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GEOLOGY OF THE MOUNT SYLVESTER (2D/3) MAP AREA, CENTRAL NEWFOUNDLAND

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ABSTRACT

The Middle Ordovician or earlier Gander Group metasedimentary rocks, Middle Ordovician Baie d'Espoir Group sedimentary and volcanic rocks and Cambro-Ordovician ultramafic rocks were mapped at 1:50,000 scale, in the Mount Sylvester (2D/3) map area.

The Gander Group is dominated by quartz-rich psammite and lesser pelite, which may represent a near-shore marine succession. The Baie d'Espoir Group is divided into three major components: 1) Isle Galet Formation, consisting of felsic and mafic volcanic rocks and sedimentary rocks, interpreted to have been deposited in a deeper water, marine to alluvial environment adjacent to a felsic volcanic terrane, 2) the combined Riches Island and St. Joseph's Cove formations, which are dominated by turbiditic gray slate and sandstone, and quartz–feldspar–porphyritic tuff, and 3) the North Steady Pond Formation, which is dominated by thin to medium bedded psammite and semipelite, possibly deposited as turbidites in a mid-fan environment.

Two lenses of ultramafic rocks are located along a northeast-trending fault that separates the North Steady Pond Formation from the Riches Island–St. Joseph's Cove formations.

The Gander and Baie d'Espoir groups are complexly folded into northeast-trending structures that are locally recumbent. First-generation axial planes are usually steeply dipping, whereas second-generation axial planes and cleavages are gently dipping. The ultramafics form part of a major thrust–shear zone, which may extend for 200 km from Newton Lake (NTS area 2D/6) west to Granite Lake (NTS area 12A/2).

The Ackley Granite intrudes the Gander and Baie d'Espoir groups and cordierite porphyroblasts and granite dikes occur extensively within 1 km of the granite.

Economic mineral occurrences are concentrated in the Isle Galet Formation: stibnite–gold mineralization occurs in the felsic volcanic rocks and massive pyrite–pyrhottite–sphalerite–galena veins occur within the pelite. Scheelite mineralization is developed in the North Steady Pond Formation psammite.

Correlation of mafic tuff of the Isle Galet Formation with mineralized tuff to the south suggests some potential for gold mineralization. Gossans in the Twillick Brook Member and the known association of gold in ultramafics give these units some economic potential.

INTRODUCTION

The Mount Sylvester (2D/3) map area is located in east-central Newfoundland approximately 25 km north of Milltown, Bay d'Espoir. There are no settlements within the map area. Route 360 from the Trans-Canada Highway to Bay d'Espoir passes through the western edge of the map area, and a few disused woods roads near the Conne River Pond area allow limited access to the country adjacent to Route 360. Extensive areas of bog permit the use of all-terrain vehicles. Much of the northern half of the map area was burned out in May, 1986. Access to areas east of Bay du Nord River is best gained by helicopter or float plane. Much of the map area is presently a provisional wilderness reserve and therefore use of motorized vehicles is prohibited, and more significantly, the land is currently closed to claim staking.

The Baie d'Espoir Group is the target of very active exploration for gold at Kim Lake and areas to the southwest, and for tungsten in the vicinity of Conne River Pond and areas to the north and west.

This report is concerned mainly with the geology of the Baie d'Espoir and Gander groups west of the Ackley Granite. The geology and geochemistry of the Ackley Granite are described in some detail in Dickson (1983) and Tuach *et al.* (1986).

This project is a contribution to the Canada–Newfoundland Mineral Development Agreement, 1984–1989

Regional Setting

The Mount Sylvester map area is located in the eastern portion of the Dunnage Terrane (Williams and Hatcher, 1983) along the northeast-trending portion of the Hermitage Flexure, a 400-km-long sinuous belt of lower Paleozoic sedimentary and volcanic rocks and syntectonic granitoids. The main components of this belt, within the map area, are the Baie d'Espoir Group of Middle-Ordovician age and the Middle Ordovician or earlier Gander Group. Minor components include several small exposures of fault-bounded ultramafic rocks, sizeable areas of intrusive diabase, and isolated areas of granite.

Physiography

Exposure of the Baie d'Espoir and Gander groups is good in the vicinity of the Ackley Granite contact, but elsewhere is very limited due to low relief, extensive till deposits and bogs.

Glacial-transport indicators, such as drumlinoids, striae and stoss and lee forms, show that ice movement was towards the south (160 to 180°). Glacial erratics of the Middle Ridge Granite, a biotite–muscovite granite, were located up to 10 km south of the northern boundary of the map area. Minimum glacial-transport distance for these erratics is unknown because the location of the southern boundary of the Middle Ridge Granite is still uncertain (see Blackwood, 1983). Much of the poorly exposed area is essentially boulder free.

Drainage is generally very poor and innumerable ponds fill glacial hollows throughout the map area. The Conne and Bay du Nord rivers are the only sizeable rivers in the map area.

Previous Work

The earliest surveys were carried out by Newfoundland and Labrador Corporation Limited (NALCO) geologists during 1954 to 1956. This work, although several rock types were misidentified, provided the framework for subsequent maps of the area, e.g., Anderson and Williams (1970). This early work resulted in the discovery of various base-metal showings in the Bay du Nord River, Kim Lake and Kaegudeck Lake areas (Berrangé and McCabe, 1955; Lebans, 1956; McPhar Geophysics Limited, 1956; NALCO, 1956), and Wall (1956) reported the discovery of stibnite at the showing that he termed Kim Lake #2.

Little work was done on the various showings following 1956. In 1969 Noranda Exploration Company Limited optioned some of the NALCO ground and carried out geological and geophysical surveys over geophysical anomalies and volcanic rocks (Hawkes, 1971; McPhar Geophysics Limited, 1969). Hudson's Bay Oil and Gas also optioned the NALCO ground in 1978 and carried out detailed geological, geochemical and geophysical surveys in areas of known showings and geophysical anomalies (Dean, 1978; Aerodat Limited, 1979; Fenton, 1981).

Dean (1978) reported highly anomalous gold values from the Kim Lake #2 prospect. Subsequent trenching and analyses from the prospect failed to reproduce the high-gold values obtained by Dean (see Fenton, 1981). However, the area became known as a gold prospect. Swinden (1980) described the mineral potential of the Bay d'Espoir area, and, following the discovery of gold at Hope Brook, west of Burgeo, much of the belt of Ordovician rocks from Kim Lake west to Facheux Bay was staked. Exploration for gold was carried out by Westfield Minerals, Tillicum Resources and Golden Hind Ventures in the Mount Sylvester map area (McHale, 1985; Murphy, 1985; Reusch, 1985), mainly in the vicinity of a belt of felsic volcanic rocks extending from 5 km northeast of Kim Lake to the southern edge of the map area. Sizeable areas of the Baie d'Espoir Group to the southwest of the map area are staked, and gold in the St. Alban's (1M/13) map area was reported in a press release by Westfield Minerals on October 22, 1986. During 1986, Westfield extended their Kim Lake claims south to the boundary of the proposed wilderness reserve. The reports for Westfield Minerals and Golden Hind Ventures are currently confidential.

Kidd Creek Mines Limited (now Falconbridge Limited) discovered stratabound scheelite mineralization in graywackes at the northwest corner of the map area. The initial discovery site is located just to the north of the map area where pegmatite, quartz veins and greisens were found to contain scheelite (Blackwood, 1983; Robertson, 1984; 1985a,b).

Butler and Davenport (1979a,b) and Butler (1985) carried out lake sediment and stream sediment surveys respectively. However, no significant anomalies were outlined. Swinden and Dickson (1981) produced a 1:50,000 scale compilation map of the Mount Sylvester map area with emphasis on the Kim Lake–Rainy Lake area. Several new areas of pyritic gossan were discovered during this study (Dickson, 1986).

GENERAL GEOLOGY

The stratified rocks of the Mount Sylvester map area (Figure 1) form parts of the Baie d'Espoir and Gander groups. The Baie d'Espoir Group is considered to be an exact equivalent of the Davidsville Group (see Blackwood and Green, 1983). The Baie d'Espoir Group has been subdivided into a number of formations that are interpreted to be mainly facies variants overlying a basal formation (Colman-Sadd, 1976; 1980a). Colman-Sadd (1980a) and Colman-Sadd and Swinden (1982) indicated the relative spatial positions of each facies variant in terms of volcanic centres, and shelf and slope facies overlying a deeper water turbidite sequence.

The oldest formation of the Baie d'Espoir Group is the turbiditic Salmon River Dam Formation. This is overlain, from northwest to southeast, by the North Steady Pond, St. Joseph's Cove, Riches Island and the Isle Galet formations (see Colman-Sadd, 1980a). The younger formations are all represented in the Mount Sylvester map area.

The Gander Group is interpreted to underlie the Davidsville Group and therefore the Baie d'Espoir Group (see Blackwood, 1981; 1983). The transitional contact described by Blackwood (1983) indicates a stratigraphic continuity from the Gander Group into the Davidsville Group; Middle Ordovician graptolites occur in the Davidsville Group adjacent to the contact with the Gander Group. This indicates, therefore, a Middle Ordovician or earlier age for the upper part of the Gander Group. Colman-Sadd (1976) obtained Middle Ordovician fossils at the boundary between the Riches Island and St. Joseph's Cove formations. Dunlop (1954) obtained poorly preserved fossils from the Riches Island and Isle Galet formations in the Bay d'Espoir area, which gave a poorly defined Ordovician to possibly Cambrian age.

Ultramafic Rocks (Unit 1)

Serpentinized peridotite and dunite form three outcrop areas between Middle Ridge and Bay du Nord River. However, aeromagnetic and electromagnetic maps (Geological Survey of Canada, 1968a, b; McPhar Geophysics Limited, 1969) indicate that the area underlain by ultramafic rocks is an elongate northeast-trending belt that extends from the Great Gull Lake (2D/6) map area, through the Mount Sylvester map area, and probably westward into the Twillick Brook (2D/4) map area.

No other rock units are exposed in close proximity to the ultramafics within the map area. It is assumed that the contacts are faults, as is also assumed by Blackwood and Green (1982, 1983).

The ultramafics are massive to sheared, white-weathering, dark-green serpentinite. In the central outcrop area, however, talc-rich layers are apparent, although there is no obvious change in overall composition. Disseminated and locally irregular knots (1 cm across) of chromite are common. Shear bands are common and these trend generally 060° and dip to the southeast at around 60°. Locally, the layers are folded into upright open folds that plunge to the northeast at 20°. No quartz veins were found.

Gander Group (Units 2, 3 and 4)

Metasedimentary rocks of the Middle Ordovician or earlier Gander Group underlie the northeast corner of the map area. Unit 2 is dominated by buff, quartz-rich, medium to thick bedded psammite, which locally contains very thin (1 to 2 mm) intercalations of phyllite. Bedding in the psammite is rarely apparent where phyllite is absent, and younging criteria are rare. Cross-beds and graded beds were found in only two places. The psammite has a well developed spaced cleavage and cleavage planes are 5 to 15 mm apart (Plate 1). Cleavage is generally subparallel to bedding. Conjugate kink bands are locally prominent, and quartz veins that cut across the cleavage are common. In one area, patches of very rusty gossan occur in the quartz-rich psammite (geochemical sample 2242834, Table 1); the larger patches are about 3 m by 2 m in area.

Unit 3 consists of medium to thick bedded, gray psammite and minor amounts of white, quartz-rich psammite and gray, medium bedded pelite. The contact between Units 2 and 3 is probably gradational over 500 m. The lack of younging criteria near the contact makes the stratigraphic succession uncertain. Parallel laminations and a few rip-up clasts are the only sedimentary structures. Cleavage is generally parallel to bedding. Tight upright folds of bedding having an axial planar cleavage are interpreted to be F_1 folds. Open folds

Plate 1: *Well developed spaced cleavage overprinted by a kink band; Unit 1 of Gander Group, Rainy Lake area. Lens cap is 5 cm in diameter.*

of bedding and the S_1 cleavage plunge steeply to the northeast and locally to the southwest. Gray psammite of Unit 3 is intruded by dikes of the Ackley Granite, and the main contact with the Ackley Granite is well exposed at Mount Sylvester.

Unit 4 is dominated by gray-black pelite, which has been extensively contact metamorphosed to cordierite hornfels up to 1 km from the contact with the Ackley Granite. Parallel bedded semipelite locally gives the only indication of bedding in the pelite.

The contact of Unit 4 with Unit 3 is a fault, which forms a prominent topographic lineament north of Mount Sylvester. To the west of this northeast-trending fault, near Mount Sylvester, there is a change from pelite to semipelite and gray psammite. The abrupt change in rock types across this fault makes the assignment of Unit 4 to the Gander Group uncertain. Units of the Baie d'Espoir Group, near their contact with Unit 4 at Kaegudeck Lake, young away from Unit 4, possibly indicating that Unit 4 is older than parts of the Baie d'Espoir Group.

The well sorted psammite (Unit 2) of the Gander Group probably represents a near-shore marine environment; deeper water sedimentation may be indicated by the change to poorly sorted and finer grained gray psammite (Unit 3) and pelite (Unit 4) to the east.

Baie d'Espoir Group (Units 5 to 12 and 14 to 21)

Isle Galet Formation (Units 5 to 12). The Isle Galet Formation has been divided into eight units based on rock types. The formation forms an east-northeast-trending belt north of the Ackley Granite. The various units form generally parallel belts, but repetition and lensing out of distinctive units

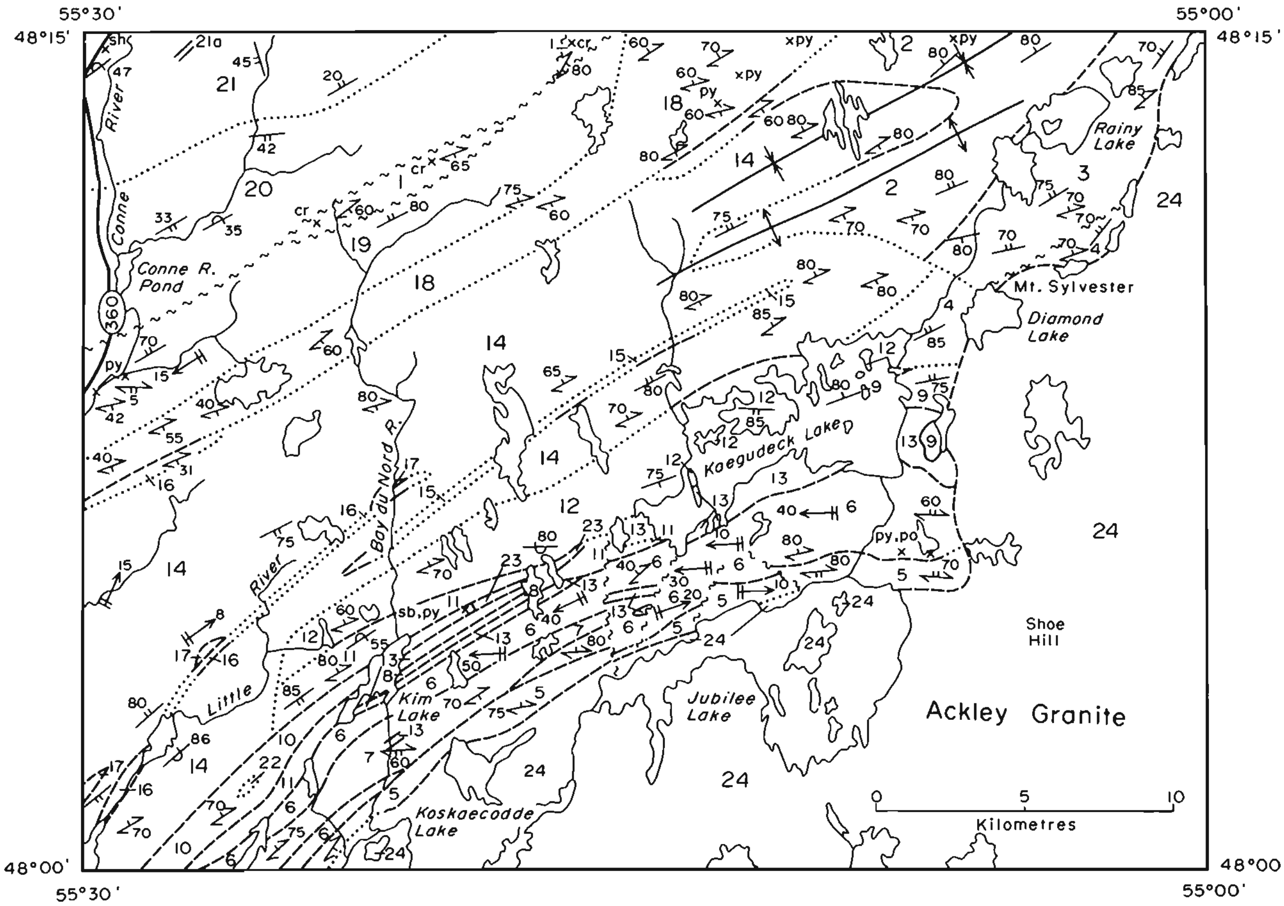

Figure 1: *Geological map of the Mount Sylvester (2D/3) map area, central Newfoundland.*

LEGEND

DEVONIAN

24 *Ackley Granite: massive, pink to buff, coarse grained, K-feldspar-porphyritic, biotite ± hornblende granite and granodiorite; locally cut by medium grained, biotite–muscovite granite dikes*

ORDOVICIAN(?)

23 *Kim Lake Granite: altered, brecciated and quartz-veined, pink, leucocratic granite containing secondary muscovite; stibnite occurs locally along joints*

22 *Gray to green, weakly foliated, feldspar-porphyritic biotite–hornblende(?) granodiorite*

MIDDLE ORDOVICIAN

BAIE D'ESPOIR GROUP (Units 5-12, 14-21)

NORTH STEADY POND FORMATION (Units 20 and 21)

21 *Gray, medium bedded, contact-metamorphosed(?), psammite and semipelite; locally highly altered, containing scheelite mineralization; 21a, metadiorite dike*

20 *Gray to buff, thin bedded sandstone and minor siltstone*

LEGEND *(Concluded)*

RICHES ISLAND FORMATION AND ST. JOSEPH'S COVE FORMATION (Units 14-19)

19 *Thin bedded, pyritic, black slate and minor, thin, interbedded, coarse grained sandstone and minor quartz-rich sandstone, and siliceous, graphitic(?) siltstone*

18 Twillick Brook Member: *very thick bedded, strongly cleaved, coarse grained, quartz–feldspar-crystal tuff and quartz-crystal tuff containing minor, interbedded, coarse grained sandstone and siltstone; locally highly altered to gossan*

17 *Thin to medium bedded, locally cross-bedded quartzite containing thin pelite interbeds*

16 *Thin bedded, black with white patches, graphitic pelite and siltstone*

15 *Thin, well bedded, black siliceous siltstone*

14 *Gray to buff, medium bedded slate, siltstone and sandstone; pebble conglomerate occurs near contact with Gander Group (Unit 2)*

13 Kaegudeck diabase: *green to gray, generally massive, medium to fine grained, mainly equigranular to locally plagioclase-porphyritic, chloritized diabase sills and dikes*

ISLE GALET FORMATION (Units 5-12)

12 *Thick to medium bedded, gray to buff, cleaved, locally cross-bedded and graded, micaceous, locally calcareous sandstone and minor interbedded gray slate*

11 *Thin to thick, interbedded quartzite, poorly sorted granule to pebble conglomerate and pelite; 11a, interbedded quartzite and pelite; 11b, granule and pebble conglomerate and sandstone*

10 *Thick massive rhyolite and lesser lapilli tuff, fine grained waterlain tuff, probable quartz–feldspar-crystal, ash-flow tuff; locally highly altered and cut by quartz veins, some containing pyrite or stibnite*

9 *Thin to medium bedded, gray sandstone hornfels and minor thin bedded pelite*

8 *Medium bedded red sandstone and minor red siltstone; locally displays cream-colored alteration; 8a, gray sandstone, epiclastic lapilli tuff and minor gray slate*

7 *Unbedded, green to gray, chlorite schist (possibly fine grained mafic tuff), interbedded with deformed basaltic pillow lava; cut by thick dikes of Unit 13*

6 *Thin bedded, buff to cream, sericite schist and minor chlorite schist, and cleaved psammite interbedded with units of rhyolitic quartz–feldspar-crystal tuff; cut by thick dikes of Unit 13*

5 *Medium to thick bedded, gray sandstone and minor interbedded pelite; contact metamorphosed to cordierite schist along the contact with the Ackley Granite (Unit 24)*

MIDDLE ORDOVICIAN OR EARLIER

GANDER GROUP (Units 2, 3 and 4)

4 *Thick bedded, strongly cleaved, cordierite-bearing pelite hornfels*

3 *Medium to thick bedded, cleaved, gray sandstone containing minor thin bedded pelite*

2 *Medium to thick bedded, cleaved, white-weathering, buff quartzitic sandstone containing thin pelite interbeds*

CAMBRO-ORDOVICIAN

1 *Cleaved and sheared, serpentinized peridotite and dunite; contains disseminated chromite and local talc layers*

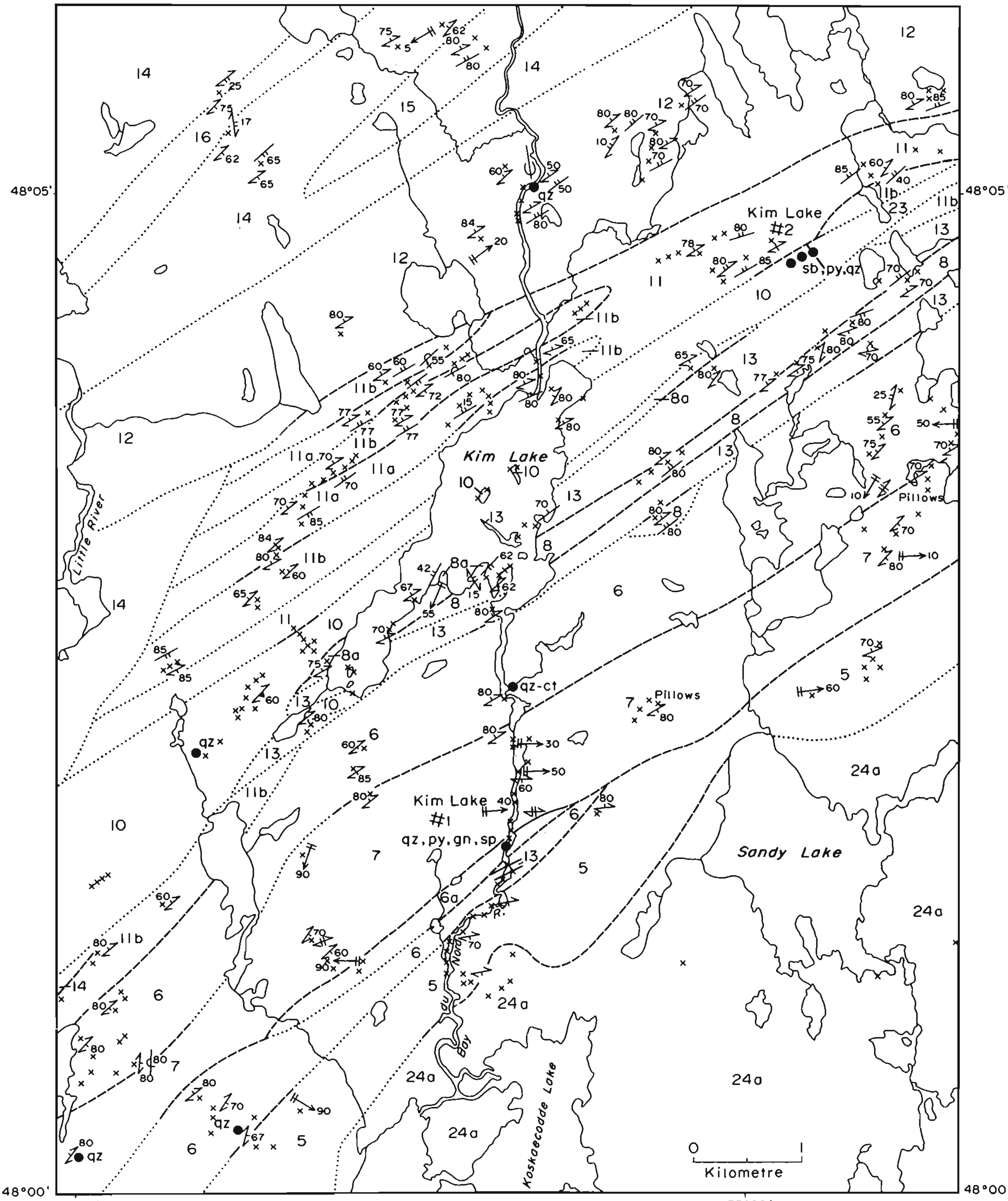

Figure 2: *Detailed map of the Kim Lake area (from Dickson, 1986); see Figure 1 for legend.*

complicate the stratigraphy. Similarly, tight folding and the lack of younging criteria hinder the interpretation of the stratigraphy. A few sedimentary structures in Units 11 and 12 indicate the succession is north younging, and it is assumed that this is true for the formation in general.

Unit 5 is dominated by gray, parallel bedded, psammite and minor semipelite. There is an abrupt change to the semipelite-dominated Unit 6 to the north. Unit 5 is contact metamorphosed and intruded by the Ackley Granite; there is a pronounced increase in the abundance of cordierite porphyroblasts toward the granite contact. No definite andalusite was found.

Unit 6 is dominated by semipelite and pelite in the Bay du Nord River area, with generally a higher proportion of semipelite and psammite to the east. Small lenses of felsic pyroclastic rocks occur within Unit 6. Dean (1978) and Fenton (1981) report that tuffaceous rocks are common. However, this study has shown that only a small proportion of the unit is volcanic. The remainder is dominated by sedimentary rocks, even in the vicinity of mineral occurrences. The pelite south of Kim Lake is generally featureless, phyllitic slate having no apparent bedding. East of Kim Lake, the psammite is parallel bedded and interbedded with pelite and semipelite. In places, red-cream psammite and semipelite are interbedded with gray sedimentary rocks. The main cleavage (S_1) is generally subparallel to bedding. Open to tight, upright, second folds, commonly having an associated axial planar cleavage, occur throughout the unit. These folds plunge gently to the east or west and verge to the north. Metamorphism is generally in the low greenschist facies; chlorite is well developed. Quartz veins are common and locally quartz–carbonate veins cut pelite; small sulfide veins also occur in the pelite (see Economic Geology).

Narrow lenses of felsic tuff occur within Unit 6 in the Bay du Nord River area (see Figure 2) and southwest of Kaegudeck Lake (Dickson, 1986). The dominant rock type is strongly cleaved, quartz–feldspar-crystal tuff, which has been converted to sericite–chlorite schist containing quartz ± carbonate veins. Some of the carbonate veins are rusty possibly because of pyrite alteration e.g., 700 m southwest of Kaegudeck Lake. The Kim Lake #1 showing on Bay du Nord River (Figure 2) occurs near the contact between quartz-crystal tuff and basaltic tuff.

Unit 7 consits of basaltic tuff and locally thick, massive, probable flows and locally well developed pillow lava (Plate 2). Bedding is rarely apparent in the tuff. The highly chloritic, dark-green tuff is characteristically highly folded, exhibiting tight F_2 folds that plunge mainly to the east at around 40° (Figure 2). Quartz veining occurs rarely, but quartz–epidote veins occur in the pillow lavas.

Unit 8 is a thin unit of medium bedded, red sandstone and siltstone having a well developed cleavage. The unit is bounded along most of its length by diabase (Unit 13), which is interpreted to have been intruded parallel to bedding. At Kim Lake, pebble-size breccia, quartzite and slate (subunit 8a of Dickson, 1986) are in close proximity to the main belt of red sandstone; an isolated outcrop of breccia occurs

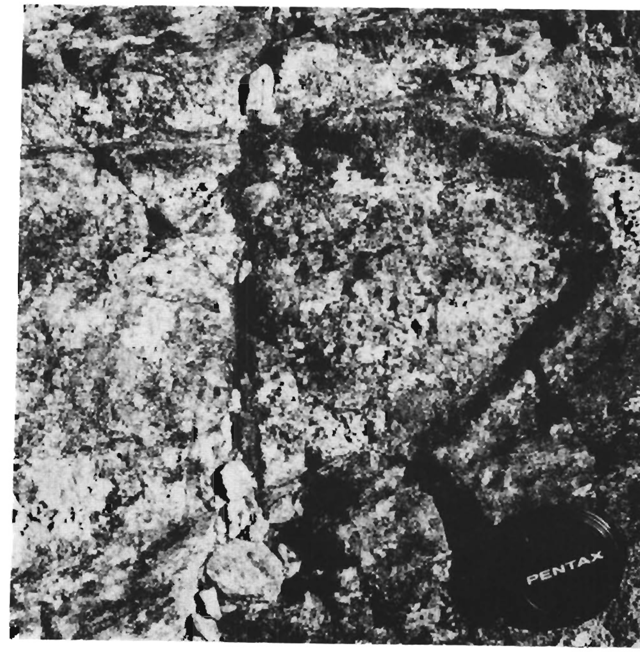

Plate 2: *Pillowed basalt in Unit 7 of Isle Galet Formation; 3.6 km east of Kim Lake. Lens cap is 5 cm in diameter.*

between Unit 10 rhyolite and Unit 13 diabase (Figure 2). Near the contact between Unit 8 and subunit 8a on Kim Lake (Figure 2), the red sedimentary rocks become increasingly silicified, and the color changes to cream. Thin carbonate veins are common.

Unit 9 is exposed around the eastern end of Kaegudeck Lake. The dominant rock type is parallel bedded, thin (1 to 4 cm) psammite and minor pelite. Locally the rock is pelitic containing fine grained sericite. Much of Unit 9, east of Kaegudeck Lake, was previously shown as layered gabbro (Swinden and Dickson, 1981). However, this area has been reassessed and is considered to contain large areas of very hard, bedded psammite, which has been contact metamorphosed by the underlying Unit 13 diabase. Folding of the bedded psammite is common, but there is no consistency to the orientation of the folds.

Unit 10 is dominated by massive but locally flow-banded and autobrecciated rhyolite flows, which form low ridges along the length of the unit. In the vicinity of the Kim Lake #2 prospect, the main rock type is a very fine grained, feldspar-porphyritic rhyolite. Southwest of Kim Lake, the outcrop width of Unit 10 increases and the rhyolite is interbedded with fine grained, thinly bedded siliceous tuff, lapilli tuff, quartz–feldspar-crystal tuff, and epiclastic breccia. The interbedded units are generally thin (10 to 50 m), but are persistent along strike for up to 2 km.

Contacts of Unit 10 with subunit 11a are exposed on both sides of the belt. Thin, gray slate beds are in sharp contact with the rhyolite, and, southwest of Kim Lake, a thin band of rhyolite occurs within subunit 11a. Coarse grained sandstone and pebble conglomerate (subunit 11b) occur on both sides of Unit 10. Felsic volcanic pebbles in the conglomerate indicate that the source is possibly Unit 10.

A thinly bedded, siliceous tuff, also termed porcellanite, occurs near the southeast margin of Unit 10 at the south end of the belt. Lapilli tuff, which also occurs near the southeast margin, is characterized by angular volcanic fragments (1 to 2 cm long) in a finer grained matrix. This tuff is compositionally similar to the epiclastic breccia (part of Unit 11), but the latter contains a significant proportion of shale fragments. An isolated outcrop of quartz–feldspar-crystal tuff occurs near the assumed western margin of the belt. Quartz veins are common throughout the belt; some contain a metallic mineral that is possibly specular hematite. At Kim Lake #2, quartz veins contain stibnite crystals.

Alteration of Unit 10 is apparent at the Kim Lake #2 showing. The volcanic rocks are distinctly red due to the development of hematite and limonite. Fine grained sericite and quartz veins are common. Around Kim Lake, the rhyolite is aphanitic, white to green and distinctly siliceous. Near contacts with adjacent units, it is difficult to determine whether the parent rock is silicified sedimentary rock, diabase or rhyolite.

Penetrative fabrics are restricted to the tuffaceous rocks, which are well cleaved. The quartz–feldspar-crystal tuff has a strong schistosity and quartz and feldspar augen. Other deformation is brittle.

Unit 11 is composed of white quartzite and gray pelite, interbedded with gray coarse grained sandstone, epiclastic breccia, and pebble conglomerate interbedded with minor red sandstone and shale. The quartzite appears to be well sorted and exhibits thin (1 to 2 mm) shale partings. Parallel laminations of pelite occur within parallel bedded (30 cm to 1 m) quartzite. The coarser clastics are thick bedded (generally 1 to 5 m) and locally display cross-beds and graded beds. Northwest of Kim Lake, these features indicate that Unit 11 is overturned to the northwest in that area, younging away from the Unit 10.

Unit 11 conglomerate consists of well rounded pebbles and, locally, cobbles. Siliceous pebbles of felsic volcanic rock and fine grained, mafic, feldspar porphyry occur in a coarse grained sandy matrix. The well sorted, clean quartzite was probably of shallow-marine origin and the coarse clastics possibly of fluvial origin. The interplay of these two lithofacies indicates that the sequence may be the deposits of a fan-delta environment (see Pudsley, 1984), with sediment derived from the volcanic rocks of Unit 10.

Unit 12 is characteristically thick bedded, gray to buff, parallel bedded, medium grained sandstone containing abundant detrital muscovite, and minor thin to thick, muscovite-bearing pelitic interbeds. One kilometre northeast of the head of Bay du Nord River, the brown-weathering sandstone has a carbonate cement. The sandstone locally contains cross-beds, which, in the Kaegudeck Lake area, occur as ripple cross-beds and trough cross-beds that are locally overlain by 2-m-thick graded sandstone beds. Flame structures were noted at one locality (Plate 3). This unit probably formed in a deltaic to shallow-marine environment, and is therefore similar in some respects to Unit 11. The younging criteria indicate that the unit is disposed in a tight, overturned, northward-facing, syncline–anticline pair, and overlies Units

Plate 3: *Flame structures in medium bedded micaceous sandstone overlain by pelite; Unit 12 of Isle Galet Formation, northeastern Kaegudeck Lake. Lens cap is 5 cm in diameter.*

4, 9 and 14. Small folds are rare, but, in the northwest part of Kaegudeck Lake, the sandstone forms a tight isoclinal fold that plunges to the west at 80°. The axial plane of the fold is parallel to regional bedding. A horizontal cleavage–bedding intersection lineation is also folded around the nose of the fold, indicating that it is a second-generation fold.

Riches Island–St. Joseph's Cove formations (Units 14 to 19). Colman-Sadd (1976) defined the term Riches Island Formation for semipelitic to psammitic schist, and St. Joseph's Cove Formation for siltstone, sandstone and volcanic rocks, in the St. Alban's (1M/13) map area. In the Mount Sylvester map area, the boundary between the formations is not a distinct line but appears to be gradational over 2 km.

Unit 14 consists of gray to buff slate, gray sandstone and siltstone. Buff slate is the dominant rock type northeast of Bay du Nord River. Southwest of Bay du Nord River, gray slate and sandstone are the main rock types. Bedding in the monotonous slate sequences is generally apparent only where sandstone beds occur. The southwestern sequence is generally well bedded, exhibiting parallel beds, 10 to 30 cm thick, of alternating sandstone and slate. Parallel laminations are the only other sedimentary features present, although Colman-Sadd (1980a) has described microscopic grading, cross-laminations and incomplete Bouma sequences from the St. Joseph's Cove Formation, indicative of turbidite deposition, possibly in a submarine fan.

Unit 15 forms a narrow zone that consists of highly folded, thin and parallel bedded, siliceous siltstone that is highly folded. No other sedimentary structures are present.

Unit 16 forms two elongate belts of graphitic pelite cut by numerous quartz veins. Parallel laminations occur in a few thin beds. Generally, however, sedimentary features have been destroyed by the intense folding.

Unit 17 occurs in three small areas generally close to Unit 16. The dominant rock type is clean quartzite containing slate laminations (1 to 2 mm thick) and slate interbeds (2 to 4 cm thick). Cross-bedding is common in 30-cm-thick beds.

Unit 18 consists of strongly cleaved, feldspar ± quartz porphyry, and very minor, interbedded, red sandstone at the northern part of the map area. This unit has been termed the Twillick Brook Member of the St. Joseph's Cove Formation (Colman-Sadd, 1980b). Most of the unit is considered to be a volcanic rock but Prince (personal communication to Colman-Sadd, 1978, *in* Colman-Sadd, 1980a) reports that the unit is in part intrusive. Blackwood (1983) has interpreted the unit ' .. as a synsedimentation intrusive porphyry and/or a porphyritic subaqueous lava flow .. '. Colman-Sadd (1980b) describes the southwest part of the unit as a pyroclastic deposit that locally contains lithic fragments. Just south of the contact of the main belt of the Twillick Brook Member, on the Bay d'Espoir highway, crystal tuff is interbedded with graphitic slate (Colman-Sadd, 1980a).

In the Mount Sylvester map area, the Twillick Brook Member is rarely exposed in contact with the adjacent sedimentary rocks. Near the contact with Unit 16, the tuff is highly sheared and altered, indicating that the contact here may be a fault. At the north of the map area, red siltstone is interbedded with the porphyry. In this area, however, Unit 18 is both quartz-feldspar porphyritic and feldspar porphyritic. Several features indicate that the unit is a tuff or flow: there is no evidence of contact metamorphism in the pelite adjacent to the porphyry; no dikes of porphyry were observed; and the unit is parallel to the other rock units.

The quartz and feldspar phenocrysts are generally 3 to 10 mm long and form augen in a strongly schistose matrix of quartz, feldspar, sericite and chlorite. The unit usually displays only one cleavage, which generally dips to the southeast at a moderate angle. Locally a strain-slip cleavage is present. In the northern portion of the unit, where it is widest, cleavages dip to the northwest in the northwestern part and to the southeast in the southeastern portion. This distribution of foliation attitudes indicates that the unit is folded. The outcrop pattern of the Twillick Brook Member to the north (Blackwood and Green, 1983) is considered to reflect refolding of F_1 folds (F. Blackwood, personal communication, 1986).

Alteration of the Twillick Brook Member is most apparent in the northeastern portion of the unit where areas of gossan occur. These form patches of 'rust' and quartz up to 15 m². In one area the entire, highly cleaved, 10-m² outcrop is altered. Samples of gossan were analysed for gold but no significant values were obtained (see Table 1).

Unit 19 is a very poorly exposed unit dominated by pyritic black slate and minor graphitic pelite containing thin coarse grained sandstone beds. The various sedimentary rocks are thin to medium bedded, and parallel laminations occur in the sandstone. Coarse grained quartz-rich sandstone forms an isolated outcrop in the vicinity of the southern margin of an ultramafic body (Unit 1) north of Bay du Nord River. The relationship of this occurrence to the pelite in the remainder of the unit is unknown. In the Great Gull Lake area, Blackwood and Green (1982) have correlated similar quartzite in a similar structural position with the Gander Group.

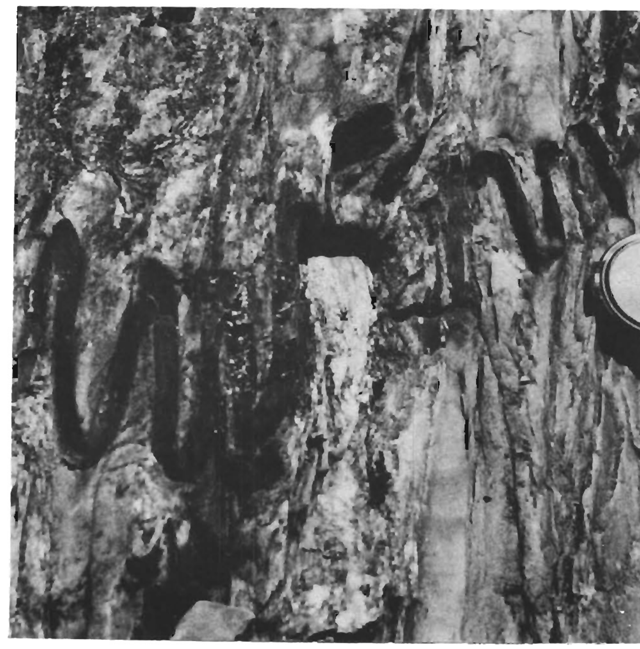

Plate 4: *Tight, steeply plunging, F_1 folds in gray sandstone; Unit 14 of St. Joseph's Cove Formation, 10 km south of Conne River Pond. Lens cap is 5 cm in diameter.*

The Riches Island and St. Joseph's Cove formations are strongly cleaved and two cleavages are commonly found. Isoclinal F_1 folds were found in only one area; an associated axial planar cleavage is parallel to bedding (Plate 4). These folds plunge steeply to the southwest. F_2 folds plunge gently to the southwest or northeast at usually less than 10°. Axial planes also dip at less than 10° to the northwest or southeast. In the Kaegudeck Lake area of Unit 14, there is only one poorly developed cleavage in the pelite. Northwest-plunging F_3 folds occur in a few areas, and these are commonly the site of quartz veins that parallel the steep, northwest-trending axial planes. In other areas, such as Conne River, quartz veins are concentrated in the hinges of F_2 folds.

North Steady Pond Formation (Units 20 and 21). Medium to thin bedded psammite and semipelite of Units 20 and 21 are assigned to the North Steady Pond Formation following Colman-Sadd (1980b). This formation is interpreted to be in fault contact with the St. Joseph's Cove Formation; intervening lenses of ultramafics (Unit 1) are located along the faults.

Unit 20 consists of monotonous, thin and parallel bedded (2 to 4 cm), gray psammite containing minor gray pelite and medium bedded psammite. The unit dips consistently to the southeast, and at one locality cross-bedding shows that it is overturned (see also Anderson and Williams, 1970).

Unit 21 consists of irregular to parallel bedded, medium bedded (10 to 30 cm), gray, garnetiferous psammite containing minor semipelite and pelite. The only reasonable exposure of this unit occurs in the northwest corner of the map area where the ground has been trenched by Kidd Creek Mines Limited. In this area, beds are not parallel but commonly have scoured bases and exhibit grading, convolute lamination, parallel lamination and cross-lamination. Grading is indicated by feldspar-rich sandstone bases and finer grained siltstone tops. Colman-Sadd (1980a,b) interpreted the North Steady Pond Formation, in the type area, as being deposited in a submarine-fan environment, and rocks similar to Units 20 and 21 as being deposited in a mid-fan environment. The thin, parallel laminated psammite and pelite of Unit 20 could be interpreted as a more distal facies of this fan system.

The main cleavage in the North Steady Pond Formation is considered to be S_1. Sedimentary features indicate that the sequence is overturned to the southeast. No minor F_1 folds were observed. S_1 generally dips to the southeast except in the eastern part of Unit 21 where dips are to the west and north; this reorientation may be related to later folds. Crenulations of S_1 plunge gently to the southwest at less than 10°, and a weak S_2 cleavage dips gently to the southwest at less than 10°.

The rocks of Units 20 and 21 are metamorphosed to biotite–muscovite grade. Static metamorphism of Unit 21 has produced biotite and garnet porphyroblasts that overprint the main fabric. These minerals may reflect contact metamorphism by the Middle Ridge Granite, which may lie underneath the North Steady Pond Formation.

Unit 21 is intruded by a dike of equigranular hornblende diorite (subunit 21a), which contains a gently dipping cleavage. Several thin quartz veins cut the dike. The orientation of the dike shown in Figure 1 has been interpreted from a northeast-trending aeromagnetic anomaly that is coincident with the dike (Geological Survey of Canada, 1968a).

Intrusive Rocks (Unit 13 and Units 22 to 24)

The Kaegudeck diabase, an informal name for Unit 13, occurs as numerous dikes and sills that occur in a belt extending from Kim Lake to eastern Kaegudeck Lake. The diabase forms 100- to 500-m-wide dikes (or sills) that intrude the sedimentary rocks of the Isle Galet Formation and generally trend parallel to the units. Sharp intrusive contacts and chilled margins are exposed in several places. At the eastern end of Kaegudeck Lake, the Unit 9 psammite forms a cap to the diabase, and is converted to hornfels. Several islands in Kaegudeck Lake are underlain by sedimentary rocks that probably overlie the sheet of diabase. On Bay du Nord River, a relatively narrow (50 m) diabase dike has produced a 5- to 50-m-wide aureole defined by cordierite porphyroblasts. Sharp contacts and locally extensive contact metamorphisms indicate that the diabase outcrops in the Kim Lake and Jubilee Lake areas are intrusive. Generally, however, the effects of contact metamorphism are not apparent.

The diabase is medium to fine grained, massive, and only locally contains small phenocrysts of plagioclase or pyroxene, which are altered to chlorite. A weak cleavage was observed in only one outcrop. Locally the diabase contains interstitial calcite. On Kim Lake the diabase has a highly weathered, rusty crust up to 2 cm thick. Thin section studies indicate that the crust was formed by leaching of carbonate. The diabase locally contains fine grained disseminated pyrite and a few widely scattered quartz veins. Glassy rhyolite (subunit 13a, Dickson 1986) is spatially associated with diabase on one island in the western half of Kaegudeck Lake; no contacts are exposed.

Coarse grained, gray, equigranular, biotite–hornblende(?) granodiorite (Unit 22) forms two small outcrops apparently within Unit 10 rhyolite; no contacts are exposed. The biotite is altered to chlorite. The granodiorite is cut by small shear bands that trend parallel to the regional fabric. Small breccia veins cut through the granodiorite and may be tuffisites formed by gas brecciation.

The Kim Lake Granite (Unit 23) is an informal name for pink to white, highly quartz-veined, altered, feldspar-porphyritic, sericitic, leucocratic granite. It forms a narrow dike that extends for 4 km northeast from the Kim Lake #2 Sb–Au showing. The granite usually contains small rusty spots, possibly from pyrite alteration. Stibnite occurs as joint coatings in the granite at Kim Lake #2.

Contacts are not exposed between the granite and the sedimentary country rocks. However, at the eastern trenches at the Kim Lake #2 showing, there are clearly two distinct igneous rock types present, and this is also reflected in the float around the trenches. The distribution of clasts in the nearby float indicates that the contact between the volcanic rocks (Unit 10) and the granite (Unit 23) trends to the southeast.

Hydrothermal alteration, common in the granite, does not appear to continue into the Unit 11 sandstone to any significant extent, although a few quartz veins occur in the sandstone.

The Ackley Granite (Unit 24) is dominated by massive, coarse grained, feldspar-porphyritic, biotite granite. South of Jubilee Lake, the granite contains hornblende, and, northeast of Mount Sylvester, secondary muscovite is common (Dickson, 1983). North of Koskaecodde Lake, muscovite–biotite granite dikes occur within the main granite.

Sharp contacts between the Ackley Granite and the metasedimentary rocks were located at several places. A few granite dikes cut the country rocks. Contact metamorphism is highlighted by extensively developed cordierite porphyroblasts in the pelitic units. Southeast of Kaegudeck Lake, the metasedimentary rocks in the aureole are extensively recrystallized and have a gneissic appearance. No hydrothermal alteration of the country rocks by the granite is apparent.

ECONOMIC GEOLOGY

This section attempts to summarize the various occurrences and indicate other areas that may have mineral potential, especially for gold.

Table 1. Gold values from chip samples in the Mount Sylvester (2D/3) map area

Sample No.	Grid Reference	Rock Type	Gold (ppb)	
		Kim Lake area	ASS†	CHEM+
2242806	5221005322100	quartz–carbonate veins	6	ND*
2242807	5222005323500	rusty basalt	11	23
2242808	5224505324600	rusty basalt	ND	ND
2242810	5203005322700	rhyolite	ND	ND
2242811	5192005321500	rhyolite + quartz veins	200	2
2242812	5176005320200	biotite–hornblende granodiorite	ND	ND
2242813	5221005320700	Kim Lake #1 quartz veins	3	8
2242814	5221005320400	diabase	ND	ND
2242816	5246005326150	Kim Lake #2; rhyolite–west trench	6	12
2242817	5246005326150	Kim Lake #2; rhyolite–west trench	29	55
2242818	5246005326200	Kim Lake #2; rhyolite–centre trench	8	12
2242820	5247005326200	Kim Lake #2; rhyolite–centre trench	82	136
2242821	5248005326200	Kim Lake #2; rhyolite–east trench	34	72
2242822	5248005326200	Kim Lake #2; granite–east trench	1	8
		Kaegudeck Lake area		
2242823	5307505328200	quartz–carbonate veins	ND	ND
2242824	5276505327700	altered granite	ND	ND
2242825	5284505328100	quartzite	ND	2
2242829		split of 2825	ND	ND
2242826	5389005328350	rusty pelite	ND	ND
2242827	5390005328400	rusty pelite	2	6
2242828	5375005331100	diabase + sulfide	ND	ND
2242830	5384005331300	diabase	ND	ND
2242831	5397505328150	pyrite–pyrrhotite vein + rusty pelite	26	49
		Conne River and Bay du Nord River north area		
2242800	5125005330400	altered tuff	ND	ND
2242801	5139005331100	altered tuff	ND	ND
2242802	5116505344100	rusty gray sandstone	39	ND
2242803	5193005338800	peridotite	ND	ND
2242804	5148005344800	hornblende diorite	ND	2
2242805	5200005343250	quartz vein, pelite	ND	ND
2242809		split of 2805	ND	ND
2242832	5333005343900	tuff gossan	ND	ND
2242833	5348005343900	tuff gossan	ND	ND
2242834	5403005345200	quartzite gossan	9	16
		Analytical Standard		
2242819		accepted value 1330 ± 50	580	1120

† Atlantic Analytical Services Ltd., Springdale, Newfoundland.
+ Chemex Labs Ltd., Vancouver, British Columbia.
* ND–not detected

The volcanic rocks of Unit 10 have become the target of detailed exploration for gold by various companies. This is due mainly to the apparent location of the Hope Brook Gold Mine, 250 km to the west, in rocks that may be of similar age, and the report by Dean (1978) of significant gold values at Kim Lake #2. Stibnite mineralization at Kim Lake #2 occurs in quartz veins as scattered crystals, 2 to 5 mm long, and as joint coatings in the porphyry. The overall grade of Sb mineralization is less than 0.1 percent. Dean (1978) reported relatively high gold values of 0.277 and 0.285 oz/ton. Subsequent analyses by exploration companies and this study (Table 1) indicate anomalous values, but less than those obtained by Dean (1978). Table 1 lists gold values for chip samples from this unit with emphasis on the Hudson's Bay Oil and Gas trenches at Kim Lake. Southwest of Kim Lake, there are few, if any, anomalous values from the felsic volcanic rocks and their quartz veins. Gold values for the other samples taken are also listed in Table 1.

B. McHale (personal communication, 1986) indicated that the new staking by Westfield Minerals, in the Kim Lake–Koskaecodde Lake area, was based on the gold potential of the chlorite schists (metabasaltic tuff and flows) determined from exploration in the Little River area to the southwest of Kim Lake. This unit has no obvious indication of mineralization, such as extensive quartz–carbonate veins, sulfide mineralization, or pyrophyllitic alteration, apart from the minor alteration at the Kim Lake #1 showing and quartz–carbonate veins on Bay du Nord River (Figure 2). Quartz veins at Kim Lake #1 contain highly anomalous Zn and Pb values and enhanced Cu (894 g/t Zn, 175 g/t Pb, 44 g/t Cu). The gold potential of this unit will only be ascertained by detailed sampling of rocks and soils.

Southeast of Kaegudeck Lake, company reports indicate that pyrite–arsenopyrite mineralization in pelite and 'tuff' is widespread. Pyrite–quartz veins occur in very rusty pelite. Dean (1978) and Fenton (1981) reported that chalcopyrite, galena and sphalerite are associated with these veins. Trace-element data indicate only minor enrichment in Cu (258 g/t), Pb (97 g/t) and Zn (241 g/t) from chip samples of the mineralized areas. These values are much higher than those derived from soil geochemistry and reported by Fenton (1981). Thus the belt of rocks southwest of Kaegudeck Lake and Kim Lake has indications of mineralization. However, little geochemical exploration has been conducted in the area between Bay du Nord River and the eastern Kaegudeck Lake showings (Dean, 1978; Fenton, 1981).

The northern portion of the Twillick Brook Member (Unit 18) and parts of the Gander Group (Unit 2) contain variably sized patches of very rusty altered rock in apparently fresh bedrock. Samples collected from the gossans indicate that the quartzite (sample 2242834; Table 1) is enriched in 214 g/t Pb, and contains trace amounts of gold. This area requires a more comprehensive geochemical survey to include apparently unaltered rock.

Scheelite mineralization occurs in the gray psammite of Unit 21 at the northwest corner of the map area. Mineralization occurs in individual beds and quartz veins. A rusty alteration zone is crudely stratiform in the same area. Extensive scheelite mineralization occurs in float. Falconbridge Limited has carried out some drilling in this area and also 4 km to the north in the vicinity of the Gull Lake microwave tower.

The zone of ultramafics (Unit 1), located in the northwest portion of the map area, forms part of a discontinuous aeromagnetic anomaly, greater than 50-km-long, that extends from northeast of Newton Lake in the Great Gull Lake (2D/6) map area to Twillick Brook in the Twillick Brook (2D/4) map area (Geological Survey of Canada, 1968b). This aeromagnetic anomaly continues toward Bay d'Espoir; small occurrences of pyroxenite have been noted at Salmon River Dam (Colman-Sadd, 1976), and magnesite and quartz veins have been reported from D'Espoir Lake (Dickson and Tomlin, 1983). The D'Espoir Lake occurrence is located along a major shear zone that extends from Salmon River (see Dickson and Tomlin, 1983) to the Granite Lake area (Dickson and Delaney, 1984; see also Tuach and Delaney, *this volume*). Should this zone be continuous with the eastern Middle Ridge belt, it would form a shear–thrust zone of about 200 km in length, a significant regional structure.

This zone of dunite and peridotite in the Mount Sylvester map area, and magnesite, periodotite and pyroxenite in the Great Gull Lake map area (Blackwood, 1983) has not been explored for gold or platinum. With recent announcements of gold in ultramafics in Newfoundland (Noranda Exploration Limited, quoted in St. John's Evening Telegram, Nov. 26, 1986), and widespread staking of ultramafic rocks in the Gander and Baie Verte areas, the eastern Middle Ridge belt forms a new exploration target. No claims exist along this belt which is well outside the proposed Middle Ridge–Bay d'Espoir wilderness reserve.

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