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GEOLOGY OF THE EAST HALF OF THE WEIR'S POND (2E/1) MAP AREA AND ITS REGIONAL SIGNIFICANCE

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ABSTRACT

The eastern half of the Weir's Pond map area is underlain principally by quartzose sandstone and pelite of the Gander Group. Two formations are defined in the Gander Group, the Indian Bay formation, characterized by black pelite, fossiliferous shale, mafic and felsic volcanic rocks, and the Jonathan's Pond formation, comprising quartzite, psammite and grey–green pelite. The definition and position of the Indian Bay formation, hitherto a suspected structural klippe of Dunnage Zone affinity, is revised and interpreted to be gradational with rocks of the Gander Group. Because of the previously discovered fauna in rocks of the Indian Bay formation, the Gander Group, at least in this area, is assigned a late Arenig age.

An ultramafic sliver in the Jonathan's Pond formation coincides with the eastern edge of an aeromagnetic anomaly, which may represent a structurally emplaced ultramafic–mafic body at depth. Synkinematic and posttectonic granites intrude the Gander Group in the northeast.

An early phase of isoclinal F_1 folds have an associated axial planar cleavage, which is the principal tectonic fabric recognized. A second phase of deformation produced open F_2 folds and distinct but heterogenously developed crenulation folds. Metamorphic isograds, based on field mapping, are roughly symmetrical about the plutons.

Either felsic volcanic rocks or partly silicified sandstone of the Indian Bay formation locally contain significant gold concentrations.

INTRODUCTION

The Weir's Pond (2E/1) map area is centred 30 km northeast of the town of Gander in northeastern Newfoundland (see inset, Figure 1). Access to the central portion of the eastern half of the area is provided by old logging roads that connect with Route 360, near Indian Bay. Helicopter-supported fly camps were used to map the northern part of the area. Numerous ponds throughout the east half of the map area make a boat indispensible. Mapping of the Weir's Pond area has been completed at a scale of 1:50,000. Figure 1 shows the general geology of the area.

Little detailed work had been carried out in that part of the Weir's Pond area covered in this report. The rocks in the eastern part of the map area were briefly examined by Blackwood (1978) and Hanmer (1981). Detailed mapping and definition of the Indian Bay formation, in and near Indian Bay Big Pond, was done by Wonderley (Wonderley and Neuman, 1984). Mapping in the Wesleyville (2F/4) area, immediately east of the present study area, was carried out by Williams (1968) and Jayasinghe (1978). No mineral exploration work has been undertaken in the area.

REGIONAL RELATIONSHIPS

Three principal tectonostratigraphic divisions are recognized in the Weir's Pond area: the Gander Group (Units 1 to 7, Figure 1), the Gander River Ultrabasic Belt, and the Davidsville Group. South of Ocean Pond, a small, tectonic sliver of pyroxenite and pyroxene gabbro (Unit 8) occurs in the centre of the Jonathan's Pond formation. The Ocean Pond pluton (Unit 9) and Deadmans Bay Granite (Unit 10), synkinematic and posttectonic granites respectively, intrude the Gander Group.

Jenness (1958) defined the Middle Ordovician Gander Lake Group as a sequence of slate, sandstone, limestone, phyllite and conglomerate exposed near Gander. The Gander Lake Group was later subdivided into conformable lower, middle and upper units (Jenness, 1963). Kennedy and McGonigal (1972) redefined the Gander Lake Group to include only the lower unit and proposed the new term Davidsville Group for the middle and upper parts. They considered that deformation and metamorphism of their Gander Lake Group occurred prior to deposition of the Davidsville Group, and cited, as evidence, the presence of

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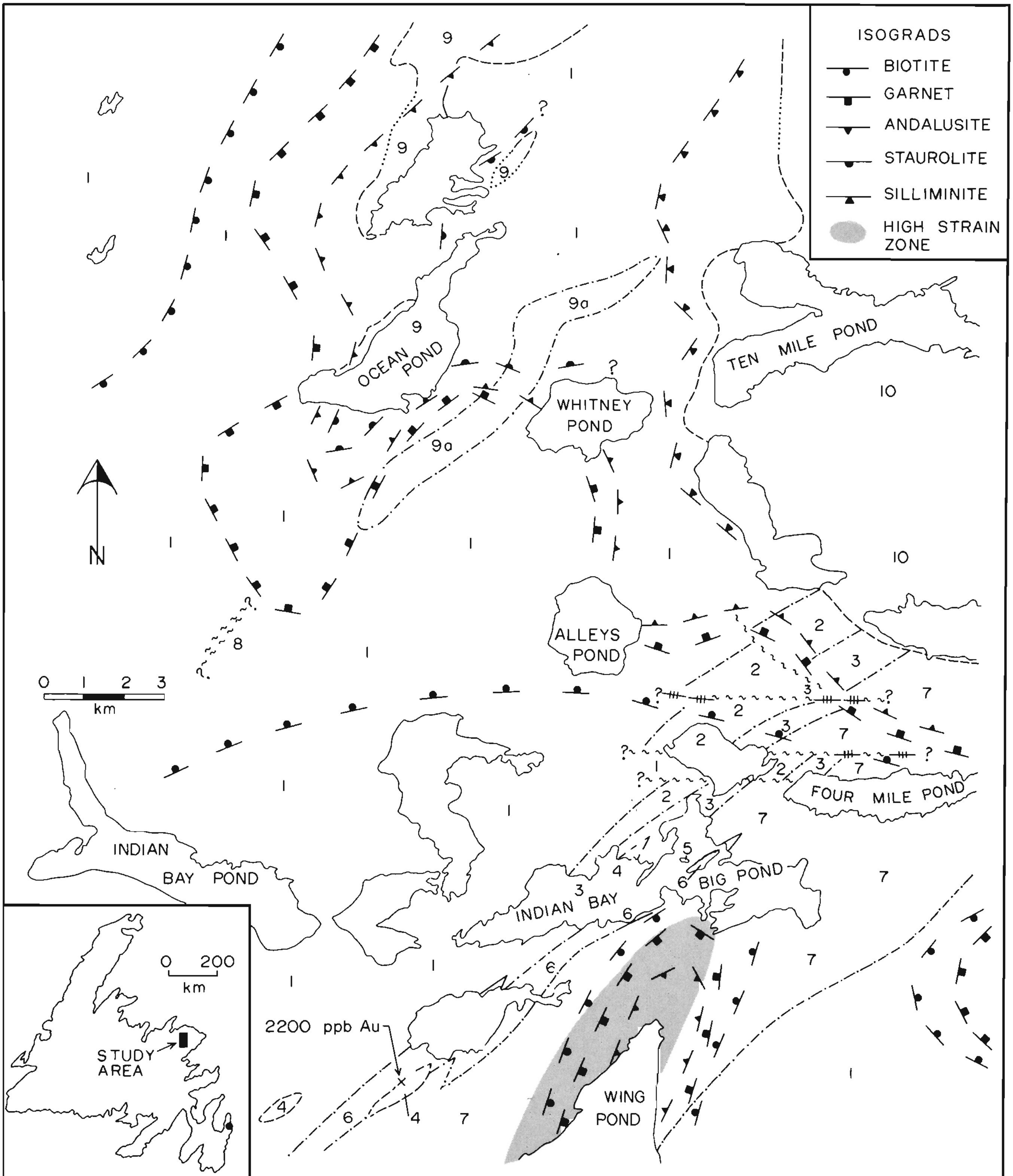

Figure 1. *Geology of the east half of the Weirs Pond (2E/1) map area.*

LEGEND (FIGURE 1)

SILURO–DEVONIAN OR EARLIER

10 Deadman's Bay Granite: *non-foliated, K-feldspar-megacrystic, biotite granite*

9 Ocean Pond granite: *equigranular muscovite granite, generally moderately foliated;* 9a, *zone containing numerous sheets of Ocean Pond granite and pegmatite*

8 *Coarse grained pyroxenite and pyroxene gabbro, locally undeformed*

LOWER ORDOVICIAN

Gander Group

Indian Bay formation (Units 2 to 7)

7 *Grey and dark-grey psammite, grey–green and black pelite, thin calc-silicate beds*

6 *Medium grained, medium to thick bedded, buff and maroon micaceous sandstone; green and maroon siltstone, minor black pelite, fossiliferous argillaceous rock, minor felsic tuff (?); intraformational pebble and cobble conglomerate; minor grey sandstone*

5 *Pillowed mafic volcanic rock, pillow breccia and/or hyaloclastite*

4 *Felsic to intermediate intrusive rock containing hornblende, feldspar and, rarely, quartz phenocrysts*

3 *Laminated black pelite containing laminae of thin sandy layers, minor, thin, grey sandstone beds, rare black-quartz-granule sandstone and a 6-m chert band*

2 *Grey psammite, grey–green pelite, black pelite and dark-grey psammite*

Jonathan's Pond formation

1 *Medium to thinly bedded grey psammite, grey–green pelite and quartzite, minor quartz-granule sandstone, amphibolite and calc-silicate layers*

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detrital biotite and garnet, and mafic schist and psammite fragments in basal conglomerate and greywacke of the Davidsville Group. The term Gander Lake Group was informally amended to Gander Group by McGonigal (1973), and formally proposed by Blackwood (1982).

The Gander Group consists predominantly of psammitic and pelitic rocks, which continue northeastward along strike to the Carmanville (2E/8) map area (Currie and Pajari, 1977) and southwestward to the Kaegudeck Lake area (Dickson, 1987). Williams (1968), mapping in the Wesleyville (2F/4) map area immediately to the east of the present study area, defined greywacke and quartzite (Gander Group) in the west as being conformable with muscovite–biotite schists in the east that locally contain garnet, andalusite and sillimanite. These sedimentary rocks and schists exposed in the southwest corner of the Wesleyville area were later included in the Square Pond Gneiss, the term proposed by Blackwood (1976, 1977 and 1978) to define rocks that essentially comprise the biotite zone and higher grade parts of the Gander Group, and included rocks immediately south and west of the Deadman's Bay Granite. The rocks in the eastern part of the Weir's Pond area were only briefly examined by Blackwood (1978). Farther east (outside the map area), migmatite of the Hare Bay Gneiss was interpreted to represent the culmination of eastward-increasing metamorphism within the Gander Group (Blackwood, 1978). The Gander Group, Square Pond Gneiss and Hare Bay Gneiss, together with a suite of (Siluro-Devonian?) synkinematic and posttectonic plutons, define the northeastern Gander Zone (Williams, 1976).

The Deadmans Bay Granite was mapped in the Wesleyville area by Jayasinghe (1976, 1978), who described it as a homogenous coarse grained biotite granite characterized by K-feldspar megacrysts. No satisfactory age is available for this granite (Jayasinghe, 1976).

The Gander Zone is bounded to the west by a complex package of ultramafic to felsic rocks, the Gander River Ultrabasic Belt (Jenness, 1958), which are structurally juxtaposed with lower units of the Ordovician Davidsville Group. North of Weir's Pond, in the Carmanville (2E/8) map area, Currie and Pajari (1977) state that the Gander and Davidsville groups are in conformable contact where the Gander River Ultrabasic Belt is absent. Blackwood (1982) advocates the same relationships south of Gander Lake. The Davidsville Group and Gander River Ultrabasic Belt lie within the Dunnage Zone (Williams, 1976).

Hanmer (1980) briefly examined rocks in the southeast part of the map area as part of a regional structural study, and proposed that much of the northeastern Gander Zone is an Acadian ductile shear zone exhibiting a dominant component of sinistral motion.

The most recent contribution to the geology of the study area was the definition of the Indian Bay formation, exposed near Indian Bay Big Pond by Wonderley and Neuman (1984). Fossils from a pelitic unit give a late Arenig age. The first author favoured interpreting the Indian Bay formation as allochthonous, representing a thrusted slice of Dunnage Zone rocks; alternative models were essentially based on the Indian Bay formation being autochthonous.

Regional foliations in the Davidsville Group and Gander River Ultrabasic Belt trend northeast, whereas the regional foliation in the Gander Group is north to north-northeast trending. Metamorphic grade varies regionally from greenschist facies in the west to amphibolite facies in the northeast and central parts; in the south and southeast, the rocks are mostly greenschist, with the exception of a small area around Wing Pond.

GENERAL GEOLOGY

Gander Group (Units 1 to 7)

In this report, the Gander Group is informally divided into the Indian Bay and Jonathan's Pond formations. The term Indian Bay formation (Wonderley and Neuman, 1984) is used, but redefined to include units gradational between the Jonathan's Pond and Indian Bay formations. The area underlain by the Indian Bay formation is also increased (Figure 1) so that it extends from Big Bear Cove Pond in the north to (at least) Little Wing Pond in the south. The term Jonathan's Pond formation is used for the remainder of the Gander Group to the west and east of the Indian Bay formation.

Jonathon's Pond formation (Unit 1). This formation includes most of the rocks formerly described (McGonigal, 1973; Blackwood, 1982) as typical Gander Group sedimentary rocks. Interbedded psammite and pelite are the major rock types (Plate 1); pelite, quartz-granule sandstone, quartzite, mafic sills and/or dykes and calc-silicate layers or lenses, in order of descending abundance, form the remainder of the group.

Despite a strongly developed foliation, bedding is well preserved in these rocks, and is due mostly to the contrast in composition and grain size between the psammite and pelite. There is a marked lack of gradation between these two rock types, and in some localities, bedding planes are defineable between quartzite and psammite even though they are compositionally similar. Although bed thickness varies due to deformation, it typically ranges from a few millimetres in the more pelitic parts to approximately 2 m in quartz-rich units. Quartzitic psammite is generally medium bedded; locally, however, it contains a thin planar stratification.

Clastic textures are preserved in the lowest grade rocks in the southwest; here the sandstone is a grey, fine- to medium-grained, quartz-dominated rock in which feldspar typically forms less than 10 percent. Quartz-granule sandstone, which contains 60 to 90 percent, commonly blue,

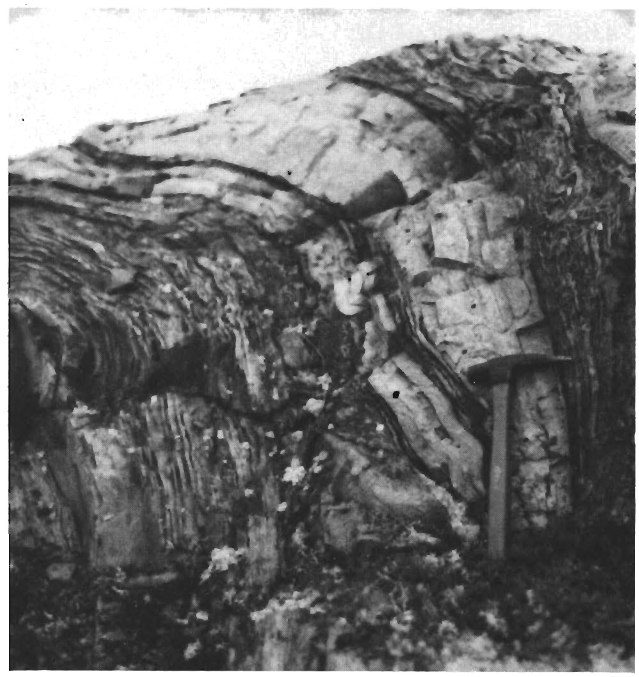

Plate 1. *Thin to medium bedded, quartzitic psammite, psammite and pelite of the Jonathan's Pond formation (Unit 1).*

quartz, shows a bimodal size distribution of quartz grains; larger grains range from 1 to 3 mm across whereas smaller grains are less than 0.2 mm across. The rocks are immature to moderately mature, containing 10 to 30 percent matrix that is recrystallized to fine grained quartz and white mica. Sorting is moderate and grains are subangular. Mafic bands, generally 0.5 to 2 m thick, form less than 1 percent of total exposures. Locally, they crosscut the sedimentary layering, but typically are conformable. They are interpreted to be pretectonic intrusive rocks.

Psammite commonly contains detrital calc-silicate minerals. These minerals locally form layers, 1 mm to several centimetres thick, and isolated pods, 5 to 20 cm across, that may have been calcareous nodules.

In low-strain zones or areas where the bedding is normal to foliation, there are locally short sections (< 25 m) that give some indication of the character of the original sediment (Figure 2). A 20-m section (Section A, Figure 2), 1 km north of the east end of Indian Bay Pond, contains distinctive, green–white-weathering, current-bedded siltstone. Pelite units, up to 500 cm thick, vary from structureless pelite to thinly (< 3 cm) and thickly (20 to 60 cm) interbedded pelite and psammite. The psammite is typically fine to very fine grained, and exhibits sharp, planar to locally erosive or scoured bases, and sharp planar tops. Above the base, the sedimentary character of sand beds is variable. Some cross-lamination occurs in the psammite and is locally undulose. Thicker sand interbeds are 0.9 to 30 m thick, and subtly graded from medium fine to fine grained. Some psammite

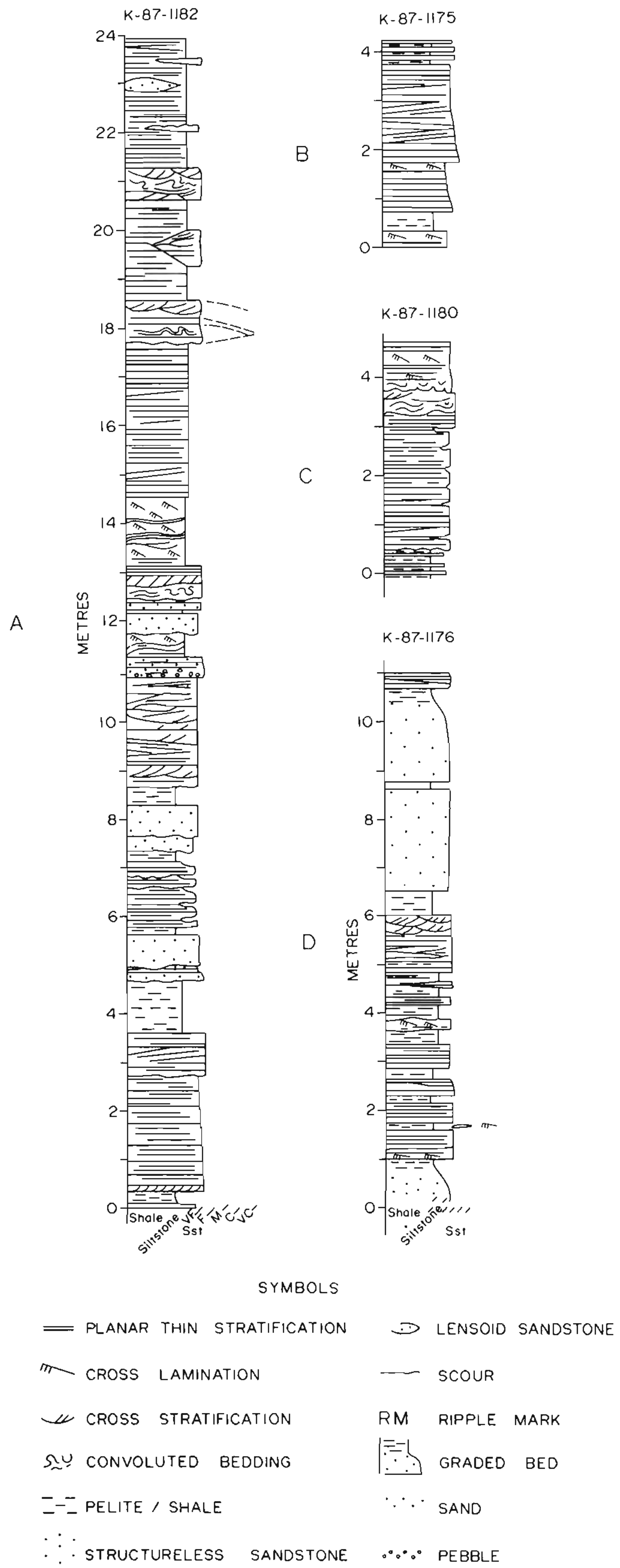

Figure 2. *Representative stratigraphic sections from Jonathan's Pond formation.*

beds are apparently structureless, but locally contain scour surfaces between beds and minor lamination. These massive sandstone beds either grade up into pelite or are overlain by beds of laminated and crossbedded psammite. The most common structure is thin (< 1 cm) planar lamination. Other psammite beds are composed of planar-laminated sandstone separated every 20 to 80 cm by either shallowly inclined surfaces or by pelitic partings. A single 10-cm-thick set of possibly planar cross-stratification overlies the basal contact of one unit. Crossbeds, however, are more commonly developed at the top of the thick bedded psammite. The trough cross-sets rework the top of the laminated sandstone and are commonly convoluted. A prominent erosional surface locally underlies either the cross-sets or a bed of stratified sandstone consisting of clean, medium- to coarse-grained quartz arenite containing well rounded quartz grains. This suggests that in some sections, there are coarsening- and maturing-upward sequences (Section C, Figure 2).

Psammite also forms lenticular bodies, 15 to 80 cm thick and several metres long, enclosed by the siltstone facies. Sharp bases and convex-upward tops characterize the sandstone bodies. The core of the thicker lenses contain undulose to planar laminations. Offlapping, narrowing, sandstone wedges of gently inclined to curved foresets occur near the margins of the sandstone bodies. Trough crossbeds produced by unidirectional paleoflow rework the top of the sandstone bodies. Crossbeds dominate the entire thickness of other sandstone beds. Ripple marks form the top of some of the thinner sandstone lenses, which have internal wavy lamination. The enclosing siltstone is up to 10 m thick and displays wavy lamination to ripple cross-lamination, including climbing-ripple drift.

Indian Bay formation (Units 2 to 7). The Indian Bay formation is a northeast-striking sequence of metasedimentary and metavolanic rocks, exposed south of Big Bear Cove Pond. Units are sequentially numbered from west to east, but stratigraphic indicators are lacking and the relative ages of the units are unknown. Contacts between all adjacent units within this formation were not observed; therefore, the complete stratigraphic continuity of Units 2 to 7 is partly inferred. The contacts between the Jonathan's Pond (Unit 1) and Indian Bay formations are placed at the western margin of Unit 2 and the eastern margin of Unit 7 (see Figure 1); these two units are gradational into Unit 1.

Unit 2 comprises rocks that are gradational between the Jonathan's Pond and Indian Bay formations, and is best observed north of Little Bear Cove Pond, in an area where exposure is semi-continuous. Within this unit, grey sandstone and grey–green pelite, typical of the Jonathan's Pond formation, is interbedded with dark-grey sandstone and black laminated pelite (Plate 2). The rocks are generally medium to thinly bedded. Black pelite, which defines the most distinctive change in sediment type, increases eastward through Unit 2, forming approximately 50 percent of individual exposures near its eastern boundary. The laminae in the black pelite are alternating grey and black layers, interspersed with 1- to 2-cm-thick light-grey sandstone bands. The dark-grey colour of the sandstone is due to 5 to 10 percent

Plate 2. *Interbedded quartzitic psammite and black pelite–siltstone in Unit 2, defining the gradational contact between the Jonathan's Pond and Indian Bay formations.*

Plate 3. *Thinly bedded and laminated black pelite–siltstone containing minor sandy layers, in Unit 3 of the Indian Bay formation.*

opaque material (pyrite or graphite or both); otherwise the rock is petrographically very similar to quartzitic sandstone of the Jonathan's Pond formation.

Unit 3 consists predominantly of black pelite, ubiquitously laminated with millimetre-thick sandy layers and rare black, quartz-granule sandstone (Plate 3). Locally, thin or medium bedded, dark-grey quartzitic sandstone is interbedded with the pelite. On the western margin of this unit, a distinctive 6-m-thick chert band, bounded by black pelite, occurs along strike for several kilometres.

Unit 4 is a sub-intrusive or extrusive porphyry of intermediate to felsic composition, containing feldspar phenocrysts and chloritized hornblende laths from 1 to 6 mm in length. Quartz phenocrysts are locally present and form $<$ 5 percent of the rock. The matrix is aphanitic and green or purple in the three exposures near Indian Bay Big Pond, whereas in the two exposures south of Southern Pond, the matrix is grey. Brecciation is locally extensive and breccia fragments are cemented by calcite. Disseminated pyrite and profuse quartz-vein development occur locally. (Contacts between this unit and adjacent units were not observed.)

Unit 5 consists of two exposures of pillowed mafic volcanic rock that occur on two small islands in Indian Bay Big Pond, east of Unit 4. The pillows range up to approximately 1 m in diameter. Their morphology is very well preserved, although the rock is extensively altered to a grey-green, calcite-rich assemblage. Unequivocal top indicators were not observed in the pillows. A hyaloclastite, which contains blocks of vesicular mafic material, is exposed nearby and occurs as numerous boulders on the shoreline. Unit 5 is not exposed north or south of the pond, but some boulders of mafic material were noted on the shores of Little Bear Cove Pond to the north. The unit's exact relationship to other units of the Indian Bay formation is uncertain because of its restriction to the islands.

Unit 6 consists of micaeous, medium grained, medium to thick bedded, buff and maroon sandstone, thinly bedded, maroon and green siltstone, and black pelite. The micaceous character and colour of the sandstone differentiate it from sandstone of the Jonathan's Pond formation. Boulders of fossiliferous argillite and fine grained sandstone, which are particularly common on the northern shores of Indian Bay Big Pond, are considered to be from this unit. Some exposures of a fine grained, sandy to argillaceous rock occur on the northern and southern shores of the pond, and are similar to the rock matrix in which the fossils are preserved; however, no fossiliferous material has been found *in situ*. Boulders from an intraformational, pebble and cobble conglomerate, which contain detritus from the Indian Bay formation, are common on the shores of Indian Bay Big Pond and Little Bear Cove Pond. Grey to dark-grey sandstone, similar to that of the Jonathan's Pond formation, is locally intercalated with the buff and maroon sandstone of Unit 6.

Unit 7 is gradational between the Jonathan's Pond and Indian Bay formations. It consists of interbedded grey and dark-grey sandstone, grey-green and black pelite and numerous calc-silicate bands, the latter are particularly common in the northern part of the area. North of Four Mile Pond, small patches of gabbro pegmatite occur in several small exposures that are characterized by sporadic occurrences of very coarse grained andalusite. The andalusite is locally intimately associated with the gabbro, which may represent the surface manifestation of a larger gabbroic body (coincides with a high aeromagnetic anomaly). Unit 7 is not well defined, as many of the rocks are highly strained, and petrographic work is necessary for further evaluation.

Ultramafic Rocks (Unit 8)

A fault-bounded, 100- to 200-m wide sliver of pyroxenite and pyroxene gabbro extends for approximately 2 km along strike north of Indian Bay Pond. The actual contacts with the enclosing rocks of the Jonathan's Pond formation were not observed. The western margin of the body is intensely foliated whereas that part of the body exposed close to the eastern edge is relatively undeformed. Pyroxenite predominates on the western side and passes into pyroxene gabbro and gabbro on the eastern side. The gabbro appears to be unaltered. Gabbro pegmatite and locally granitic pegmatite (the latter containing tourmaline) intrude the gabbro.

Ocean Pond Pluton (Unit 9)

The Ocean Pond pluton comprises several northeast-trending small bodies exposed near Ocean Pond and Little Ocean Pond in the north-central part of the Weir's Pond area. It is an equigranular, muscovite granite that is typically foliated. The intensity of the foliation varies from place to place and is usually defined by an alignment of muscovite. The foliation is subhorizontal or shallowly dipping, either to the northwest or southwest. Small garnets, up to 3 mm across, occur sporadically, and tourmaline is common, forming several modal percent locally. In one exposure, tourmaline defines a subhorizontal northeast-trending lineation.

Pegmatites, characteristically containing coarse grained garnet and tourmaline, and rarely beryl, are associated with this granite. They comprise more than 60 percent of exposures west of Whitney Pond, and this zone (subunit 9a) is separated from the Jonathan's Pond formation.

The Ocean Pond pluton is a synkinematic, probably synmetamorphic, granite that was intruded after the D_1 deformation.

Deadman's Bay Granite (Unit 10)

The Deadman's Bay Granite, outcropping in the northeastern part of the area, is a posttectonic biotite granite that contains distinctive K-feldspar megacrysts ranging up to several centimetres across. This granite cuts across structures of all ages in the Gander Group, and, in the south, cuts across the sillimanite isograd. Its contact with the Gander Group is intrusive and marked by blocks of psammite and pelite in a granite matrix over a zone several metres wide. Granitic material also intrudes the sedimentary rocks along bedding and foliation planes in a restricted zone close to the contact. Isolated K-feldspar megacrysts clearly grow in the sedimentary rocks at the contact zone. The granite has very few pegmatites associated with it.

DEFORMATION

All the units described above, with the exception of Units 8 to 10, exhibit the effects of two stages of deformation. During D_1, a penetrative foliation, striking north-northeast to northeast, developed in all rock types. This fabric is the earliest foliation recognized and is therefore designated S_1. Dips of S_1 are shallow near Indian Bay Pond, moderate in the central and western portions and become steep toward the Deadmans Bay Granite on its southwest margin; it also steepens toward a high-strain zone at Wing Pond. S_1 is axial planar to microscopic and mesoscopic tight to isoclinal folds in multilayered sequences. Refraction of S_1 is locally pronounced due to sharp contacts between beds and a lack of grading in the metasedimentary rocks. Variation in bed thickness and composition has, in places, caused disharmony in folds (Plate 4). F_1 fold hinges commonly are not seen, but tend to vary in the amount and direction of plunge due to later deformation. Plunges are generally westerly, ranging from vertical (reclined) to approximately 10°.

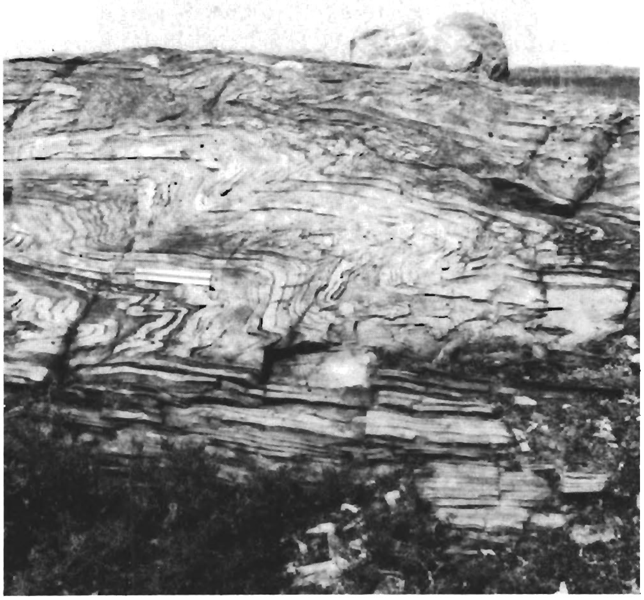

Plate 4. *Disharmonic folds in thinly bedded quartzitic psammite, psammite and semipelite of the Jonathan's Pond formation.*

A second phase of deformation has folded S_1 around upright, open to tight, microscopic to mesoscopic folds (Plate 5). F_2 folds are most commonly developed as crenulations that locally have an associated crenulation cleavage (Plate 6), which strikes north-northeastward and dips steeply either to the northwest or southeast. In the central parts of the area,

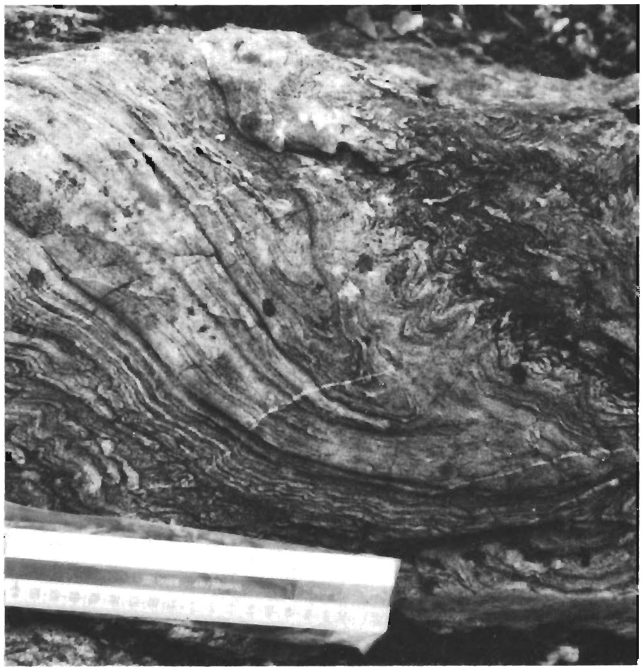

Plate 5. *Isoclinal, recumbent F_1 folds, folded around open F_2s; the pelitic layers contain abundant F_2 crenulations.*

Plate 6. *Asymmetric crenulation cleavage with associated cleavage and lineation in the Jonathan's Pond formation.*

a subhorizontal, crenulation lineation is very well developed and lies parallel to F_2 fold axes. The intensity of the second-deformation phase increases toward the granitic plutons, but within the sillimanite zone, F_2 crenulations are not exceptionally well developed. Brittle-deformation effects are represented by kink bands, which are common throughout the area and locally occur as conjugate sets.

High-Strain Zone

Near Wing Pond, rocks in the Gander Group are highly strained in a zone that is a minimum of 4 to 5 km wide and extends in a northeasterly direction for a minimum of 7 km. It extends southward outside the map area. Quartz veins are profusely developed (Plate 7) in pelitic and semipelitic rocks, and the majority of these veins are folded or show some strain effects. The foliation is intensely developed, marked by millimetre-wide discrete foliae, numerous quartz platelets and ribboned quartz veins. Folds are locally complex (Plate 8) exhibiting curvilinear fold axes that commonly curve through 90°. Asymmetric folds defined by quartz veins are later features; they apparently fold the mylonitic fabric and have consistent vergence. High strain is also evident in rocks north of Little Bear Cove Pond but its development is more heterogenous.

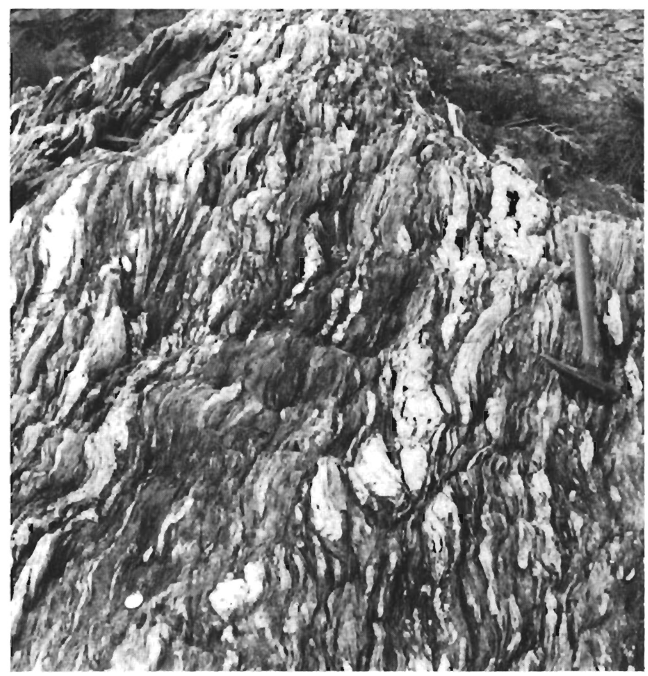

Plate 7. *Profuse quartz veins variably deformed in the high-strain zone near Wing Pond.*

METAMORPHISM

The ubiquitous occurrence of a pelitic facies in most exposures of the Jonathan's Pond and Indian Bay formations, in the Weir's Pond area, allows evaluation of the continuous variation in metamorphic grade from west to east. Limited bulk compositional variation in pelite composition has resulted in the identification of a simple progressive change in metamorphic facies from greenschist through to upper amphibolite. Biotite, garnet, andalusite, staurolite and sillimanite isograds, as defined in the field (Figure 1), are very roughly symmetrically related to the Ocean Pond pluton

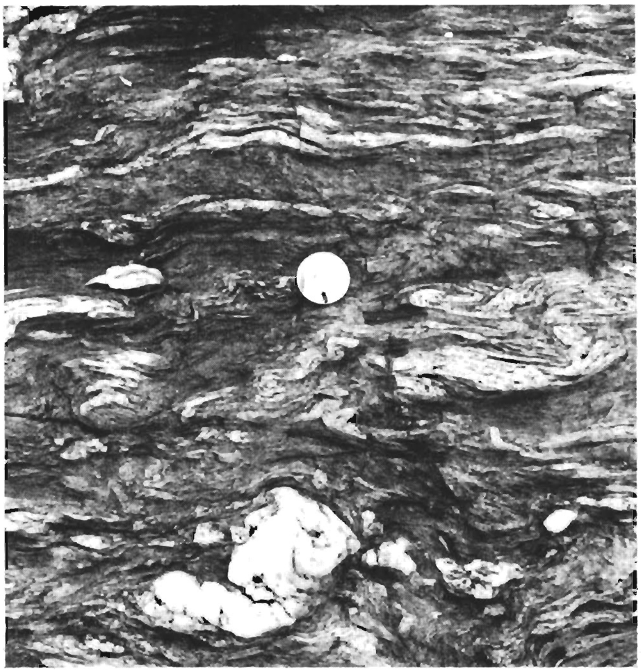

Plate 8. *Complexly folded quartz veins in the high-strain zone.*

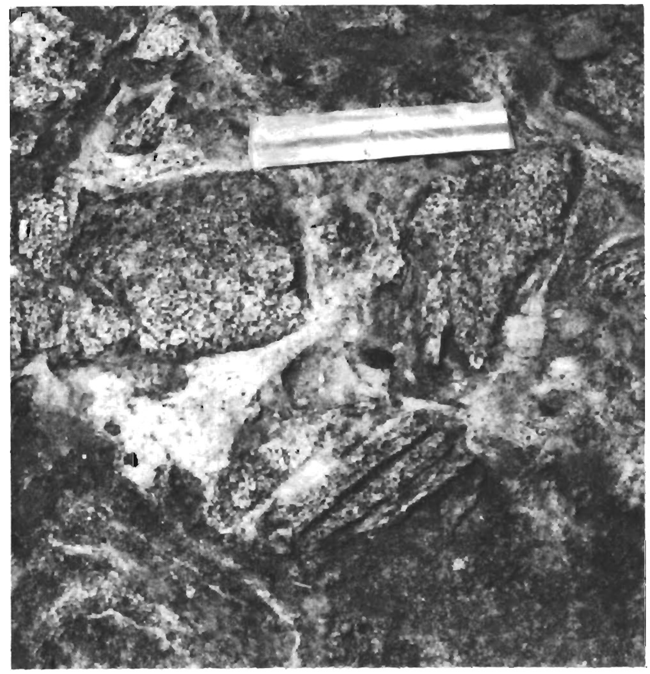

Plate 9. *Disrupted sillimanite-rich pods in pelitic 'matrix' in the sillimanite zone.*

and the Deadmans Bay Granite. In the northwest and south, the assemblage muscovite–chlorite–quartz–plagioclase in pelitic and semipelitic rocks, and chlorite–calcite–epidote–plagioclase in mafic rocks, is indicative of low greenschist facies (Winkler, 1979). Farther east, biotite becomes a stable phase coexisting with muscovite and chlorite. At higher grades, the stable asemblage is garnet (almandine?)–biotite–muscovite–chlorite; chlorite locally persists up to the staurolite zone. Andalusite, coexisting with biotite and garnet, is common around Ocean Pond and Little Ocean Pond, and forms large crystals up to several centimetres long, particularly in association with quartz in veins. The beginning of the amphibolite facies is defined by the appearance of staurolite, coexisting with garnet and biotite, which occurs sporadically and typically forms large crystals up to 2 cm across. The andalusite and staurolite isograds appear to cross the outcrop pattern of the Ocean Pond Pluton.

At 1 to 5 km from the western margin of the Deadmans Bay Granite, andalusite is replaced by sillimanite and the two polymorphs coexist over a several-hundred-metre-wide transition zone; sillimanite commonly rims the andalusite. Sillimanite grows profusely in pelitic and semipelitic rocks in the sillimanite zone, forming fibrolite buttons. Evidence of the enhanced mobility of the rock is given by disrupted sillimanite-rich layers in a psammitic matrix (Plate 9). Locally, in the northeast, small, granitic sweats define the beginning of anatexis. At the southern margin of the granite, the pluton cuts across the sillimanite isograd into the andalusite zone. Evaluation of the relationship between the metamorphism and the granites will require a more detailed petrographic analysis.

Near Wing Pond, biotite, garnet and andalusite isograds occur, and outline an isolated metamorphic high or culmination. These isograds are roughly symmetrical about an elongate aeromagnetic high that is probably a continuation of that at Four Mile Pond.

MINERALIZATION

That part of the northeastern Gander Zone examined here has not previously attracted any mineral exploration companies, principally because of the apparently barren and monotonous nature of the Gander Group. However, recognition of the Indian Bay formation (Wonderley and Neuman, 1984) and its intermediate to felsic volcanic rocks makes the area an attractive exploration target. A grab sample taken south of Southern Pond consisted of representative chips of pyrite-rich rock and crosscutting quartz veins. The exposure sampled is near the edge of a small felsic body, and may contain felsic volcanic and/or patchily silicified psammitic rock; the sample assayed 2200 ppb gold. A conglomeratic unit mapped south of this area by Blackwood (1977) implies that the Indian Bay formation continues along strike to the southwest; therefore, the volcanic rocks may be more extensive. The mafic and felsic–intermediate volcanic rocks exposed at Indian Bay Big Pond are considered to be part of a single volcanic episode contemporanaeous with the sedimentary rocks of the Indian Bay formation.

The contact zone between the chert and laminated black siltstone of Unit 6 locally contains disseminated pyrite and molybdenite. A grab sample assayed 123 ppm molybdenite and 1.5 ppm silver. Molybdenite specks were also noted in pegmatites associated with the Ocean Pond pluton.

DISCUSSION

The depositional setting of the psammite and pelite of the Jonathan's Pond formation is still uncertain. Sharp interbedding of well sorted, quartz-rich, very fine- to medium-grained sandstone with pelite is the characteristic feature of the succession. This suggests that each sandstone bed represents a distinct event when sand was transported into a mud-dominated depositional setting. The well sorted, mature, quartzose nature of the sandstone, is possibly indicative of shallow-marine, near-shore or shelf environments (Pettijohn *et al.*, 1973). This may suggest recycling of earlier sands, some of which may have been aeolian.

Massive graded sandstone suggests deposition from a decelerating current, possibly a turbidity current or liquified sand flow. Most of the sandstone, however, whether amalgamated or interbedded with pelite, is characterized by apparently planar thin stratification and lamination (some of this planicity may be due to tectonic flattening). However, the presence of some undulose lamination, slight discontinuity between stratification and internal scours, and convex-upward lenticular sandstone bodies, composed of similar lamination, suggests many of these beds may be composed of hummocky cross-stratification rather than true plane beds. If this is true, the sands were transported into a muddy shelf by storms and by density currents, and deposited below or fairly close to fair-weather wave base (cf. Walker, 1984). Crossbeds, ripple marks or prominent scours, overlain by better sorted sandstone at the top of the same thick sandstone bed or sandstone lens, suggest that the storm-deposited sands were later reworked by bottom currents during lesser storms or during fair weather, further indicating deposition close to this fair-weather wave base.

Thick planar stratified sands can also occur at the beach face or in washover fans in siliciclastic shoreline sequences (Reinson, 1984). The stratified sands, however, in these settings, are associated with distinctive sequences of offshore to subaerial sands and muds with a predominance of cross-stratification, both of which are generally lacking in the Jonathan's Pond formation. Planar stratified sands are also common in ephemeral, sandy fluvial systems of semi-arid settings (Tunbridge, 1981). The sands are deposited by flash-flood-generated streams that rapidly decelerate, producing only upper-flow plane beds. However, further evidence for a subaerial, semi-arid depositional setting for the rocks of the Jonathan's Pond formation is absent.

The Indian Bay formation has a three-fold significance. Firstly, it includes argillite or fine grained sandstone that contains the only fossils (late Arenig—early Llanvirn) found to date in the northeastern Gander Zone (Wonderley and Neuman, 1984). Secondly, this study defined a gradational transition between the Indian Bay and Jonathan's Pond formations, indicating the Gander Group is late Arenig in this area. Thirdly, the formation contains intermediate to felsic volcanic rocks, previously unrecognized, that are locally mineralized.

Sandstone exposures at Gander Lake (McKerrow and Cocks, 1976) and 2 km southwest of Weir's Pond (O'Neill, 1987; Boyce *et al., this volume)* also contain fauna of late Arenig to early Llanvirn age, and are included in the Davidsville Group. Fossils collected from bioclastic limestone on the northwest shore of Weir's Pond indicate a late Llanvirn to early Llandeilo age (Blackwood, 1978; Stouge, 1979). Williams (reported in Dean, 1978) collected middle Caradoc graptolites from black shales above this exposure on Weir's Pond.

If these rocks containing the late Arenig, Llanvirn—Llandeilo and Caradoc fossils are presumed conformable, a 25-Ma time span is defined by the lower part of the Davidsville Group. The basal part of the Davidsville Group may either form a condensed sequence, or, alternatively, disconformities may be present within the sequence that are now obscured by complex structure. The presence of late Arenig rocks in the Gander and Davidsville groups implies that they are partly time equivalent.

The sandstone of late Arenig age from southwest of Weir's Pond is quartz rich and petrographically similar to Gander Group sandstone; however, it does contain some volcanic fragments. This suggests that volcanic islands or island arcs formed a major source area.

The lower Davidsville Group was deposited after rocks of the Gander River Ultrabasic Belt were emplaced and eroded, providing detritus for the 'basal' conglomerate of the Davidsville Group. Final structural juxtapositioning of the Gander and Davidsville groups and the Gander River Ultrabasic Belt occurred in post-Middle Ordovician times. The contact zone of the Gander and Davidsville groups in the Carmanville area (several kilometres north-northeast of Weir's Pond) is interpreted as a mylonite zone, at least 1 km wide (Ken Currie, personal communication, 1987). Petrographic work on samples from the Gander River Ultrabasic Belt in the Weir's Pond area, shows that many rocks are intensely foliated and locally mylonitic.

The occurrence of the ultramafic rock in the centre of the Jonathan's Pond formation is significant in several respects. It is the first such isolated piece of ultramafic rock discovered within the Gander Group in the northeastern Gander Zone. Spatially, it coincides with the eastern edge of an aeromagnetic anomaly that extends, on a northeasterly trend, from Home Pond in the south to west of Little Ocean Pond in the north. In the Carmanville area to the north, the anomaly terminates; however, if its trend is extrapolated northward it would intersect the Gander River Ultrabasic Belt at an acute angle. Its northern terminus may also be related to the presence of a mylonite zone several kilometres northeast of Weir's Pond (Currie, personal communication, 1987). The ultramafic occurrence agrees with an ultramafic—mafic block modelled by Miller *(in preparation)* to explain the aeromagnetic anomaly. It is uncertain whether this ultramafic body is an imbricate slice of Dunnage Zone material, part of a basement block upon which the Gander Zone has been thrust, or part of original basement to the Gander Zone. Alternatively, the anomaly may reflect a major gabbro intrusion such as at Rodeross Lake in south-central Newfoundland (S. Colman-Sadd, personal communication, 1987).

The small patches of gabbro noted in Unit 7 north of Four Mile Pond are also important. Miller *(in preparation)* has modelled an aeromagnetic anomaly in that area as a mafic block representing a thrusted slice of Dunnage Zone material. If the metamorphic isograds that coincide with this anomaly near Wing Pond were produced by a localized thermal anomaly associated with the magnetic high, this would appear to mitigate against this mafic block being a thrusted (i.e., cold) slice, and would suggest an intrusion. The geology of this area is further complicated by the high-strain zone that affects all the rocks involved.

SUMMARY

1:50,000 mapping of the Weir's Pond area has now been completed. Two main divisions are recognized in the Gander Group: the Jonathan's Pond and Indian Bay formations, which are considered to be gradational. The Jonathan's Pond formation principally comprises psammite and pelite, and minor quartzite, mafic layers and calc-silicate lenses or layers. The gradational contact between the two formations is defined north of Little Bear Cove Pond, where black pelite is intercalated with psammite. The definition of a gradational contact between the Indian Bay and Jonathan's Pond formations implies a late Arenig age for the Gander Group in this area. Mafic and felsic to intermediate volcanic rocks are contemporaneous with sedimentary rocks of the Indian Bay formation. A promising gold assay of 2200 ppb occurs in a possible felsic volcanic exposure near Southern Pond.

All the sedimentary rocks in the area exhibit the effects of two stages of deformation. D_1 produced isoclinal folds, to which the axial planar fabric is the principal regional foliation. D_1 folds were later folded around open to tight, microscopic- to mesoscopic-scale D_2 folds that have an associated crenulation cleavage. A prograde series of metamorphic zones, defined by biotite, garnet, andalusite, staurolite and sillimanite isograds, outline a high-temperature—low-pressure type of metamorphism. The isograds are approximately symmetrical about, but locally crosscut, granitic plutons.

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