREAT BURNT LAKE (12A/8) AREA

by

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ABSTRACT

The Great Burnt Lake area is located northwest of St. Alban's in the centre of the Central Mobile Belt. This report is concerned only with the western two thirds of the area which are underlain by clastic metasedimentary rocks of presumed Ordovician age and by granitoid rocks that probably range in age from Silurian to Devonian. The metasedimentary rocks contain a prominent component of quartzite and psammite and are probably correlatives of the Spruce Brook Formation to the east. They have been penetratively deformed three times and metamorphosed in the lower to upper amphibolite facies. Mafic dikes intruded the metasediments pretectonically. The oldest of the granitoid intrusions has been very strongly deformed and has a linear outcrop area along the boundary with the Great Burnt Lake volcanic belt. Post tectonic granodiorite and minor garnet-muscovite granite are extensions of the North Bay Granite. A small body of pink biotite and/or muscovite granite is probably the youngest intrusion. The greatest potential for mineralization is in the more highly differentiated granitic rocks.

INTRODUCTION

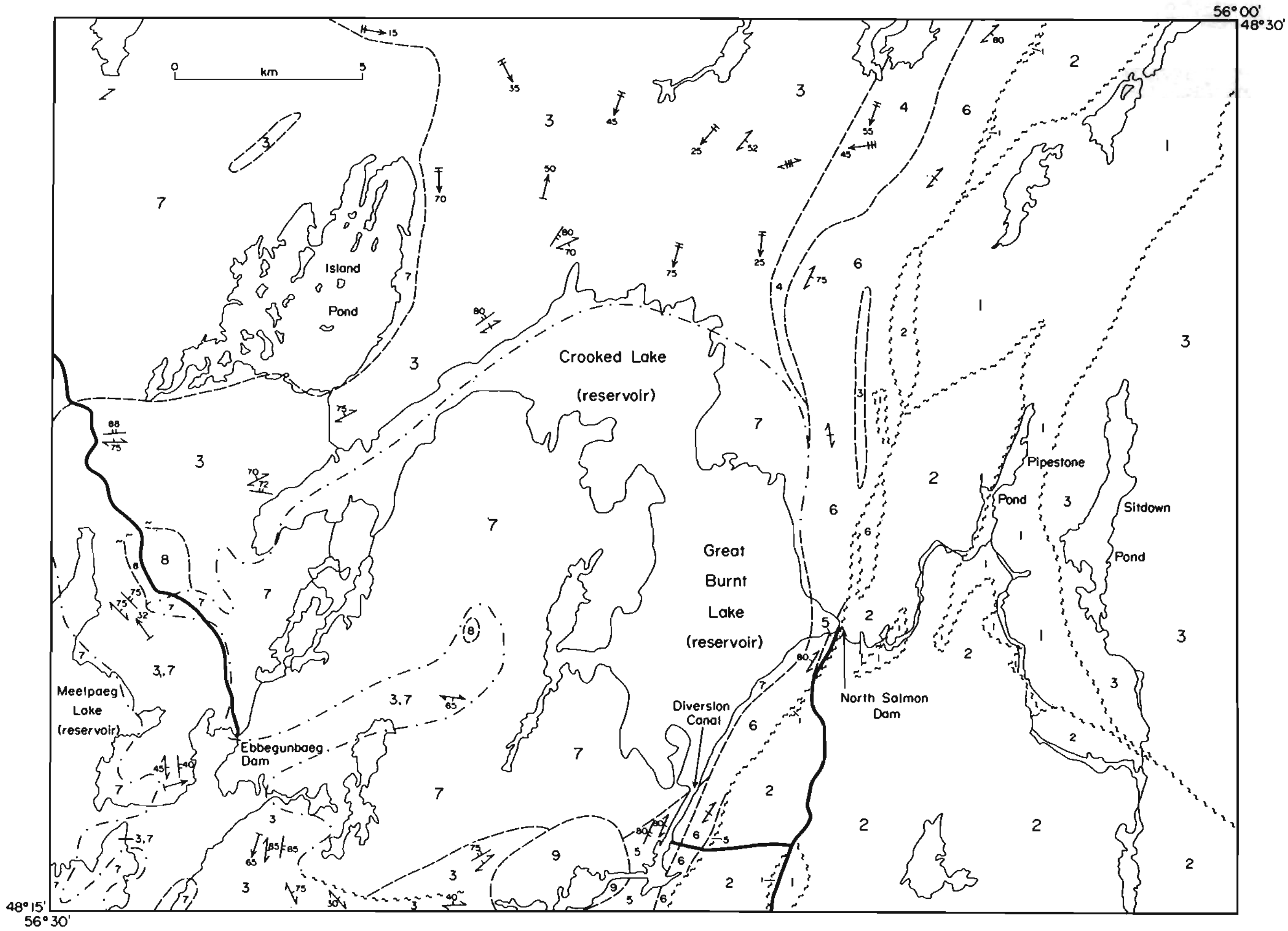
The Great Burnt Lake area is located in the center of the Newfoundland Central Mobile Belt (Williams, 1964) about 60 km northwest of St. Alban's. It is underlain in part by rocks typical of the Dunnage Zone (Williams, 1978) which form the Pipestone Pond ophiolitic complex (Unit 1) and the Great Burnt Lake volcanic belt (Unit 2) (Colman-Sadd and Swinden, 1982) in the eastern half of the area (Figure 1). To both the east and the west of these Dunnage Zone rocks are large areas of monotonous clastic metasediments (Units 3-5) intruded by granitoid rocks (Units 6-9). Where the clastic metasediments occur to the east of the Pipestone Pond Complex, they have been considered distinct from the Dunnage Zone sequences and have been named the Spruce Brook Formation. Colman-Sadd and Swinden (1984a) interpreted them to occur in a tectonic window through the Dunnage Zone. The metasedimentary rocks to the west of the Great Burnt Lake volcanic belt are essentially similar to the Spruce Brook Formation and most of them are here included in the formation.

The present report is concerned only with rocks west of the Great Burnt Lake volcanic belt, since it is these that have been mapped during 1984. The eastern part of the area was mapped at 1:20,000 in 1981 by H.S. Swinden (Swinden, 1981; Swinden and Collins, 1982) and is not discussed here. A 1:50,000 compilation map of the whole area has been published by Colman-Sadd and Swinden (1984b).

The earliest geological investigations in the Great Burnt Lake area were those of Cormack (1823) during his walk across the island of Newfoundland. Murray (Murray and Howley, 1881) visited the east shore of Great Burnt Lake on foot from Pipestone Pond, after ascending the Salmon River from Bay d'Espoir in 1870. He had intended to visit Crooked Lake and Island Pond but was prevented by the low level of the rivers. It was not until 1888 that the geological survey of Newfoundland was extended across the western part of the Great Burnt Lake area by Howley (1917), who reported that "the country around Burnt Pond (Great Burnt Lake) presents anything but an inviting prospect"; "huge angular fragments of granite are strewn in every direction" giving "the appearance of a vast ruin, which is really its true character".

No further work was done in the western part of the area until the Buchan's Mining Company set out to explore its concession in the early 1950's. Phendler (1950) and Higgins (1951) concluded that the rocks of the Pipestone Pond ophiolite and the Great Burnt Lake volcanic belt (Units 1 and 2) had by far the greatest apparent mineral potential in the area. Since then, mineral exploration, which had taken place sporadically in the ophiolite complex since 1901 (Willis, 1901), was focussed on these two units (Colman-Sadd and Swinden, 1982) and the western part of the area was explored only as a part of a 1:250,000 mapping project by the Geological Survey of Canada (Williams, 1970).

Access to the area has been much improved in recent years by the construction of roads to Ebbegunbaeg Dam in the west and North Salmon Dam in the east. Furthermore, flooding of the Meelpaeg Lake and the Great Burnt Lake - Crooked Lake reservoirs permits easy access by boat to most of the country between the two dams. During the 1984 mapping project aircraft were only needed to reach the northern edge of the area.



LEGEND

LATE SILURIAN TO DEVONIAN

9	*Equigranular pink biotite and biotite-muscovite granite.*	
8	*Equigranular pink garnet-muscovite granite.*	*Phases of North Bay Granite*
7	*Equigranular to porphyritic, gray, biotite granite and granodiorite with unseparated migmatitic gneiss.*	
6	*Very strongly deformed pink megacrystic biotite granite.*	

EARLY TO MIDDLE ORDOVICIAN

5 *Semipelitic and psammitic metasedimentary rocks of uncertain affinity.*

4 *Psammite with minor quartzite and amphibolite lenses.*

3 *Spruce Brook Formation: Interbedded quartzite, psammite, semipelite and pelite; unseparated amphibolite dikes.*

2 *Great Burnt Lake volcanic belt: Unseparated metavolcanic and metasedimentary rocks.*

LATE CAMBRIAN OR EARLY ORDOVICIAN

1 *Pipestone Pond Complex: Ultramafic, mafic and felsic igneous rocks of ophiolitic affinity.*

Figure 1: *Sketch map of the Great Burnt Lake (12A/8) area. The geology of Units 1, 2 and 3 east of Great Burnt Lake is simplified after Swinden and Collins (1982).*

GENERAL GEOLOGY

The map pattern of the western part of the Great Burnt Lake area is deceptively simple, consisting of three rather similar metasedimentary units and four different types of granitoid rocks. However, the monotony of the original sedimentary units is not reflected in their complex structural and metamorphic history, which involved at least three periods of penetrative deformation and one (or more?) period of metamorphism, ranging in grade from lower amphibolite facies to the generation of a partial melt. Furthermore the contact with the Great Burnt Lake volcanic belt is marked by an abrupt change in rock types as well as by a zone of unusually intense deformation that extends for over 60 km. This contact, however it is interpreted, is a geological feature of regional significance.

Metasedimentary Rocks of Unit 3:

Most of the metasedimentary rocks in the western part of the Great Burnt Lake area are derived from essentially the same protolith as those mapped at the eastern edge of the area by Swinden and Collins (1982). The rocks at the eastern edge have been named the Spruce Brook Formation by Colman-Sadd and Swinden (1984a), and this name is probably applicable across the western part of the area and into the Cold Spring Pond (12A/1) (Colman-Sadd, 1984) and Wolf Mountain (12A/2) (Dickson and Delaney, 1984) areas.

Unit 3 consists of interbedded quartzite, psammite, semipelite and pelite. Bed thickness varies from 5 cm to 3 m and the proportions of the rock types are quite variable. Overall, quartzite and psammite each form about 20 to 30 per cent of the unit in the western part of the Great Burnt Lake area. The quartzite is light gray on fresh surfaces, but weathers white. Its grainsize is 2 mm or less and graded bedding is present in the thicker beds which have sharp, loaded bases (Plate 1). The upper parts of these beds commonly have parallel or cross laminations defined by micaceous minerals which are almost entirely absent from the massive lower parts of the beds. The psammite is darker gray than the quartzite and weathers brown. It contains more mica, but petrographic examination is required before its feldspar content can be determined. Most psammite beds are massive with sharp bed contacts and lack recognizable sedimentary structures. The pelite is medium to dark gray and, where its fine structure has not been destroyed by porphyroblast growth, is faintly laminated. Beds in which the original siltstone laminations are particularly common, have semipelitic or even psammitic compositions. The pelite and semipelite commonly contain thin interbeds of laminated and crosslaminated quartzite (Plate 2) or psammite which contrast with the thicker more massive beds described above.

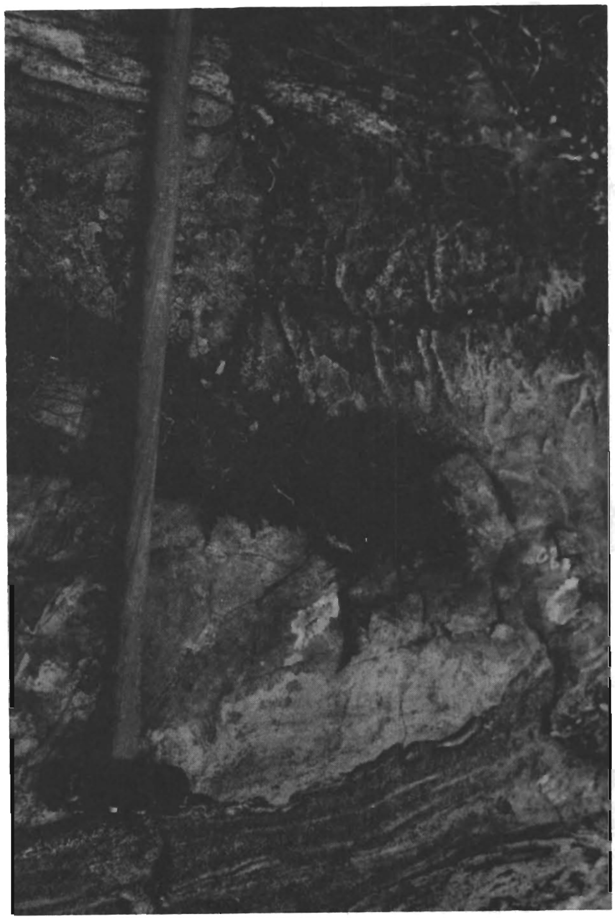


Plate 1: *Quartzite bed with loaded base (under hammerhead) overlying laminated and thinly bedded sillimanite-bearing pelite, semipelite, psammite and quartzite. The quartzite bed grades towards the top of the photograph into sillimanite-bearing psammite. Spruce Brook Formation (Unit 3), near Ebbegunbaeg Dam.*

Unit 3 can be divided into two structural domains, separated by a line joining the northeastern boundaries of the two lobes of granodiorite (Unit 7), around Island Pond and Crooked Lake respectively. Southwest of this line the principal penetrative cleavage appears to have been formed during the first deformation of Unit 3 and is axial planar to tight or isoclinal folds of bedding. The cleavage is uniformly developed through the pelitic and semipelitic rocks on the mesoscopic scale, but in the psammites and particularly the quartzites it is spaced 2 to 10 mm apart and the cleavage surfaces are commonly coated with biotite and muscovite. Second deformation structures within the south-

Plate 2: *Crosslaminated quartzite bed interbedded with sillimanite-bearing pelite. Spruce Brook Formatin (Unit 3), near Ebbegunbaeg Dam.*

western domain consist mainly of open folds and a poorly developed crenulation cleavage or a further flattening of the first deformation cleavage. The second deformation structures are most prominent adjacent to the granitoid intrusions, either because of increased ductility of the metasediment due to partial melting or to deformation caused by the intrusive process.

Northeast of the Island Pond and Crooked Lake granodiorite lobes, there is an increase in both the intensity and the complexity of the structure of Unit 3. Most identifiable folds were formed during the second deformation and the first cleavage, especially the spaced cleavage in the quartzite beds, is clearly bent around the fold noses (Plate 3). In the area 5 km northeast of Island Pond, S, M and Z type folds can be used to define a major fold that is faintly visible on air photographs and has a wavelength of about 1 km. This major fold is isoclinal although the minor folds that are used for vergence determinations are mostly tight. Eastwards the minor folds also become isoclinal as the rocks become progressively more flattened. About 5 km northeast of Crooked Lake, lenses of quartzite with constant thicknesses of 5 cm to 1 m and exposed lengths of up to 20 m have either first or second deformation fold noses at their terminations, indicating that they formed by extreme flattening of Type 1 interference patterns (Ramsay, 1967). Despite the intensity of the second deformation, as indicated by the tightness of the folds, a good second deformation cleavage is not generally developed, except insofar as there is accentuated flattening of the first cleavage.

Plate 3: *Second deformation folds of the first deformation spaced cleavage in quartzite of the Spruce Brook Formation (Unit 3), north of Crooked Lake.*

Throughout most of the northeastern domain, both the first and second deformation structures trend northeast or north, except close to the Island Pond granodiorite lobe where they curve around the intrusion to the northwest. Generally the first deformation fold axes plunge fairly steeply to the northeast and the second deformation axes plunge fairly steeply to the south or southwest. Superimposed on all these structures in the easternmost part of the outcrop area, are structures of a third generation. The third deformation folds are tight to open mesoscopic structures that refold second deformation folds and have moderate plunges to the west-southwest. They are associated with a well developed crenulation cleavage that strikes west-southwest and in many places can be observed to cut obliquely across both limbs of second deformation folds.

Unit 3 is everywhere metamorphosed in the amphibolite facies and metamorphic biotite is universally present. Except in the northeastern structural domain, andalusite porphyroblasts or sillimanite aggregates are generally recognizable. It is uncertain whether the apparent absence of these minerals from the northeastern domain is due to a lower grade of metamorphism or to their destruction by the later structural events. Sillimanite appears to have a spatial relationship to the contacts with the granodiorite plutons. The inversion of andalusite to sillimanite in most cases occurs within 0.5 to 1.5 km of the contacts, although around Meelpaeg Lake where dikes and sills of granodiorite are common in the metasediments the width of the sillimanite zone is somewhat greater. Partial melting of the sediments has taken place in the arm of Unit 3 that extends east from Meelpaeg Lake towards Great Burnt Lake and adjacent to the Island Pond granodiorite lobe on the Ebbegunbaeg road. In these places the rocks have been converted to migmatitic gneisses with few relics of original bedding (Plate 4).

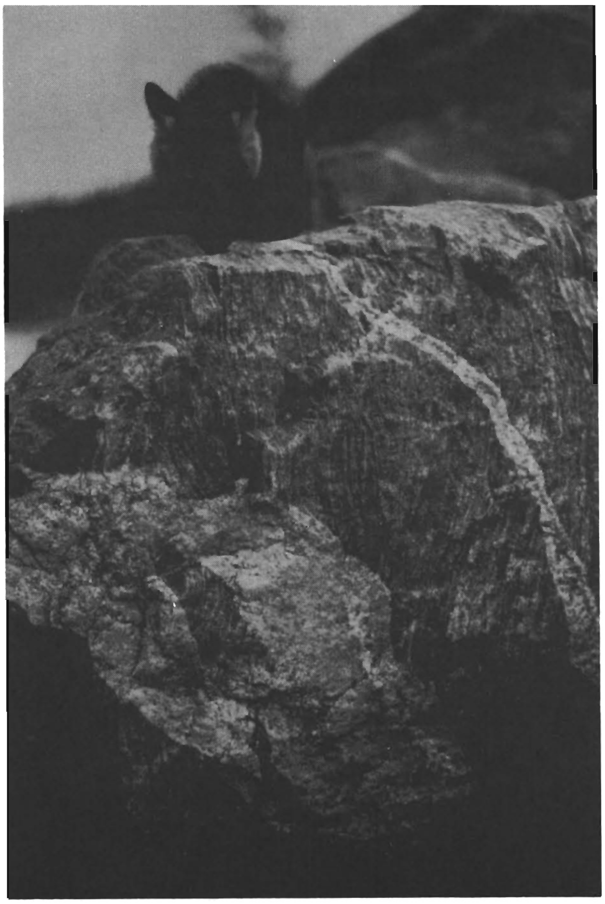


Plate 4: *Migmatitic gneiss probably formed by metamorphism of the Spruce Brook Formation (Unit 3) and cut by garnet-tourmaline-muscovite pegmatite veins. Road to Ebbegunbaeg Dam, west of Island Pond.*

The peak of metamorphism marked by andalusite and sillimanite growth probably took place after the first but before the second deformation. Andalusite porphyroblasts have inclusion trails of the first fabric, but they also appear to form augen in the main fabric, perhaps as a result of flattening during the last part of the first deformation or during the second deformation.

Metasedimentary Rocks of Unit 4:

Unit 4 is separated from Unit 3 because it has a much greater content of gray, brown-weathering psammitic schist and most exposures consist of homogeneous psammite with little or no evidence of the original bedding. A close relationship to Unit 3 is indicated by relics of white-weathering quartzite beds, mostly preserved in dismembered fold hinges. Unit 4 occurs as a single narrow belt at the east edge of the main outcrop area of Unit 3, but rocks of Unit 3 do occur farther east, enclosed in the foliated megacrystic granite (Unit 6) and to the east of the Pipestone Pond ophiolitic complex (Colman-Sadd and Swinden, 1984a).

The psammitic schist of Unit 4 has a pervasive, but poorly developed foliation which is tightly crenulated on a scale of about 1 cm and generally has no consistent orientation. A second cleavage, formed axial planar to the crenulations, has a steep attitude that trends north-northeast parallel to the length of the belt. The second cleavage has locally been refolded by the third generation of west-southwest plunging folds, noted in Unit 3, and these folds have a third axial planar crenulation cleavage associated with them. The most prominent metamorphic minerals in the are biotite and muscovite, defining the foliations, and garnet porphyroblasts up to 1 cm across that form augen within the second foliation, but appear to overgrow the first.

Metasedimentary Rocks of Unit 5:

Rocks of Unit 5 occur as a narrow, probably faulted, slice on the road just south of the North Salmon Dam, and on the Diversion Canal south of Great Burnt Lake. Their stratigraphic affinity is uncertain. Lithologically they most closely resemble rocks of the Salmon River Dam Formation which forms part of the Baie d'Espoir Group and is in conformable contact with rocks of the Great Burnt Lake volcanic belt (Unit 2) in the Cold Spring Pond (12A/1) area to the south (Swinden and Collins, 1982). Within the Great Burnt Lake area, however, Unit 5 is apparently separated from Unit 2 by faults (and also locally by granite of Unit 6) and has a metamorphic grade that is markedly higher than that of Unit 2, but similar to that in parts of Units 3 and 4.

Unit 5 consists of dark purplish-gray psammite interbedded with similarly coloured schist. Beds are up to 1 m thick in the psammite and 10 cm thick in the schist. Garnet porphyroblasts commonly occur as augen within the main cleavage (S_2?) in both rock types. Thin beds of laminated green or white quartzite with gradational boundaries occur in the psammite beds and these are associated with sharply bounded beds or lenses of garnetiferous calc-silicate rock. Both of these latter, accessory rock types, as well as the purplish gray colour of the psammite and schist, are characteristic of the Salmon River Dam Formation.

Mafic Intrusive Rocks (unseparated on map)

Mafic dikes clearly cross cut rocks of Unit 3 in many exposures between Island Pond and Meelpaeg Lake, and southwards into the Cold Spring Pond area. The dikes now consist of amphibolite with or without plagioclase phenocrysts and have a moderate foliation which probably corresponds to the first deformation cleavage in the country rocks. Dikes and probable relics of dikes also occur in the rocks of Units 3 and 4 east of Island Pond, but they are much less common. In the rocks northeast of Crooked Lake, that have undergone intense second deformation strain, dismembered fold hinges of amphibolite are the main evidence for the original presence of the dikes.

Strongly Deformed Megacrystic Granite (Unit 6):

Granite of Unit 6 (Plate 5) forms a narrow belt extending from north to south across the Great Burnt Lake area. In the Cold Spring Pond (12A/1) area to the south, the granite reappears south of rocks correlative with Unit 2 and continues with minor interruption to the northern edge of the North Bay Granite (Colman-Sadd, 1984). The belt has a total length of about 60 km, but at no point is it more than 7 km wide. In a general way the granite follows the boundary that separates, in the west, rocks of Units 3, 4 and 5 and their more metamorphosed equivalents in the Cold Spring Pond area from, in the east, the Great Burnt Lake volcanic belt (Unit 2).

The groundmass of the granite consists of elongated grains or grain aggregates of quartz and feldspar, and strongly oriented biotite. Muscovite occurs as an accessor mica probably of secondary origin. Potassium feldspar forms megacrysts up to 2 cm across which are subhedral or anhedral and are enclosed in the foliation as augen. The fabric is either linear with a moderate planar component or entirely linear. The planar component is generally nearly vertical and the linear component is nearly horizontal. The fabric is parallel to the overall trend of the granite outcrop which varies from northeast to just west of north. The granite contains xenoliths of psammitic schist and amphibolite which are oriented parallel to the fabric, and is cut by aplite dikes that have been deformed with the granite but which remain slightly oblique to the fabric.

Plate 5: *Megacrystic granite of Unit 6 with a strong L-S fabric, northeast of Crooked Lake.*

No contacts have been observed between the megacrystic granite and the other units. It is presumed to be in fault contact with Units 1 and 2 because of the abrupt truncation of many divisions within these units (Swinden an Collins, 1982) and because of the absence o these units farther to the west. Also the presence of several deformed ophiolite pods (Unit 1) along the line of the contact suggests that it is tectonic. The contacts with Units 3, 4 and 5 may be faulted or intrusive. The intense deformation of the more easterly parts of Units 3 and 4 is a feature that they have in common with the granite, suggesting that their contact is pretectonic and may well be intrusive; this would be consistent with relationships observed in the Cold Spring Pond area (Colman-Sadd, 1984).

North Bay Granite (Units 7 and 8):

The northern part of the North Bay Granite (Jewell, 1939; Dickson and Delaney, 1984) extends into the Great Burnt Lake area as two lobes around Island Pond and the Crooked Lake - Great Burnt Lake reservoir respectively. The latter lobe is separated from the main part of the intrusion by a zone (Units 3 and 7) of mixed metasediment (75 percent) and granite/granodiorite (25 percent) northwest of Ebbegunbaeg Dam.

Unit 7, which forms the greater part of the intrusion in the map area, consists of gray, medium grained, biotite granodiorite. Although in a few places the granodiorite is equigranular, generally it contains prismatic phenocrysts of potassium feldspar, 1 to 4 cm long (Plate 6). The granodiorite passes, over a fairly sharp transition zone along the Ebbegunbaeg Dam road, into pink, medium-fine grained, muscovite-garnet granite (Unit 8). Farther to the north, and south of the Island Pond lobe, the metasediments of Unit 3 are cut by numerous veins of pegmatite and aplite containing muscovite, garnet, tourmaline and beryl (Plate 4). Similar pegmatites also occur northeast of Island Pond, and another small intrusion of Unit 8 is suspected west of Great Burnt Lake on the basis of boulder distributions. Rocks of Units and 8 are, for the most part, undeformed, but in a few exposures, especially northwest of Island Pond, there is a very slight fabric defined by alignment of mica and elongation of quartz grains. In some exposures just west of Great Burnt Lake a gneissic foliation has resulted from the partial assimilation of metasedimentary xenoliths (Plate 7), and is not the result of post intrusion deformation.

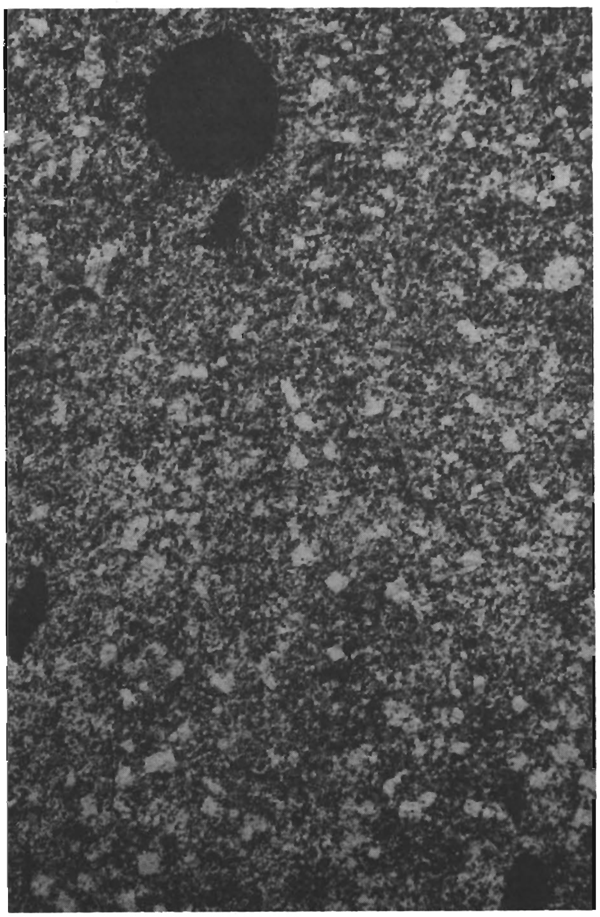


Plate 6: *Porphyritic granodiorite (Unit 7) of the North Bay Granite, east shore of Great Burnt Lake.*

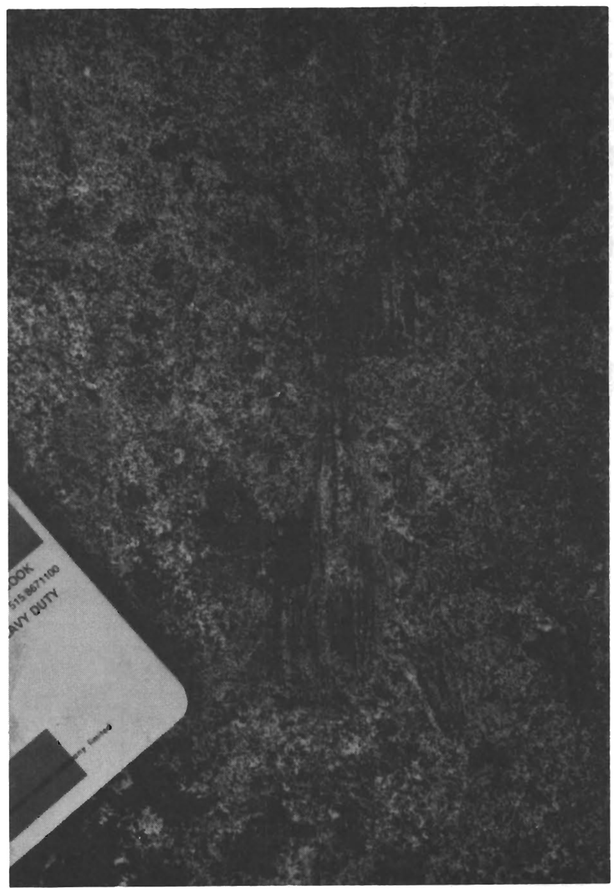


Plate 7: *Partially assimilated xenoliths of metasedimentary rock in granodiorite of Unit 7, just west of Great Burnt Lake.*

Both Units 7 and 8 have exposed intrusive contacts with Unit 3. The relationships to Units 4, 5 and 6 have not been observed, but are assumed to be intrusive and post-tectonic.

Pink Equigranular Granite (Unit 9):

Unit 9 has been observed in only two exposures in each of the Great Burnt Lake and Cold Spring Pond areas (Colman-Sadd and Swinden, 1983). It consists, in all of these localities, of unfoliated, equigranular, medium grained, pink biotite granite. The presence of a muscovite bearing phase is suspected from the occurrence of boulders of pink biotite-muscovite granite close to the exposures of biotite granite. The granite is assumed to be intrusive into Units 3, 5 and 7, although in the case of Unit 7 there is no structural evidence on which to base a time relationship.

MINERAL POTENTIAL

Higgins (1951) indicated that the main potential for economic mineralization in the Great Burnt Lake area resides in the ophiolitic and volcanic rocks of the Pipestone Pond complex (Unit 1) and the Great Burnt Lake volcanic belt (Unit 2). His recommendations have apparently turned out to be correct, although they may have been to some degree self-fulfilling, since they have caused exploration companies to ignore all units other than 1 and 2.

The present work has confirmed Higgins' opinion of most of the units in the western part of the area, but has also identified two exceptions. The highly differentiated granites of Units 8 and 9 present a prospecting environment that has only become popular in the northern Appalachians since the mid 1970's. Unit 8, in particular, appears to have formed from a silica rich fraction of the main North Bay Granite and occurs in close proximity to garnet-tourmaline-beryl pegmatites. The association is similar to that found 50 km away, near Granite Lake, where extensive tungsten mineralization is known to occur in highly differentiated parts of the same batholith (Dickson, 1982).

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