

## GEOLOGY OF THE EASTERN PORTION OF THE DAWES POND (NTS 12H/1) MAP AREA, CENTRAL NEWFOUNDLAND

W.L. Dickson, P.Geo.  
Regional Mapping Section

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### ABSTRACT

*The northwestern part of the Dawes Pond map area (NTS 12H/1) is underlain by Early to Middle Ordovician volcanic and sedimentary rocks of the Roberts Arm Group. To the east, much of the Roberts Arm Group is in fault contact with psammites, tentatively assigned to the Badger group. In the southern portion of the area mapped, volcanic and sedimentary rocks of the Roberts Arm Group are interpreted to have overthrust the Badger group. In the Powderhorn Lake area, a newly discovered area of felsic tuff is correlated with the Roberts Arm Group and is interpreted to have been overthrust by a sequence of pelite and psammite assigned to the Caradocian Shoal Arm Formation and the overlying Badger group, respectively. A fault-bound slice of highly deformed pillow lava within the Badger group at Burnt Pond is assigned to the Roberts Arm Group.*

*The Upper Ordovician–Early Silurian, turbiditic, pebble conglomerate and sandstone of the Badger group form a series of overturned folds that have been openly refolded in the Badger Brook area. In the area extending northeast from Dawes Pond, contact metamorphosed biotite ± muscovite ± cordierite ± andalusite ± garnet psammite and pelite are assigned to the Badger group. In the northeastern Burnt Pond area, thick-bedded sandstone and cordierite pelite are assigned to the Badger group. Along the rail line north of Badger, the core of an overturned anticline within the Badger group contains slate of the Shoal Arm Formation in which late Caradocian graptolites were found.*

*The western termination of the Hodges Hill intrusive suite, which occurs within the area mapped, is dominated by massive, medium-grained, pyroxene gabbro that is cut by several granite plutons and numerous granite and rhyolite dykes. The Dawes Pond granodiorite is a massive medium-grained biotite–hornblende granodiorite that has intruded the Roberts Arm Group and the Badger group. Diabase dykes are common and cut all units within the area.*

*Pyrrhotite mineralization occurs in two separate areas within gabbro plugs and dykes at the western margin of the Hodges Hill intrusive suite. The mineralization assayed up to nearly one percent Ni, but nickel minerals have not been identified.*

*The Roberts Arm Group is the host of the former Gullbridge copper mine and the Lake Bond copper–lead–zinc prospect; both lie just outside of the area studied. Immediately to the north of Powderhorn Lake, exploration work has recently indicated the presence of significant zinc–copper ± lead mineralization. Along with the previously known zinc prospect located nearby on Powderhorn Lake, there is potential for a significant area of mineralized tuff.*

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### INTRODUCTION

The eastern portion of the Dawes Pond map area (NTS 12H/1) was mapped at a scale of 1:50 000 during the summer of 1999. The northwestern part of the map area is underlain by the Early to Middle Ordovician bimodal volcanic and sedimentary rocks of the Roberts Arm Group (Figure 1). To the east, much of the Roberts Arm Group is in thrust contact with psammites tentatively assigned to the Badger group. In the Powderhorn Lake area, a newly discovered area of felsic tuff is correlated with the Roberts Arm Group.

The Upper Ordovician–Lower Silurian turbiditic pebble conglomerates and interbedded sandstones of the Badger group are found mainly in the southeast of the map area. Along the rail line north of Badger, the core of an overturned anticline contains slate in which Caradocian graptolites are found. In the Burnt Pond area, thick-bedded sandstone is assigned to the Badger group. A fault-bound slice of highly deformed pillow lava lying within the Badger group is assigned to the Roberts Arm Group.

The massive gabbro and granite rocks of the Silurian Hodges Hill intrusive suite have intruded the Roberts Arm

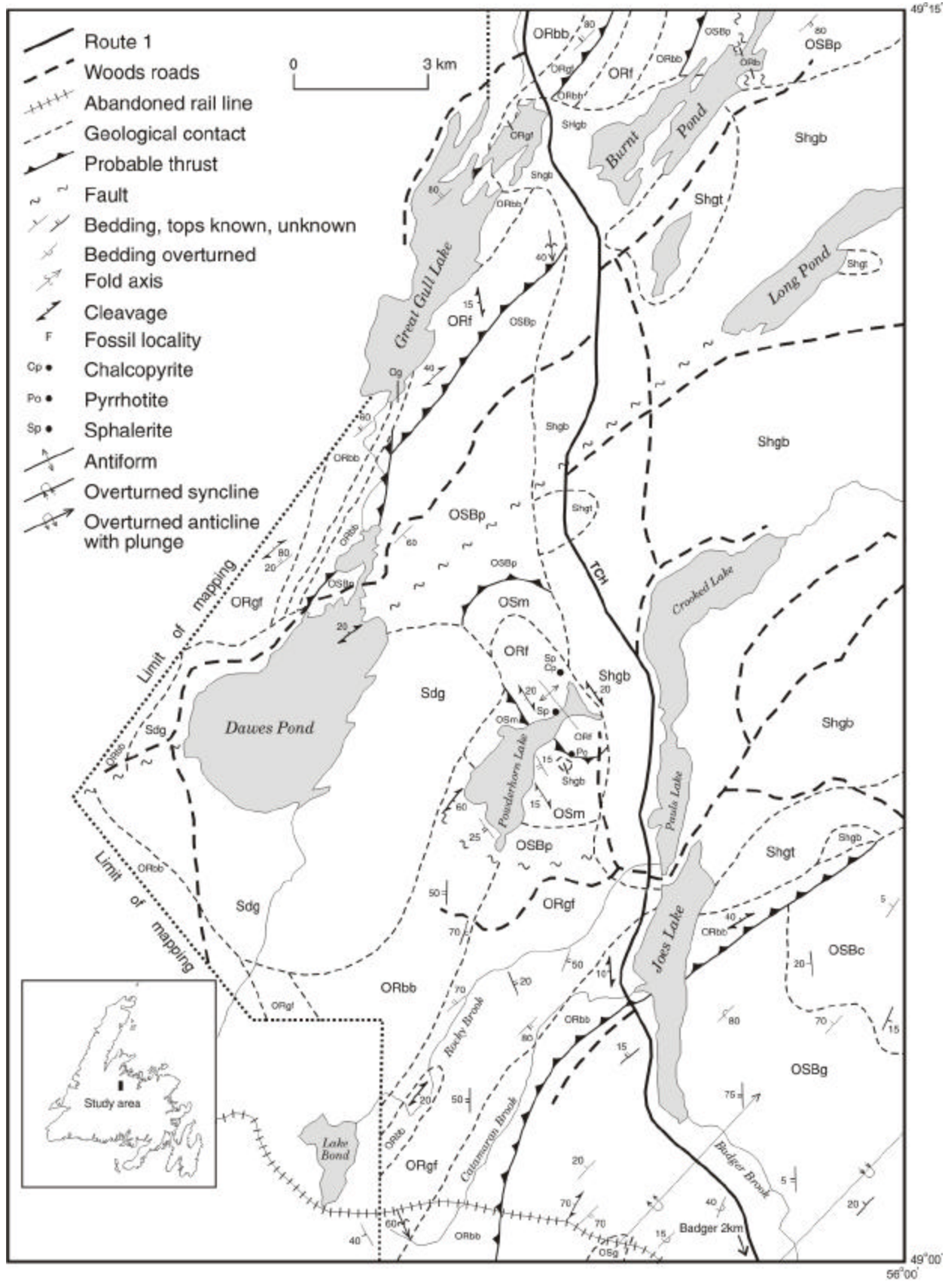


Figure 1. General geology of the eastern portion of the Dawes Pond (NTS 12H/1) map area.

## LEGEND

### SILURIAN

Hodges Hill intrusive suite (Sh)

Shgt Massive, buff to pink, equigranular, medium- to coarse-grained, biotite granite

Shgb Massive, grey, equigranular, medium- to coarse-grained pyroxene gabbro

Dawes Pond granodiorite

Sdg Massive, buff to grey, equigranular, medium-grained biotite ± hornblende granodiorite

### LATE ORDOVICIAN to EARLY SILURIAN?

Badger group (OSB)

OSBc Very thick-bedded chert- and volcanic- and granitic-pebble conglomerate and coarse-grained sandstone

OSBs Thick-bedded, crossbedded and graded, grey sandstone

OSBp Thin- to medium-bedded, biotite ± muscovite ± cordierite ± garnet semi-pelite and psammite

### LATE ORDOVICIAN

Shoal Arm Formation (OS)

OSm Highly metamorphosed, grey to black, cordierite pelite interbedded with minor thick-bedded, quartz-rich sandstone; possibly equivalent to the Shoal Arm Formation

OSg Thin- to medium-bedded, grey to black, slate and siltstone containing Late Caradocian graptolites

### LOWER ORDOVICIAN

Og Massive, metamorphosed, coarse-grained, pyroxene gabbro

Roberts Arm Group (OR)

ORf Thick- to thin-bedded felsic tuff, locally containing quartz and feldspar phenocrysts, and thick-bedded feldspathic sandstone; in the Powderhorn Lake area, the tuff is highly altered to rusty gossan and quartz-sericite schist and contains pyrite, pyrrhotite ± chalcopyrite ± sphalerite mineralization

ORb Strongly sheared pillow basalt and massive basalt flows

ORbb Massive basalt flows and pillowed basalt; minor rhyolite and felsic tuff

ORgf Interbedded felsic tuff and rhyolite, chert and minor sandstone, minor massive and pillowed basalt

and Badger groups. This portion of the suite is dominated by medium-grained gabbro that is cut by several small granite plugs and numerous granitic and rhyolitic dykes. The Dawes Pond granodiorite forms a large ovoid intrusion of massive biotite-hornblende granodiorite and minor tonalite and granite. Massive diabase dykes are common and cut all the units within the area.

The Roberts Arm Group is the host of the former Gull-bridge copper deposit and the Lake Bond copper-lead zinc prospect; both lie just outside of the area studied. South of Powderhorn Lake pyrrhotite-rich gabbro dykes and plugs have assayed nearly one percent nickel. Immediately to the north of Powderhorn Lake, recent prospector and company

exploration work has indicated the presence of significant zinc-copper ± lead mineralization.

### REGIONAL SETTING

The Dawes Pond map area is located within the Dunge Zone and straddles the "Red Indian Line", which is the boundary between the Exploits and Notre Dame subzones (Williams *et al.*, 1988). In the map area, this boundary is described by Williams *et al.* (1995) as separating the Early Ordovician Roberts Arm Group of the Notre Dame Subzone from the Middle Ordovician and younger Shoal Arm Formation and the Badger group of the Exploits Subzone. The eastern portion of the map area is dominated by the western

portion of the probable Silurian Hodges Hill intrusive suite, a composite batholith composed of a variety of posttectonic gabbros, granodiorite and granites.

## LOCATION AND ACCESS

The southeast corner of the Dawes Pond map area is located about 2 km north of the town of Badger and the northeast corner is located 20 km south of the town of South Brook; within the area studied there are no communities. However, there is a large concentration of cabins along the western shores of Joes Lake, Pauls Lake and Crooked Lake (collectively locally termed "Badger Lake"). Other cabins are scattered throughout the area, mainly where woods access roads are close to ponds.

The Trans-Canada Highway (TCH) runs northward through the entire length of the map area. The present-day TCH has replaced much of the Badger Halls Bay Road (also termed the "Halls Bay Line") but from Crooked Lake to Burnt Pond, the original Halls Bay Line is preserved although it is locally overgrown by alders. Much of the map area is accessible by major networks of gravel forest access roads that cover the eastern and western parts of the map area. These roads also provide access to the larger ponds for boat work. The more extensive areas of bog with little bedrock exposure in the Dawes Pond to Long Pond area were surveyed by helicopter.

There are numerous branch roads and trails, representing several generations of logging activity, many of which are passable only with difficulty by use of an ATV. Several major woods-roads shown on the published topographic map are in bad condition and are hazardous for use by ATV because of severe washouts, e.g., west of Dawes Pond. Most of the woods roads are not shown on the topographic map but are visible on the 1983 1:12 500-scale colour aerial photographs. However, there has been extensive woods road construction since 1983 in the areas to the east of Joes Lake and south of Burnt Pond.

The abandoned Newfoundland Railway line runs through the southern portion of the map area. The rail bed is accessible from Badger and currently motor vehicles are permitted to use the rail bed. In the near future, use of the rail bed by motorized vehicles will be restricted to ATVs, motor cycles and snowmobiles.

Several of the larger ponds and lakes in the area are navigable by boat and provide access to large areas and also numerous exposures. These include Great Gull Lake, Lower Gull Lake, Burnt Pond, Long Pond, Dawes Pond, Powderhorn Lake, Joes Lake, Pauls Lake and Crooked Lake. Badger Brook is navigable by boat or canoe upstream from Bad-

ger for about 2 km. Access to the poorly exposed and more isolated parts was gained on foot or by helicopter available at Glenwood and Gander to the east, or from Pasadena, to the west.

The topography of the area is gently rolling with only a few steep hills and cliffs to the east of Crooked Lake. Extensive areas of bog having only isolated bedrock exposures lie to the south and northeast of Dawes Pond. A veneer of till covers most of the area varying in thickness from one to over ten metres. The till is thickest on the southwest-facing slopes of the larger hills. Outwash sand and gravel form thick deposits immediately to the west and north of Dawes Pond. A northeast-trending crag-and-tail is well displayed to the south of Burnt Pond.

## PREVIOUS WORK

The earliest geological excursion into the area was by James P. Howley in 1875 who climbed Hodges Hill starting from Badger and ascending the lower portion of Badger Brook. No geological observations were recorded from the Badger area. An engineering survey was started in 1882 by Howley and Mr. Charles Harvey C.E. from Grand Falls to Halls Bay to determine a route for a railway line. Harvey started at Halls Bay and Howley at Grand Falls with the intent of meeting at Badger. However, Harvey did not appear at Badger and Howley canoed up Badger Brook and "Badger Lake" and ascended the highest hills to try and find Harvey. This was the only trek by Howley into the area and geological observations were not recorded (Murray and Howley, 1918, page 40).

The geological map of Newfoundland by Howley (1907) indicates that the eastern portion of the Dawes Pond area is composed of "Serpentine, diorite, diabase etc." having intruded undetermined "Laurentian" rocks to the west.

Most of the early geological research was concerned with the mineralization known from the west side of Great Gull Lake (commonly referred to as Gull Pond in various reports). Martin (1983, page 85) reports that the Gull Pond copper deposits were discovered in 1905 by George Gillard, although the discovery was possibly made by Levi Joe in 1903. The Rent Roll of Mining Locations indicates that the Great Gull Lake area was first leased to the Great Gull Lake Copper Company in 1917.

Dougherty (1928) refers to a 1919 report by Forbes of the Natural Resources Department of the Reid Newfoundland Company. Forbes obtained mineralized samples from surface workings and subsequently Reid Newfoundland Company optioned the ground, possibly from Edward Doyle (*see* Department of Natural Resources, 1909?, page 14), or

from the Great Gull Lake Copper Company, and carried out some drilling which indicated a copper orebody. However, the ground was dropped in 1923 as the terms of the option were considered by the company to be "onerous" (Dougherty, 1928, page 1).

The first detailed report of the map area was by Snelgrove (1923), who provided a summary of the rock types, geological structure, and drilling results in the Great Gull Lake area (near the site of the former Gullbridge Mine). He described various diabase units, including gneissic diabase and banded chert mainly from the vicinity of an "Iron Hat" on the north shore of Great Gull Lake. He did include a brief description of diabase from the eastern shore of the lake. He also interpreted the structure of the units to be a series of northeast-trending parallel folds that had been modified by shearing.

Lundberg (1928) (included in Dougherty, 1928) carried out a reconnaissance geological and magnetic survey to the northeast of Great Gull Lake (assumed by the writer to be Lower Gull Pond and the area to the northeast). Mineralized boulders containing "copper ore and pyrite" had been located. The contact between basalt and diabase with granite was mapped out.

Bray (1929) carried out a petrographic study of the cordierite-bearing rocks that hosted the copper mineralization at Great Gull Lake. No regional mapping was carried out but the presence of a variety of mafic, felsic, sedimentary and plutonic rocks in the general area was noted.

John Jesse Hayes and assistants mapped the Dawes Pond map area (formerly Gull Pond; NTS map area 12H/1) as far west as the Badger-Halls Bay road (now partially replaced by the Trans-Canada Highway) as part of a survey of the Hodges Hill (NTS 2E/4) map area. This work started in 1947 with the Geological Survey of Newfoundland and continued in 1949 with the Geological Survey of Canada. The reports, map and thesis by Hayes (1947, 1951a,b) and a report and map by one assistant B.G. Craig (1949) are the first known regional geological reports and maps on the area. Hayes (1947) described in some detail the various rock units and their relationships in the Hodges Hill-Badger Lake area, noting the folding in the rocks east of Joes Lake. The sedimentary rocks were assumed to be Middle Ordovician and the intrusive rocks viz., Twin Lakes gabbro, the Hodges Hill granite, and mafic dykes were all post-Middle Ordovician.

Hayes (1951a) provided the first published map of the geology of the eastern portion of the Dawes Pond map area. The stratigraphic nomenclature of Heyl (1936) was adopted by Hayes and the sedimentary rocks were considered to be

equivalent to the Sivier, Sansom and Hornet formations of the Ordovician Exploits Group. The intrusive rocks were generally considered to be of Devonian age. In his thesis, Hayes (1951b) described the sedimentary rocks, the extensive, high-grade, contact metamorphism of the sedimentary units adjacent to the gabbro, and the mineralogy and textures of the diorite and gabbro of the Twin Lakes diorite, Hodges Hill granite and mafic dykes. Hayes (1951b) also indicated that there was evidence of interaction between the diorite and granite. The glacial features indicated movement toward the northeast.

Craig (1949) produced the first detailed geological map of the eastern part of the Dawes Pond map area. He also included the various sandstones and grits along with the plutonic and metamorphic rocks up to three miles west of the Halls Bay Line. Much of the lithological description was also given by Hayes (1947). The sedimentary rocks in the Badger Brook area were interpreted as forming a broad synclinal structure.

An aeromagnetic survey was carried out by for the Newfoundland and Labrador Corporation Ltd. (Nalco), which included the Dawes Pond map area (Aeromagnetic Surveys Ltd., 1950). No significant anomalies were reported from the area.

Falconbridge Mines Ltd. (1954) produced a compilation map that included the area along the Halls Bay Line. The map appears to be based on Hayes (1951a) but, in error, their legend indicates that the gabbro of Hayes is shales and slates (their Unit G).

Kalliokoski (1955) produced the first detailed geological map (one inch to one mile scale) of the 12H/1 map area. The sedimentary and volcanic rocks were assigned to the Middle Ordovician? Badger Bay 'Series' of Espenshade (1937). The oldest sequence of rocks was located mainly in the eastern portion of the map area, and comprising greywacke, conglomerate, slate, chert, basalt and pillow lava. Kalliokoski (*op. cit.*) indicated that two fossil localities in the formation occur along the rail line, about 4 km south of Joes Lake. However, no description of the fossils was presented. Stratigraphically overlying this sedimentary sequence was a sequence of mainly mafic volcanic rocks, which was in turn, overlain by the "Crescent Lake formation" containing a variety of felsic, mafic and sedimentary rocks. An alternating sequence of felsic and mafic volcanic rocks and minor sedimentary rocks, extending from Lake Bond to north of Great Gull Lake, was assigned to the "Roberts Arm formation". The map of the plutonic rocks showed less detail and some internal intrusive contacts were different from those of Hayes (1951a, b). Sphalerite mineralization was noted from the northwest shore of Powderhorn Pond.

In the mid-1950s, extensive mineral exploration and mapping was carried out on Reid Lot 50, which extended from the rail line south of Lake Bond to north of Dawes Pond and the adjacent areas to the north, east and west for British Newfoundland Exploration Ltd (Brinex) and New Jersey Zinc (Canada) Ltd. A good summary of the geology is given by Newman (1956, 1957) who gave detailed descriptions, including thin-section analyses, of the felsic and mafic volcanic rocks, sedimentary rocks, Dawes Pond granite, rhyolitic and basaltic dykes and mineralized units. Extensive areas of metamorphic rocks, described as gneisses, were considered by Newman (*op. cit.*) to be related to the effects of the Dawes Pond granite. The mineralization included chalcopyrite, galena, pyrite and sphalerite. The chalcopyrite was concentrated in the mafic flows and the galena, pyrite and sphalerite were found mainly in the felsic volcanic rocks. The Powderhorn Lake sphalerite showing of Kalliokoski (1955) was included in the report and Newman (*op. cit.*) reported that sphalerite was not found but there was extensive pyrite and traces of chalcopyrite.

Timofeeff (1956) reported on field work in the Burnt Pond area, which extended from Powderhorn Lake northward to the adjacent NTS 12H/8 map area and, eastward, to include the eastern portion of the NTS 2E/4 map area. The highly metamorphosed rocks in the Powderhorn Lake to Burnt Pond area were interpreted to be the oldest formation. He interpreted the sedimentary and basaltic sequence east of Burnt Pond to be younger and overlie the Powderhorn Lake sequence. The sedimentary rocks and basalt flows in the Gull Pond area were interpreted to be "in part younger" than the Powderhorn Lake succession. Variations were noted in the texture, grain size and mineralogy of the extensive "North Twin Lake diorite complex". Brief descriptions of widespread mineralization in the vicinity of Powderhorn Lake indicated the presence of pyrite, chalcopyrite, sphalerite. Three quarters of one mile (about 1300 m) north of Powderhorn Lake, chalcopyrite was found in "rhyolite bedrock". The presence of graphite in the sedimentary rocks at Powderhorn Lake was noted so that it would be taken into account in interpretations of the geophysical anomalies. In an accompanying letter, Timofeeff describes an anticlinal structure at Powderhorn Lake.

Bedford (1957) reported on detailed mineral exploration and drilling in the area between Powderhorn Lake and the Trans-Canada Highway. This work was the result of earlier Brinex geophysical exploration (cited in Bedford, 1957) by S. Roderick in 1956 (reference not available) and soil geochemistry by J. Hansuld in 1957 (reference not available). Location maps are missing from the Bedford report but it is clear from the report that the drill sites were located west of the "metasediment diorite" contact of Kalliokoski (1955) and Powderhorn Lake. The drill sites were based on

the EM conductors and they were interpreted to reflect the presence of graphite in the metasedimentary rocks. Minor pyrite and pyrrhotite mineralization was noted but assays for copper and zinc were "negative".

Upadhyay (1970) and Upadhyay and Smitheringale (1972) carried out a detailed study of the mineralogy and metamorphism of the host rocks at the Gullbridge Mine. They also produced a sketch map indicating that the area east of Great Gull Lake contained a variety of sedimentary, mafic and felsic volcanic rocks, sedimentary rocks and gabbro. The metamorphism of the host rocks was interpreted to be related in part to heat accompanying emplacement and crystallization of the adjacent intrusions such as the Twin Lakes diorite.

Questor Surveys Ltd. (1972) carried out airborne electromagnetic surveys in the area around Dawes Pond as part of a more extensive study of the Brinex Concession for Noranda Exploration Co. Ltd. Numerous magnetic anomalies were obtained in the Powderhorn Lake area and these were interpreted to reflect pyrrhotite mineralization.

Numerous reports were written on mineral exploration in the Roberts Arm Group during the seventies mainly on prospects west of the area covered in this report. Among these, Swinden (1975) reviewed the geology of the Great Gull Lake to Lake Bond area and suggested a stratigraphic succession for the Roberts Arm Group.

Dean (1977) published a compilation map of the Dawes Pond (formerly named Gull Pond) map area. The Roberts Arm Group was considered to be of Upper Ordovician to Silurian age as it was interpreted to overlie the Upper Ordovician Point Leamington Formation (Badger group). The various plutonic rocks were Devonian or younger.

Stirling (1978) carried out a detailed petrographic and geochemical study of a thick granitic dyke that had intruded the gabbro near Crooked Lake. Stirling concluded that the gabbro was between 75 and 100 °C when the dyke was emplaced.

Swinden (1984) summarized the geology of the Great Gull Lake area indicating that the oldest unit was the Sansom Greywacke (now included in the Badger group). It was interpreted to structurally underlie the the Crescent Lake Formation that formed the lower part of the Roberts Arm Group, the contact being possibly a fault. A conformable sequence of rhyolites and basalts, forming the upper portion of the Roberts Arm Group, was considered to stratigraphically overlie the Crescent Lake Formation. The entire sequence was also interpreted to young to the west.

Swinden and Sacks (1985, 1986, 1996) carried out a study of mineral occurrences along with some regional mapping in the Lake Bond to Hand Camp area (NTS 12H/8, just north of the Dawes Pond map area). They suggested that the sedimentary rocks east of Great Gull Lake were probably not equivalent to the Sansom Formation as they were highly metamorphosed and locally highly deformed. The possibility of an Early Ordovician or older age was proposed for these metasediments, although Swinden and Sacks (1996) indicate that these rocks are of uncertain age, possibly ranging from Early Ordovician to Silurian.

Dunning *et al.* (1987) dated felsic tuff from the Roberts Arm Group at Roberts Arm and showed that it was equivalent in age to the Buchans Group at about 472 Ma (uppermost Arenig of Tucker and McKerrow, 1995). This date clearly indicated that the Roberts Arm Group was older than the Sansom Formation.

A detailed aeromagnetic total-field, gradiometer and VLF-EM survey was carried out by the Geological Survey of Canada in the Hodges Hill map area as part of a larger survey (*see* Geological Survey of Canada, 1988a, b; Tod and Ready, 1989a, b). These data highlighted many of the lithological and structural features in the map area. Faults and contacts such as the western margin of the Hodges Hill intrusive suite are quite apparent. A digital presentation of the geophysical data from this survey is available in Davenport *et al.* (1996).

Pope *et al.* (1990) greatly modified the stratigraphy and structural interpretation of the Roberts Arm Group, in the Great Gull Lake area, by proposing that many of the stratigraphic contacts of previous workers were actually thrust faults and that many of the units were repeated by tight folding. The highly metamorphosed rocks to the east of Great Gull Lake (their eastern felsic tuff) were considered to be possibly the youngest unit of the Roberts Arm Group but to be in tectonic contact with other units.

Ice-flow directions were examined by St. Croix and Taylor (1992) and Klassen (1994a) who reported that the earliest ice-flow direction was to the northeast followed by flow to the north. Locally, a third easterly ice flow was noted in the area, e.g., north of Dawes Pond.

Pudifin (1993) provided the most recent summary of the geology of the Great Gull Lake area. It incorporated the work of Calon and Pope (1990a, b) and clearly indicated that area was structurally complex and included southeast-directed recumbent folds, followed by east-southeast-directed thrusting and folding of the earlier folds. The thrust contact between the Roberts Arm Group and the Sansom Greywacke, east of Great Gull Lake, was interpreted to be

the Red Indian Line separating the Notre Dame and Exploits subzones of the Dunnage Zone (Williams *et al.*, 1988).

Klassen (1994b) and Liverman *et al.* (1996) carried out a till-geochemistry survey along available woods roads including the Great Gull Lake map area. The highlights in the eastern portion of the area included high Cu (>100 g/t) trending northeast from Great Gull Lake, anomalous zinc between Lake Bond and the southwestern end of Powderhorn Lake, and anomalous gold (>25 g/t) from the area northeast of Joes Lake.

In October 1998, Canaco Resources Ltd. (1998a) released information on newly discovered Ni-Cu sulphide showings at Powderhorn Lake. The discoveries were made by prospectors Jacob Kennedy and William Mercer of Badger during a search for the source of high-grade nickel-bearing float found in a glacial boulder train. Logging activity exposed several widely spaced outcrops containing 10 to 15% sulphides that returned assays from random sampling of up to 0.62% Ni, 0.12% Cu and 0.05% Co. Three hundred metres southeast from the original discovery a short prospector-style diamond-drill hole on a mineralized gabbroic outcrop yielded an average of 0.4% Ni over 7 m. Specific sample results by Eastern Analytical Laboratories included 0.7% Ni and 0.09% Co over 1.0 m and 0.82% Ni and 0.08% Co over 1.1 m. Subsequent drilling (Canaco Resources Ltd., 1998b) of three geophysical targets intersected "strong sulphide/graphite mineralization within the metasedimentary rocks". "The low-grade nickel values returned by the shallow diamond-drill holes were associated with gabbroic dykes containing various-sized xenoliths of the overlying metasediments". The report also mentioned that "significant concentrations of zinc mineralization (sphalerite) and copper mineralization (chalcopyrite)" had been discovered in outcrop and float around the northeastern shore of Powderhorn Lake. Subsequently, Canaco Resources Ltd. gave up their option on the ground.

Kerr (1999) described in detail the geology, mineralization and exploration in the immediate area of Ni-Cu mineralization. The two main areas of mineralization occurred in pyrrhotite-rich gabbro that cut a sequence of metasedimentary rocks including graphitic shale and greywacke and felsic tuff, part of which was interpreted to be possibly equivalent to the "Caradocian shale" (Shoal Arm Formation). The mineralization in the gabbro was dominated by pyrrhotite and there was good evidence for a magmatic sulphide liquid at one showing whereas the other showing displayed features indicative of hydrothermal processes (Kerr, 1999).

Copper Hill Corporation (press release 1999a) optioned the property in August 1999 and reported the results of assays of chalcopyrite-sphalerite-mineralized boulders and

bedrock found in the area around the northeast portion of Powderhorn Lake (Copper Hill Corporation news release, 1999b). The assays of the drill core indicated significant copper, zinc, silver and gold values. Subsequent drilling of the property indicated a thick sequence of "variably siliceous sediments/tuffs/rhyolites" containing zinc values up to 7.4 percent (Copper Hill Corporation press release, 1999c).

Dickson (1999a) gave a brief report on the geology of the area. Significant results included the probable thrust contact between the Roberts Arm Group and the Badger group east of Catamaran Brook, the anticlinal structure of the metasedimentary rocks at Powderhorn Lake, the probable inclusion of a fault block of Roberts Arm Group pillow basalt at Burnt Pond, and mylonitized metasediments exposed along the northeastern shore of Dawes Pond that had been intruded by the Dawes Pond granodiorite. Assessment reports on mineral claims in the eastern part of the map area, generally staked following the discovery of the Ni-Cu mineralization, are currently confidential.

The adjacent NTS map areas have been mapped at scales of 1:50 000 or greater. These are the Hodges Hill map area (2E/4) by Dickson (1999b), the Badger map area (12A/16) by Kean and Jayasinghe (1982) and Evans and Kean (1994), and the eastern portions of the Dawes Pond (12H/1) and Springdale (12H/8) map areas by Swinden and Sacks (1996).

## DESCRIPTION OF UNITS

### ROBERTS ARM GROUP

In the present map area, the Roberts Arm Group (Unit OR) was examined on the east side of Great Gull Lake along with the poorly exposed areas to the north of Burnt Pond, around Dawes Pond and in the Catamaran Brook and Rocky Brook areas. The Roberts Arm Group comprises a variety of bimodal felsic and mafic volcanic formations and associated sedimentary rocks with complicated structural relationships that are best exposed in the Great Gull Lake area. The group has been found to be more extensive than previously shown and has been extended to the east of Joes Lake where a belt of deformed pillow lavas occur in faulted contact with Badger group sandstone, to the south, and in probable intrusive contact with granite of the Hodges Hill intrusive suite, to the north. A narrow fault-bound slice of probable Roberts Arm Group comprising deformed, massive and pillowed basalt occurs within rocks assigned to the Badger group near the northeast end of Burnt Pond. In the Powderhorn Lake area, a newly discovered sequence of felsic tuff is interpreted to be affiliated with the Roberts Arm Group.

In the Great Gull Lake area, the main components of the group are massive and pillowed basalt, interbedded felsic and mafic volcanic flows and tuffs, and a highly variable sequence of red and purple chert, greywacke and felsic tuff, and a mainly sedimentary sequence of thin-bedded sandstone and possible felsic tuff. The stratigraphic succession is repeated due to thrusting and folding and has been described by Pope *et al.* (1990) and Pudifin (1993). This has resulted in a decrease in the number of units compared to that proposed by Swinden and Sacks (1986). The sequence proposed by Pudifin (1993) and followed in this report comprises a sequence of rhyolites interbedded with tuffs and sediments (not found in the present map area), an overlying sequence of interbedded basalt, tuff, rhyolite and chert (Unit ORgf) overlain by thick mafic volcanic rocks including massive and pillowed basalt (Unit ORbb) and a conformably overlying sequence of generally thick-bedded felsic tuff and rhyolite flows (Unit ORf).

Contacts between the units are rarely exposed and the stratigraphic sequence is based mainly on changes in the dominant rock type. Younging criteria are also rare and some, such as nesting of pillows in lava flows, are commonly ambiguous. However, graded bedding and crosslamination in finer grained siltstone and tuff (Unit ORgf) and steep bedding clearly indicate that the units are tightly folded. Evidence for thrusting is apparent in several areas where intensely sheared and brecciated rocks are exposed on the eastern shore Great Gull Lake in Units ORgf and ORbb.

Unit ORgf comprises a sequence of thin- to medium-bedded felsic tuff, purple chert and siltstone, and thick-bedded rhyolite and basalt flows. This unit is best exposed south of and along Rocky Brook where steeply dipping, highly siliceous, thin- to medium-bedded siltstone and feldspathic sandstone and thick-bedded felsic tuff form extensive outcrops. Small upright open folds, having northwest-trending fold axes, are apparent in the Rocky Brook area. Northwest of Dawes Pond, thick units of quartz-feldspar crystal tuff are interbedded with thick-bedded sandstone units. Northeast of the Great Gull Lake, a well-exposed sequence of interbedded thin (1 m) basalt flows, chert horizons, and felsic tuff form a steeply west-facing sequence. This succession forms a horizon that can be traced for several kilometres to the northeast and southwest.

Unit ORbb comprises a thick sequence of thick massive, uniform basalt flows interbedded with pillow lava (Plate 1). This sequence is best exposed along the northeastern portion of Great Gull Lake and also along Catamaran Brook and the upper reaches of Rocky Brook in the Lake Bond area. The basalts are fine grained and locally contain small plagioclase phenocrysts. The pillows vary in size from



about 1 m in length to around 30 cm. In the area east of Joes Lake, the pillow lavas contain abundant altered, white interstitial pillow material. Flows are very thick and clearly exceed 50 m in places where contacts can be determined. Rarely, thin rhyolitic flows occur within the basalt sequence, e.g., along Gull Brook, which drains Great Gull Lake to the north.

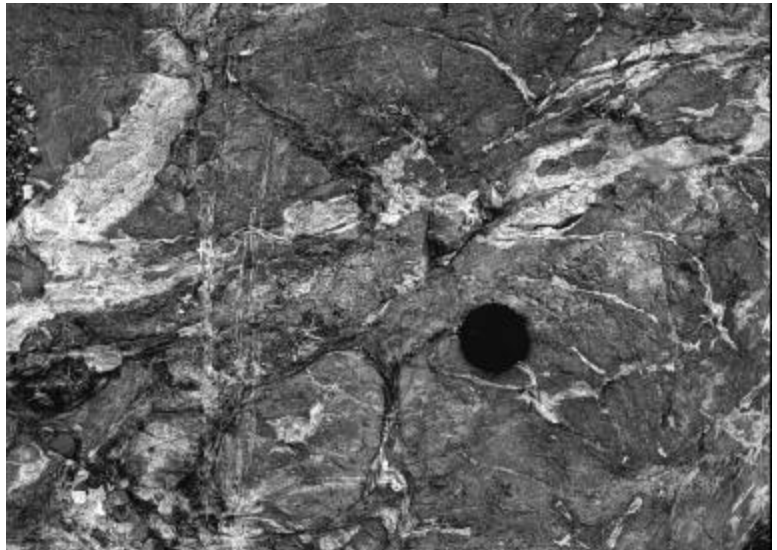
Along the Trans-Canada Highway, west of Joes Lake, basalts of Unit ORbb contain a shallow-dipping cleavage (Plate 2) that increases in intensity toward the southeastern margin of the unit. Southwest of Great Gull Lake, the basalts are metamorphosed to green, amphibole-bearing rock. There is no tectonic foliation in these rocks and the metamorphism may be associated with a 100- to 200-m-thick gabbro dyke (Unit Og) that can be traced southwestward from Great Gull Lake.

Near the northeastern end of Burnt Pond, a narrow northwest-trending, fault-bounded belt of highly deformed pillow breccia and pillow basalt (Unit ORb) lies within a sequence of sandstones assigned here to the Badger group. The basalts are highly brecciated and also contain a strong steeply dipping, northwest-trending cleavage and shear bands that are parallel to the flattening in the pillows. The basalts are cut by massive granitic dykes, presumably from the nearby Hodges Hill intrusive suite, and by massive diabase dykes.

Six-hundred metres east of Rocky Brook, near Joes Lake, the pillow basalt contains zones of intensely altered, white siliceous rock, possibly a felsic tuff, that is cut by thin quartz veins (Plate 3). The alteration outcrops over a distance of about 100 m along a new forest access road.

Unit ORf comprises a thick sequence of generally very thick-bedded, light-grey felsic tuff and tuffaceous feldspathic sandstones and thin-bedded siliceous siltstone and quartz-rich sandstones best exposed along and to the east of Great Gull Lake.

The unit forms a 1-km-wide belt that extends to the northeast of the lake. The thick-bedded sandstones contain metamorphic biotite that is randomly oriented. The thin-bedded units exposed along the shore of Great Gull Lake are parallel-bedded, laminated and steeply dipping. The locally well-developed cleavage is parallel to bedding and folded by steeply southeast-plunging, tight, second-generation folds. To the east, the thick-bedded felsic tuff and sandstones contain a variably developed cleavage that is parallel to bedding. Thin quartz veins are flattened and boudinaged paral-



**Plate 1.** Massive basalt pillow lava from the Roberts Arm Group (Unit ORbb) 500 m west of Joes Lake. Lens cap is 5 cm in diameter.



**Plate 2.** Vertical cross-section of strongly deformed basalt flow of the Roberts Arm Group (Unit ORbb) containing a gently dipping cleavage, Trans-Canada Highway, 1 km north of Catamaran Brook. Lens cap is 5 cm in diameter.

lel to the main (first) fabric. The second deformation has produced interference patterns with the first fabric and dome and basin structures are locally well developed (Plate 4). Locally, a strong tectonic banding parallel to bedding is apparent. Along the shore of Great Gull Lake, the unit is cut by numerous granite veins and contains isolated pods of granite indicative of migmatization.

At Powderhorn Lake, a sequence of strongly foliated felsic tuff, dark-grey sandstones and siltstone forms a newly

discovered unit that is interpreted to be equivalent to Unit ORf of the Roberts Arm Group. The tuffs are medium to thick bedded, and quartz phenocrysts are common. The tuffs are commonly very rusty and also highly altered to white, quartz-sericite rocks. Toward the core of the anticline, the rusty tuffs are commonly mineralized containing elongate patches of chalcopyrite, pyrite and pyrrhotite. Abundant, angular mineralized float, along the shores and forest access roads in the northeastern area of Powderhorn Lake, also contains veinlets of black, coarsely crystalline sphalerite.

The tuffs and sandstones are commonly strongly deformed and contain a prominent shallow-dipping foliation that defines an asymmetric anticlinal structure (Figure 1). The fabric on the northeastern limb dips at around 50° whereas the fabric on the southwestern limb dips at 20 to 30°. Near the exposed southwestern margin of the unit on the northwest shore of the lake, the tuffs contain an intense planar tectonic fabric that gives the rocks a banded appearance that may be a mylonitic fabric (Plate 5). The bands also contain coarse, probably mimetic, biotite flakes that have grown parallel to the banding. On the southeast shore of Powderhorn Lake, the western limb of this anticline is in tectonic contact with black, highly metamorphosed cordierite pelite (Unit OSm), which is locally graphitic, and to the south is interbedded with quartz-rich sandstone. The contact is a highly fractured zone probably indicating that it is cut by a late brittle fault. This overlying pelite sequence may be a correlative of the Caradocian Shoal Arm Formation.

### SHOAL ARM FORMATION

Two areas of the Caradocian (Upper Ordovician) Shoal Arm Formation (Unit OS) were located during mapping. Along the railway line, west of Badger, an approximately 150-m-long section of highly cleaved shales, siltstone and minor sandstone (Unit OSg) was found to contain several varieties of graptolites. The section occurs within the core of an overturned, northeast-plunging anticline with sandstones of the Badger group exposed to the west and east of the shales. A preliminary examination of the generally poorly preserved graptolites indicates that they are mainly *Climacograptus spiniferus*, confirming a *D. clingani* Zone (late Caradoc) age (Henry Williams, written communication, 1999).



**Plate 3.** Highly altered felsic tuff horizon within pillow lava (Unit ORbb) cut by vuggy quartz veins 600 m east of Rocky Brook. Lens cap is 5 cm in diameter.



**Plate 4.** Polydeformed felsic tuff of the Roberts Arm Group (Unit ORf) showing dome and basin interference patterns, two km east of Great Gull Lake.

As noted above, the pelite and sandstone (Unit OSm) overlying the tuffs in the southern portion of Powderhorn Lake are also correlated with the Shoal Arm Formation. The section comprises a thick sequence of thin- and parallel-bedded, black, rusty, commonly pyritic pelites locally interbedded with cream-coloured, thick-bedded sandstone. Sandstone increases in abundance toward the top of the succession, which is estimated to be over 500 m thick (assuming

no repetition). The pelite is locally rich in graphite. This sequence is characteristic of the Caradocian Shoal Arm Formation that is known from several areas to grade upward into the sandstones of the Badger group.

The pelites are highly metamorphosed and locally contain abundant cordierite and rarely andalusite porphyroblasts that overprint the cleavage (Plate 6). Some sandstone beds contain a very strong planar fabric similar to that near the top of the mineralized tuff at Powderhorn Lake. About 1 km east of Powderhorn Lake, the thin-bedded pelite and sandstones have been intruded by gabbro cupolas from the Hodges Hill intrusive suite and this may be the source of heat for porphyroblast development.

### BADGER GROUP

The Badger group (Williams *et al.*, 1995; Unit OSB) comprises an extensive sequence of thick-bedded turbiditic sandstone and siltstone (Unit OSBs) overlain by very thick-bedded pebble conglomerate and coarse-grained sandstone (Unit OSBc). The group is best exposed in the Badger Brook area where the sequence forms a series of overturned folds locally containing a core of Caradocian Shoal Arm Formation. The lower unit (OSBs) is dominated by thick- to very thick-bedded, parallel-bedded, grey to buff sandstones locally containing graded beds, crosslamination and parallel lamination, and possibly large-scale ripple marks. Along Badger Brook, an area of grey slate and siltstone may also be a correlative of the Shoal Arm Formation. Two kilometres east of Joes Lake, the sandstone beds are thinner and flame structures are also common. Coarse-grained sandstone and chert-rich granule conglomerate, exposed along the rail line immediately east of the graptolite locality, was found to contain fossil fragments and molds. A small body fossil fragment is interpreted to be part of a solitary coral. The various small molds, most commonly found in the granule conglomerate, appear to contain the hinge zone of small (5 mm) brachiopods. These fossils require further expert study before a positive identification is made.

The conglomerates (Unit OSBc) are well exposed 3 km east of Joes Lake where very thick-bedded poorly sorted pebbly sandstone and an uppermost sequence of pebble and cobble conglomerate are commonly interbedded with coarse-grained sandstone. Normal and reverse grading, crosslamination, and scours are common. The clasts in the



**Plate 5.** Vertical cross section of very strongly foliated to mylonitic felsic tuff (Unit ORf) from north of the probable thrust contact with the Shoal Arm Formation on the northwest shore of Powderhorn Lake. Lens cap is 5 cm in diameter.



**Plate 6.** Highly metamorphosed, cordierite-rich pelite of the Shoal Arm Formation (Unit OSm) on the shore of Powderhorn Lake. Lens cap is 5 cm in diameter.

conglomerate are dominated by subangular grey chert, but locally the conglomerate is coarse grained and contains rounded cobbles and pebbles of felsic tuff, welded crystal tuff, quartz porphyry, basalt, sandstone, siltstone and minor chert, and fine- and coarse-grained granite (Plate 7).

The contact between the Badger group sandstone (Unit OSBg) and the Roberts Arm Group pillow lava (Unit ORbb), in the Joes Lake area, is certainly a northeast-trending-in fault. West of Joes Lake, the nearly horizontal fracturing

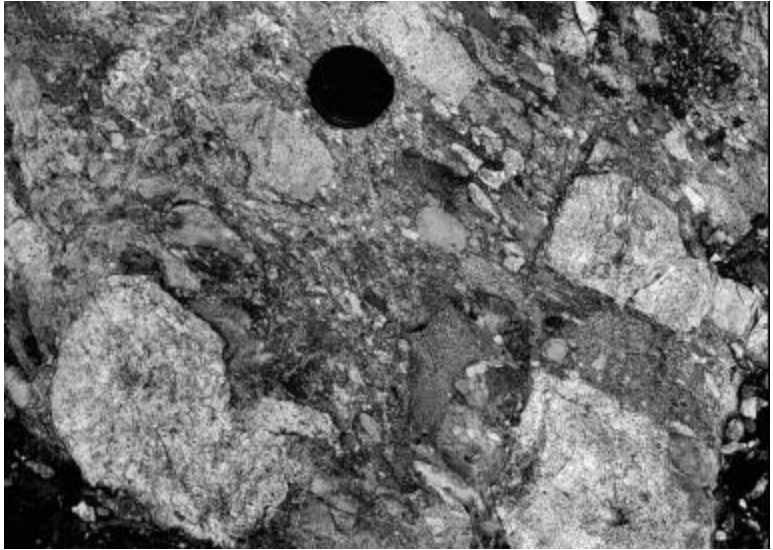
and cleavage in the metabasalt, along the southeastern margin of the unit, could indicate that the metabasalt has been thrust over Badger group. East of Joes Lake, the same contact has been modified by a later northeast-trending vertical fault.

The metamorphic grade of the Badger group in this area is generally subgreenschist facies. However, close to the gabbro of the Hodges Hill intrusive suite, 4 km east of Pauls Lake, thin-bedded, siltstone and sandstone have been converted to migmatite and thin biotite granite veins cut the sediments. Similar features were noted in the Badger group in the Mary Ann Lake area (Dickson, 1999c).

The belt of rocks extending from Dawes Pond northeastward to the northeast end of Burnt Pond is a poorly exposed succession of highly metamorphosed, medium-bedded, medium- to fine-grained psammite and semipelite (Unit OSBp). The affiliation of these rocks has always been a problem as they have been highly deformed and metamorphosed to form schists, particularly just northeast of Dawes Pond. These are the most metamorphosed rocks in the map area. These schists still contain well preserved bedding, lamination and locally graded beds. The schists near Dawes Pond commonly contain metamorphic biotite, and cordierite and garnet are locally present. These metamorphic minerals are undeformed and either overprint the foliation or are mimetic along the pre-existing cleavage. Kalliokoski (1955) and Pudifin (1993) correlated these rocks with the presently termed Badger group whereas Swinden and Sacks (1986, 1996) and Pope *et al.* (1990) were uncertain and indicated a Lower Ordovician to Silurian age for the same rocks. Pope *et al.* (1990) correlated the sandstone and pelite at the north end of Burnt Pond with the Silurian Springdale Group.

The gradational contact between the Shoal Arm Formation pelite (Unit OSg) and the thick-bedded sandstone assigned to the Badger group, exposed along the southeastern shore of Powderhorn Lake, is comparable to the contact between these two units in other areas, e.g., New Bay Pond (Dickson, 1999c; *see also* Williams *et al.*, 1995). This is taken to indicate that the sandstones are part of the Badger group.

The psammities exposed to the northeast of Dawes Pond contain a strong schistosity that is generally parallel to bedding and is east or west dipping. Small folds are tight and plunge at shallow angles to the southwest. Close to the contact with the Dawes Pond granodiorite along the northeastern shore of Dawes Pond, the psammities are intensely deformed and abundant tiny, isoclinal, recumbent folds



**Plate 7.** *Rounded to subrounded coarse clasts of felsic tuff in conglomerate of the Badger group (Unit OSBc) 4 km northeast of Badger Brook. Lens cap is 5 cm in diameter.*

verge to the southeast and the axial planes dip at around 15° to the northwest. The intense fabric resembles a mylonitic fabric and may define a low-angle thrust in this area. The adjacent Dawes Pond granodiorite is completely undeformed and granitic dykes that cut the mylonite are also undeformed. This clearly indicates that the deformation of the psammities predates the undated Dawes Pond granodiorite that is assumed to be Silurian in age. Similar mylonitic fabrics occur within the sandstone sequence on the southeastern shore of Powderhorn Lake. The nearby gabbro and granite of the Hodges Hill intrusive suite is also undeformed. These relationships suggest that the thrusting in the area occurred during the Early Silurian.

The sandstone and minor interbedded pelite (Unit OSBp), exposed around the north end of Burnt Pond, are mainly medium to thick bedded and contain graded beds, cross- and parallel-lamination, and locally scours. These sedimentary features indicate turbidite deposition. To the east of Burnt Pond, the dominant rock type is dark brown siltstone and pelite. All of the finer grained beds contain cordierite and biotite porphyroblasts that have overgrown the variably developed cleavage. The sandstones adjacent to the pillow lavas (Unit ORb) are highly schistose and thin quartz veins are ptymatically folded. There is a strong similarity between these rocks and the Badger group sandstones that occur in the Badger Brook area.

The apparently high metamorphic grade of Unit OSBp has commonly been related to contact metamorphism by the Dawes Pond granite. However, the extent of this metamorphosed unit would preclude that the Dawes Pond granodior-

ite is the source of the heat. It is more likely that the gabbro of the Hodges Hill intrusive suite may have underplated the metasediments with the resultant contact metamorphism.

## METAGABBRO

An approximately 200-m-thick, northeast-striking, massive, coarse-grained, metagabbro dyke (Unit Og) has intruded the Roberts Arm Group basalts between Dawes Pond and Great Gull Lake. The dyke contains variably sub-hedral amphibolitized pyroxene phenocrysts set in a coarse-grained pyroxene-rich-plagioclase matrix. The dyke is assumed to be of Ordovician age as it is apparently restricted to the Roberts Arm Group. Swinden and Sacks (1996) also assigned an Early Ordovician age to the dyke.

## HODGES HILL INTRUSIVE SUITE

The Hodges Hill intrusive suite (Unit Sh) is dominated by grey, massive, fine- to medium-grained pyroxene gabbro (Unit Shgb) but extensive areas of medium- to coarse-grained biotite  $\pm$  hornblende granite (Unit Shgt) have also been mapped out generally within the gabbro. The granites are everywhere younger than the gabbro. The Roberts Arm Group and the Badger group have been intruded by both the gabbro and the granite of the suite and the adjacent Badger group has been converted to migmatite near the contact. The gabbro is commonly cut by granite, aplite and feldspar-porphyrific rhyolitic dykes (*see* Stirling, 1978) that are particularly abundant along the Trans-Canada Highway at Crooked Lake and along the abandoned forest access road 1 km east of Crooked Lake. Small medium-grained gabbro dykes and plugs cut the Roberts Arm Group (Unit ORf) and the Shoal Arm Formation (Unit OSm) southeast of Powderhorn Lake. Extensive epidotization and quartz-veining of the gabbro occur at the narrows between Pauls Pond and Crooked Lake.

The larger areas of granite occur south of Burnt Pond and east of Joes Lake. Other sizeable areas of granite occur 3 km northwest of Crooked Lake and east of Long Pond. These intrusions are similar comprising massive, medium- to coarse-grained, equigranular biotite  $\pm$  hornblende granite. Some dykes of granite, a few over 100 m thick, have intruded the gabbro adjacent or parallel to the contact of the gabbro with the country rocks, e.g., at the contact east of Powderhorn Lake.

Only rarely does the granite in the suite show any penetrative fabric. An island in Long Pond, is comprised of moderately deformed biotite granite having a steeply south-east-dipping fabric. This fabric is parallel to the northeasterly orientation of Long Pond and is in line with an elongate topographic depression, which extends southwestward to the southeast side of Dawes Pond, where a northeast-trend-

ing fault cuts the Dawes Pond granodiorite. There is the strong possibility that this fault continues from Dawes Pond to beyond Long Pond.

## DAWES POND GRANODIORITE

The Dawes Pond granodiorite (Unit Sdg; originally informally termed Dawes Pond granite, e.g., Swinden and Sacks, 1996) is an ovoid intrusion composed mainly of buff, medium-grained, massive, biotite  $\pm$  hornblende granodiorite, tonalite and minor pink biotite granite. It has intruded the Roberts Arm Group basalts and the Badger group sandstones. The contact with the Roberts Arm Group is cut by a steep, dextral fault west of Dawes Pond. Granite dykes are abundant in the Badger group (Unit OSBp) at the northeast corner of Dawes Pond.

The high proportion of granodiorite and tonalite within the Dawes Pond granodiorite distinguishes it from the granitic rocks of the Hodges Hill intrusive suite.

## DIABASE DYKES

Massive, diabase dykes are common throughout the area and virtually all dykes have a northeasterly orientation. All units are cut by diabase dykes although they are generally less abundant in the Badger group in the Badger Brook area. The dykes vary in thickness up to about 2 m. Fine-grained, equigranular diabase dykes are most common whereas porphyritic diabase dykes are rare. Some diabase dykes are cut by granite dykes indicating that there are probably several generations of dyke intrusion.

## MINERALIZATION

Within the area considered in this report, significant mineralization is restricted to the Powderhorn Lake area. Massive pyrrhotite mineralization occurs in two separate areas within gabbro plugs and dykes at the western margin of the Hodges Hill intrusive suite. The exposed areas of mineralization are each about 100 m<sup>2</sup> (Plate 8). The mineralization assayed up to nearly one percent Ni but nickel minerals have not been identified. A detailed description of this mineralization is given by Kerr (1999). A chip sample from the mineralised area (sample 2244023) assayed at the Department of Mines and Energy gave 1127 g/t Ni, 1933 g/t Cu, 158 g/t Co, 1.2 g/t Ag and 11.90 percent Fe. The sample was analysed for gold at Activation Laboratories and gave 14 mg/t.

Previous workers (Kalliokoski, 1955; Swinden and Sacks, 1996) have noted that gossans (Plate 9) containing pyrite-sphalerite mineralization outcrop on the north shore of Powderhorn Lake. This occurrence has a correlative on

the south shore of the lake where highly altered tuff is exposed. Immediately north of Powderhorn Lake, extensive rusty angular float was found by prospectors William Mercer and Jacob Kennedy to contain significant concentrations of pyrite, pyrrhotite, chalcopyrite and sphalerite mineralization (Plate 10) and high values of copper and zinc (Copper Hill Corporation, 1999b). The boulders of mineralized host rock consist of a rusty, grey, felsic quartz-crystal tuff. Associated with the mineralized blocks is highly altered quartz-sericite rock that also forms angular blocks. Rounded, large gabbro boulders are also found in the float. No bedrock outcrops of mineralized rock occur in the area. The quartz-sericite rock is similar to altered tuff exposed on the south side of Powderhorn Lake, about 1 km to the south.

Drilling by Copper Hill Resources (press release, 1999c) reported that a significant thickness of mineralized rock had been indicated from holes drilled in the mineralized float area. They reported that drillhole "...PN-99-01 intersected 80 feet of banded, base metal-rich sulphides including sphalerite, pyrite, pyrrhotite and chalcopyrite. The sulphides are dominantly stratiform/stratabound and hosted by variably siliceous sediments/exhalites/blue-quartz eye crystal tuff similar to those observed in outcrops and boulders dispersed throughout the property". The grades of mineralization in drill core indicated in the press release included the following: from 24.5 – 26.8 m, 0.115 – 0.262 % Cu, and 0.34 – 7.40 % Zn.

Two chip samples (samples 2244058, 2244060) obtained by the author from mineralized float in this area were assayed, at the Department of Mines and Energy Laboratory, for copper, lead and zinc by the inductively coupled plasma-emission spectrometry method (ICP-ES) and for silver by the atomic absorption method (AA). The samples were also analysed at Activation Laboratories Ltd., Ancaster, Ontario, for zinc, gold and silver by the induced neutron activation analysis (INAA). The results are given in Table 1 and indicate significant values for zinc, copper and gold.

A chip sample (sample 2244053) obtained from the gossanous bedrock at the zinc showing (Sp on Figure 1) on the shore of Powderhorn Lake was also assayed. The results indicate that this gossan is distinctly less mineralized in copper, lead, zinc and gold than that obtained from the float.

The mineralized float is glacially transported. From the work of St. Croix and Taylor, (1992) the source of the float



**Plate 8.** Rusty, washed outcrop of a pyrrhotite-rich gabbro dyke from the Hodges Hill intrusive suite within the Roberts Arm Group (Unit ORf), 1 km east of Powderhorn Lake. Note book is 18 cm long.



**Plate 9.** Ridge of pyritic gossan in felsic tuff of the Roberts Arm Group (Unit ORf) from the north shore of Powderhorn Lake. Barry Wheaton (1.83 m) for scale.

lies to the south. The angular nature of the float indicates that it has probably not been transported a great distance. The limit of exposed mineralized and altered bedrock available for transportation by glacial ice lies a maximum distance of about 1200 m south of the mineralized float. Undiscovered mineralization may also occur to the east, as far as the contact with the Hodges Hill intrusive suite, and is open to the north and west.

Narrow rusty zones were noted on the eastern shore of Great Gull Lake in a gabbro dyke. These contained disse-

**Table 1.** Analyses of mineralized samples from the Powderhorn Lake area. ME - Mines and Energy Laboratory; AL - Activation Laboratories; ND - below detection limit. Note: mg/t is equivalent to parts per billion

Sample Number	Zn - ME	Zn - AL	Pb - ME	Cu - ME	Ag - ME	Ag - AL	Au - AL
2244058	1777 g/t	1750 g/t	465 g/t	5726 g/t	7.6 g/t	8 g/t	433 mg/t
2244060	1175 g/t	1610 g/t	27 g/t	1630 g/t	1.3 g/t	ND	72 mg/t
2244053	141 g/t	151 g/t	7 g/t	103 g/t	0.7 g/t	ND	14 mg/t

inated pyrite and possibly pyrrhotite. A chip sample from the mineralized area assayed 125 g/t copper, <2 g/t lead and 45 g/t zinc.

## CONCLUSIONS

The Roberts Arm Group, in the area mapped, comprises a Lower Ordovician bimodal volcanic and sedimentary sequence that is highly folded and has been transported along southeast-directed thrusts. The lower sequence contains siltstone and chert interbedded with massive and pillowed basalt flows and felsic tuff. The overlying sequence is dominated by massive and pillowed basalt containing minor felsic tuff. The uppermost succession is dominated by thick felsic tuff and sandstone. A sequence of highly deformed felsic tuff was identified in the Powderhorn Lake area and these tuff are assigned to the Roberts Arm Group.

The Shoal Arm Formation was identified along the rail line west of Badger Brook and Upper Caradocian graptolites were obtained from the unit. Similar locally graphitic pelite in the Powderhorn Lake area is assigned to the Shoal Arm Formation. The turbiditic sandstones and conglomerates of the Badger group, located mainly in the Badger Brook area, have been recumbently folded. The graptolitic Shoal Arm Formation outcrops within the core of one of these overturned anticlines. The highly metamorphosed sandstone and pelite that outcrop to the northeast of Dawes Pond are interpreted to be the high-grade equivalents of the Badger group.

The precise position of the Red Indian Line should be modified because of the widespread thrusting of the Roberts Arm Group over the Shoal Arm Formation and the Badger group and also by the discovery that the Roberts Arm Group extends east of Joes Lake. The line is actually a zone of imbrication and folding similar to that indicated by Pudifin (1993) but with a greater areal extent.

Massive pyrrhotite mineralization occurs in gabbro plugs and dykes at the western margin of the Hodges Hill intrusive suite, south of Powderhorn Lake. The mineraliza-



**Plate 10.** Samples of rusty, copper-zinc mineralized float atop an angular mineralized boulder, from the woods road 300 m north of Powderhorn Lake. Lens cap is 5 cm in diameter.

tion assayed up to nearly one percent Ni but nickel minerals have not been identified.

Widespread, copper-zinc mineralization occurs in angular glacial float in the area around the northern end of Powderhorn Lake. Exploration drilling within the float identified over 25 m of mineralized and highly altered rock containing significant values for copper and zinc. The exposed volcanic rocks are highly altered up to 1.2 km from the drill site. The source of the high-grade float has yet to be identified.

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