Geology of the east half of the Cold Spring Pond map area (12A/1), Newfoundland

by

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Introduction

During 1982, 1:50,000 scale mapping has been done in the part of the Cold Spring Pond area that is easily accessible from the road servicing the Upper Salmon River hydroelectric development. Together with the mapping of Swinden at the 1:20,000 scale (Swinden, 1981; Swinden and Collins, 1982), this year's work has resulted in detailed coverage of slightly more than half of the entire map area (Figure 1). Eastwards it connects with 1:50,000 scale mapping in the Twillick Brook area (2D/4) (Colman-Sadd, 1980a) and southwards with 1:50,000 scale mapping in the D'Espoir Brook area (11P/16) (Dickson and Tomlin, 1983). This report deals only with units that have been mapped during 1982. For descriptions of other units in the north of the area, which appear on the map but not in the text, the reader is referred to Swinden and Collins (1982).

Previous work in the Cold Spring Pond area has been reviewed by Colman-Sadd and Swinden (1982), and their report places it within the general context of the geological exploration of south-central Newfoundland. The first investigations were those of Murray (Murray and Howley, 1881) when he ascended the Salmon River system through Round Pond and the North Salmon River. Work done by the Buchans Mining Company during the 1950's has been summarized in the maps of Swanson (1952-1960); a study that is particularly relevant to the present project is a thesis by Slipp (1952) that was sponsored by the company, and which describes Round Pond and the adjacent area to the west. Exploration was done by the Hansa Syndicate in the northern part of the area during the late 1960's (Sander and Owen, 1968; Sander, 1969; Sander and Heshka, 1970); it involved both bedrock mapping and geophysical surveys. This work was followed up by Consolidated Morrison and Riocanex between 1975 and 1980 (Harris, 1976; Bucknell *et al.*, 1976; Bucknell, 1977; Bucknell and McKenzie, 1977a, b; Harris, 1980). Regional studies that have included the Cold Spring Pond area are the 1:250,000 map series of the Geological Survey of Canada (Williams, 1970), and the lake sediment geochemistry survey of the Newfoundland Department of Mines and Energy (Butler and Davenport, 1978).

Two main divisions of stratified rocks outcrop in the area. These are the North Steady Pond Formation in the north and west and the Salmon River Dam Formation in the south and east. Both formations are included in the Baie d'Espoir Group which is considered to be Lower to Middle Ordovician in age (Colman-Sadd, 1980b). Both formations have been polydeformed and, although mainly metamorphosed in the greenschist facies, locally show sharp metamorphic gradients up to migmatite. Migmatites form a domal structure around White Hill, and, to the west, a concordant belt along the southern edge of the North Steady Pond Formation. A large body of

Contribution to Canada-Newfoundland co-operative mineral program 1982-84. Project carried out by Newfoundland Department of Mines and Energy.

gabbro and diorite separates the migmatites from the outcrop of Salmon River Dam Formation in the south of the area, and gabbro also occurs at Round Pond. Biotite and biotite-muscovite granite occurs in the southeast corner of the area where it has intruded the White Hill migmatite and the Salmon River Dam Formation; it forms part of the North Bay Granite batholith (Jewell, 1939; Colman-Sadd, 1980b; Dickson and Tomlin, 1983). At the western limit of mapping there are isolated exposures of foliated megacrystic granite and quartz-rich migmatitic sedimentary rocks; further mapping is necessary to determine the relationships of these rocks to the other units.

SALMON RIVER DAM FORMATION (Unit 5)

Part of unit 5 is physically continuous with the Salmon River Dam Formation as mapped in the Twillick Brook (2D/4) and St. Albans (1M/13) areas (Colman-Sadd, 1976, 1980a). The outcrop south and west of Ahwachenjeesh Pond is separated from the main outcrop by granite and migmatite, but has the same lithologic characteristics. The unit is divided into a mainly medium to thick bedded variety (unit 5a) and a thin bedded variety (unit 5b). The latter can be separately mapped in the area of Godaleich Pond, where it appears to be transitional into thinly bedded and more argillaceous rocks of the North Steady Pond Formation. Elsewhere it occurs as a minor and unseparated component within the medium to thick bedded unit.

Rocks of unit 5a are composed mainly of quartzo-feldspathic siltstone and very fine grained sandstone in beds between 10 cm and 1 m thick. On fresh surfaces the rock is dark purplish gray and weathers light brown. The beds are mostly massive, but in a few there are faint diffuse parallel laminations of light green siltstone. A number of different kinds of thin interbeds occur. The most common of these are medium grained, purplish gray sandstone beds, 1 to 10 cm thick, with sharply defined tops and bases, cross laminations and load casts. Pelitic and semipelitic beds, 1 to 5 cm thick, are also common throughout the unit. Calc-silicate beds are a very distinct component of most parts of the unit; they are especially common west of Ahwachenjeesh Pond where they locally form up to 20 per cent of the rock. The beds consist of a white, medium grained matrix of quartz, plagioclase and clinozoisite, with disseminated needles of dark green actinolite. They are generally 1 to 5 cm thick and either massive or cross laminated. Light green quartzite occurs locally forming massive beds 3 to 30 cm thick; in an exceptional occurrence south of Round Pond this rock type is the only one represented in a series of exposures along 1.5 km of shoreline.

Unit 5b is composed of fine to medium grained purplish gray sandstone, interbedded on a scale of 1 to 10 cm with massive dark gray siltstone. The sandstone beds are characterized by well defined parallel and cross laminations. Minor pelitic and semipelitic beds are present, but calc-silicate and green quartzite beds are absent.

Most of the Salmon River Dam Formation has been metamorphosed in the greenschist facies and metamorphic biotite is visible in hand specimens of the siltstone and sandstone. Close to the North Bay Granite (unit 17) the formation contains porphyroblasts of biotite and chlorite, and there are chloritized spots that are thought to have been originally cordierite (Colman-Sadd, 1980a, p. 14). Exposures along the road within the outcrop of the White Hill migmatite (unit 14) have coarse biotite growth and contain quartz and granite segregations. Segregations are also present in some exposures on the west shore of Round Pond where the sediments are intensely deformed and contain discordant and concordant intrusions of foliated biotite granite.

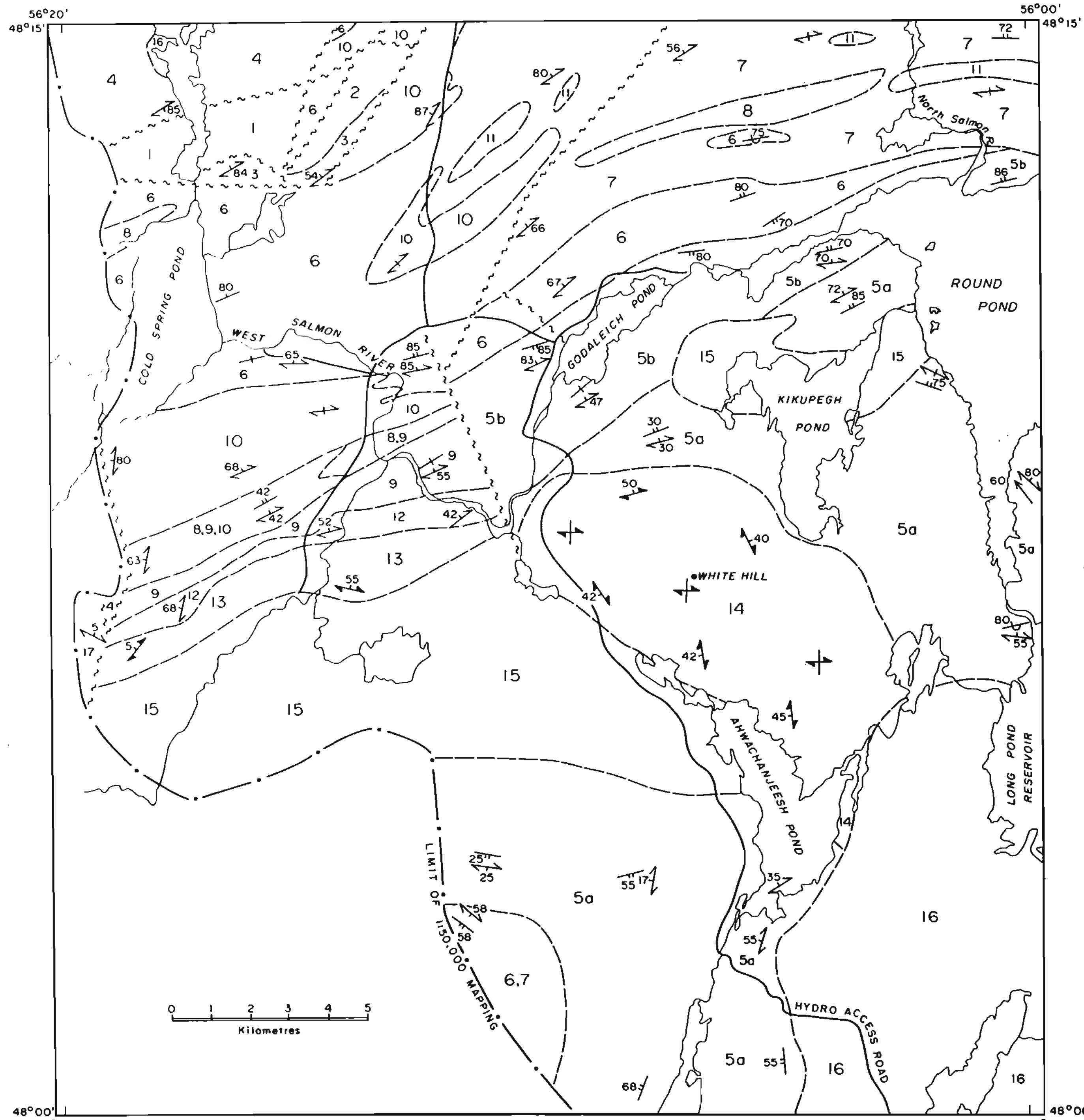

Figure 1: Geological sketch map of the eastern part of the Cold Spring Pond area. Note that information north of Godaleich Pond is simplified from Swinden (1981); only the area from Godaleich Pond southwards has been mapped during 1982 and is the subject of this report.

DEVONIAN OR OLDER

17 Foliated, megacrystic, biotite granite.

16 Equigranular to porphyritic, medium to coarse grained, biotite or biotite-muscovite granite. Includes North Bay Granite.

15 Gabbro, diorite and minor granodiorite.

14 Well foliated, medium to coarse grained migmatite, with schlieren structure.

13 Diffusely banded muscovite-biotite granite and migmatitic schist.

12 Psammitic schist with quartz and granite sweats.

LOWER TO MIDDLE ORDOVICIAN

Baie d'Espoir Group (no stratigraphic order implied by sequence)

North Steady Pond Formation and related units

11 Mafic pillow lava, massive basalt, pillow breccia. Includes considerable fine grained chloritic tuff and lesser fine grained sediments.

10 Silicic pyroclastic rocks; dark green to black, siliceous tuff with abundant quartz crystals and local concentrations of feldspar crystals and/or lithic fragments.

9 Dark green thinly bedded phyllite.

8 Conglomerate; polymictic, unstratified to poorly stratified boulder and pebble conglomerate; commonly matrix supported and poorly sorted.

7 Silicic tuff and reworked tuff, quartz and feldspar crystal tuff and crystal-lithic tuff; commonly unstratified but locally shows evidence of reworking.

6 Sedimentary rocks; includes gray to green, thick to thin bedded, arkosic sandstone, siltstone and laminated phyllite, with local, black, graphitic argillite.

5 **Salmon River Dam Formation:** Dark purplish gray siltstone and very fine grained sandstone, with minor calc-silicate, pelitic and quartzitic beds. 5a mainly medium to thick bedded; 5b thin bedded.

ORDOVICIAN OR OLDER

4 Psammitic to semipelitic schist and paragneiss.

CAMBRIAN TO LOWER ORDOVICIAN

3 Basalt; pillowed to massive flows, commonly variolitic, pillow breccia, minor tuff.

2 Coarse to medium grained gabbro and trondhjemite, with minor pyroxenite.

1 Peridotite; fine grained, commonly with pyroxene phenocrysts and disseminated chromite.

The first deformation of the Salmon River Dam Formation formed pervasive tight folds. A related axial planar cleavage is clearly seen in pelitic and semipelitic interbeds, but is poorly developed in the siltstone and sandstone beds that are the dominant rock type. In the outcrop south and west of Ahwachenjeesh Pond the folds are recumbent with a gently dipping cleavage and gently plunging axes. The strike of beds and cleavage tends to follow the boundaries of the adjacent igneous and metamorphic rocks. At the south end of Round Pond the axial planar cleavage dips moderately to the north and the folds, which face upwards, have overturned limbs towards the south and plunge moderately to the east. Northwards, away from the North Bay Granite contact, the strike and plunge become more northerly. Unit 5b, at Godaleich Pond and northern Round Pond, has a cleavage that dips moderately northwest, and forms folds that plunge gently to the northeast and are overturned to the southeast; exposures in the West Salmon River, southwest of Godaleich Pond show complex chaotic folding. Second deformation structures are most easily seen in the thin bedded rocks of unit 5b, where they form crenulations of the bedding and early cleavage.

NORTH STEADY POND FORMATION (Units 6,8-10)

Rocks which are provisionally assigned to the North Steady Pond Formation outcrop southeast of Cold Spring Pond and are along strike from rocks described by Swinden and Collins (1982). Similar rock types also occur southwest of Ahwachenjeesh Pond, but further mapping is required to establish how these relate to the geology of the area as a whole. The North Steady Pond Formation is characterized by volcanic rocks, which in the area described in this report are exclusively felsic crystal and lithic tuffs. Associated with the volcanic rocks are metasedimentary rocks ranging from phyllite to conglomerate. The contact between the North Steady Pond and Salmon River Dam Formations is exposed in the tailrace immediately northwest of Godaleich Pond. The small scale structure is so complicated, however, that it has obscured the original relationships of the two formations and although they appear to have been conformable, their stratigraphic order is uncertain.

Unit 6 consists of dark gray phyllite, siltstone and sandstone that weather light green. The sandstone is arkosic and forms graded beds 1 to 2 cm thick; close to the contact with unit 10 some of the beds are massive and contain prominent quartz crystals similar to those in the tuff of unit 10. The sandstone is interbedded with 2 to 3 cm beds of phyllite containing parallel laminae of siltstone.

Tuff of unit 10 forms a homogeneous outcrop, immediately southeast of Cold Spring Pond, that narrows towards the northeast and appears to pass laterally into unit 6. South of this homogeneous zone is a belt in which tuff (unit 10) is mixed with conglomerate (unit 8) and green phyllite (unit 9). The tuff is dark gray, unbedded and fairly well cleaved. Quartz crystals up to 2 mm across form up to 10 per cent of the rock, and there are also smaller amounts of feldspar crystals and disseminated grains of pyrite. At the southern boundary of unit 10, in the West Salmon River, there has been sericitic alteration and the rock weathers mostly brown instead of the more usual white. In the zone where tuff is interbedded with conglomerate, it contains lithic fragments and there is some difficulty in making a distinction between the two rock types. One particularly good exposure of probable lithic tuff is essentially unbedded and consists mainly of crystals and flat felsic volcanic fragments between 1 mm and 1 cm across; exceptional fragments are as long as 5 cm with a maximum thickness of about 1 cm. Rare accidental fragments of granite are rounded, unflattened and form augen within the fabric. In the West Salmon River, felsic volcanic rocks are absent from this horizon which is composed entirely of interbedded conglomerate and phyllite. The phyllite is dark green and beds are defined by dark, slightly more pelitic, 1 to 5 mm laminae between the 1 to 5 cm beds of the dominant rock type; locally thin siltstone beds occur.

Metamorphism of the North Steady Pond Formation was in the greenschist facies except in a southwest trending zone adjacent to the linear outcrop of migmatite (units 12-13). Across the zone, which is about 2 km wide, there is a rapid increase in grade, from rocks containing first chlorite porphyroblasts and then andalusite in semipelitic compositions, to migmatite and granite. Exposures of psammitic schist with granitic segregations (unit 12) in the southernmost bend of the West Salmon River are thought to have been originally felsic tuff because of their unbedded nature and the presence of what may be relict quartz crystals.

The structural history of the North Steady Pond Formation is similar to that of the Salmon River Dam Formation. The first deformation formed a penetrative cleavage in most rock types and bedding has been tightly or isoclinally folded. The cleavage dips steeply to the northwest except at the western edge of the outcrop where it appears to parallel an assumed fault extending south from Cold Spring Pond. Bedding-cleavage intersection lineations plunge gently to the northeast. Second deformation structures are limited to steeply plunging crenulations and vertical kink bands.

MIGMATITES (Units 12-14)

Migmatitic rocks form two areas of outcrop that may or may not be genetically related. The first of these is the narrow zone of migmatized metasedimentary rock and granite at the southern edge of the North Steady Pond Formation (units 12, 13). The second is the elliptical outcrop of migmatite that is centered on the White Hill (unit 14).

The progressive southward metamorphism of the North Steady Pond Formation has produced thin concordant quartz and granite sweats in the largely unbedded psammitic schist (unit 12) that extends across the south lobe of the West Salmon River. Where the unit is exposed farther to the southwest across the river's tributary, the sweats can be seen to increase in size from 1 mm lenses into sheets of biotite granite up to 15 cm thick, until the metasediment has become completely pervaded by granite and is a foliated migmatite. Exposures within about 1 km of the contact with the gabbro/diorite of unit 15 vary from a diffusely banded muscovite-biotite granite (nebulitic migmatite of Mehnert, 1971) to a quartz-biotite schist with an interfolial migmatitic matrix (unit 13). A fabric defined by mica orientations parallels the banding which locally is isoclinally folded. The migmatite contains sheets of black carbonaceous schist and abundant xenoliths of psammitic schist, finely banded psammite and quartzite, massive gabbro, epidote and tremolite-talc schist.

The migmatite around the White Hill is more homogeneous than that at the edge of the North Steady Pond Formation even though it underlies a greater area. There is no section that shows a clear metamorphic gradation from surrounding low grade rocks, either because the gradation does not exist, or else, as is more likely, because it is unexposed. The Salmon River Dam Formation which forms most of the country rock shows incipient migmatization farther east at the western edge of Round Pond and also in isolated exposures of the formation within the main White Hill migmatite outcrop. It is possible, therefore, that the migmatite has been derived by ultrametamorphism of this formation. Typically the rock consists of coarse grained biotite foliae or schlieren (Mehnert, 1971) spaced 2 mm to 5 cm apart in a granite leucosome. The foliae define complex flow folds and intrafolial isoclines are present in some exposures. The leucosome is medium grained equigranular biotite-muscovite granite with disseminated tourmaline. The migmatite contains xenoliths, up to 1 m across, of foliated amphibolite, as well as xenoliths and screens of psammitic and semipelitic schist some of which appear to be bedded. Some of the xenoliths are folded or boudinaged and their foliations may be strongly discordant with that in the migmatite itself. The semipelitic schist locally contains sillimanite porphyroblasts. Dikes of muscovite-garnet-tourmaline granite, aplite and pegmatite crosscut many of the exposures and quartz veins are common. Measurements of the gross orientation of the migmatite foliation show that it is generally flat in the centre of the outcrop, and that it dips at moderate angles towards all the contacts, except for that in the southeast with the North Bay Granite. The entire outcrop has the form of an elongated dome.

GABBRO/DIORITE (Unit 15)

Two intrusions of gabbro, diorite and very minor granodiorite have been mapped in the area. The first of these, at Kikupegh and Round Ponds, is probably continuous with the Round Pond Gabbronorite of Colman-Sadd (1980a). It is interpreted as intrusive into the Salmon River Dam Formation although no actual contacts are exposed. The second intrusion stretches west from Ahwachenjeesh Pond and the edge of the White Hill. It is bordered on the south by the Salmon River Dam Formation and on the north by migmatite of unit 13; the natures of the contacts are unknown because none are exposed. Likewise the contact with the White Hill migmatite (unit 14) may be a fault or may be intrusive; if the latter is the case, it is not known which unit is intrusive into which. It is possible that the two mafic intrusions were originally one and have been split apart by diapiric emplacement of the White Hill migmatite. The northeasterly intrusion and the migmatite are separated by an area of no exposure which could be underlain by gabbro, although it is not interpreted to be so on the map. Furthermore, mafic xenoliths are a characteristic component of the migmatite terrain. The xenoliths, however, are commonly foliated and do not bear a striking resemblance to either of the mafic intrusions.

Both intrusions consist mainly of gabbro composed of plagioclase, hornblende, biotite and accessory pyrite; the hornblende:biotite ratio varies considerably and, locally, substantial amounts of quartz are present. The rock is light to dark greenish gray, medium grained, equigranular and massive. A tectonic fabric is only rarely present; in the west intrusion it is either a horizontal lineation or a flat planar fabric, whereas the intrusion at Round Pond is cut by several steeply dipping shear zones that appear to be related to the regional structure. The west intrusion varies from gabbro to granodiorite but within any one exposure is homogeneous; the Round Pond intrusion, however, consists entirely of gabbro, but within single exposures different phases, distinguished by grain size, show intrusive contacts. Both intrusions contain small clots of biotite and hornblende as well as xenoliths of biotite psammite, amphibolite and coarse pyroxenite; the largest xenoliths are a metre across. Both intrusions are also commonly cut by quartz-feldspar-tourmaline veins, generally 10 cm or less in width; veins of gabbro aplite and pegmatite, the latter with 5 cm long hornblende crystals, occur in some parts of the west intrusion.

NORTH BAY GRANITE (Unit 16)

The North Bay Granite outcrops in the southeastern corner of the map area. It forms part of a batholith that extends south into the D'Espoir Brook area (11P/16) (Dickson and Tomlin, 1983), east into the Twillick Brook area (2D/4) (Colman-Sadd, 1980a) and southeast into the St. Albans area (1M/13) (Colman-Sadd, 1976).

No contacts between the granite and surrounding rocks have been observed in the Cold Spring Pond area. The granite, however, is quite clearly intrusive into the Salmon River Dam Formation from evidence outside the area (Colman-Sadd, 1980b) and from the increase in metamorphism of the formation close to the contacts. Garnet-tourmaline-muscovite granite veins that cut the granite and appear to be genetically related to it also form an integral part of the White Hill migmatite terrain (unit 14).

The granite has two main phases which appear to be gradational into each other. At the southern edge of the area is a porphyritic granite, in which white potassium feldspar phenocrysts are set in a medium grained equigranular matrix of biotite granite. The phenocrysts have square or rectangular cross sections with dimensions up to 10 cm by 5 cm, and in many places there is a slight preferred orientation. Northwards the proportion of phenocrysts decreases and muscovite occurs as a primary constituent of the granite in some exposures. Occurrences of the granite east of Ahwachenjeesh Pond are all equigranular and contain both muscovite and biotite.

FOLIATED MEGACRYSTIC GRANITE (Unit 17)

South of Cold Spring Pond, two exposures of foliated, megacrystic, biotite granite occur along strike from rocks of the North Steady Pond Formation and its migmatized equivalents. The granite is assumed to be separated from the metasedimentary rocks by a fault since there is no indication from veining or metamorphism that there may be an intrusive contact. Mapping during 1982 has only been sufficient to indicate the presence of this unit; its extent and true relationships to the other units may become clear with further work.

MINERAL POTENTIAL

The rocks with the most obvious potential for economic mineral deposits in the area are the volcanic units of the North Steady Pond Formation (units 6,8-10). Mapping during 1982 has extended detailed coverage of the formation a few kilometres farther to the southwest, but has not added any new metallogenic information. The reader is therefore referred to Swinden and Collins (1982) for a discussion of the economic geology of these rocks and in particular for information on their relationship to the pyrrhotite-chalcopyrite mineralization farther to the north at Great Burnt Lake. The most significant discovery with regard to the volcanic rocks in the Cold Spring Pond area is that they also occur near its southern edge; only a few exposures have been visited and these are at the extreme limit of mapping, but they do indicate that there may be significant outcrops of volcanic rocks in country that has not previously been regarded as having high potential.

The North Bay Granite (unit 16) gives no indication of mineralization, but it should be remembered that the same batholith is mineralized at Granite Lake, 70 km to the west (Dickson and MacLellan, 1981). The migmatites (units 12-14) likewise are unmineralized except for widespread disseminations of pyrite; the best potential is in units 12 and 13 which may have been derived from volcanic rocks and which could, therefore, have inherited metamorphosed massive sulphide deposits. There is no indication that the Salmon River Dam Formation (unit 5) and the gabbro/diorite intrusions (unit 15) are anything but barren.

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