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GEOLOGY OF THE CENTRAL PORTION OF THE HERMITAGE FLEXURE AREA, NEWFOUNDLAND

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ABSTRACT

The oldest known rocks in the region are pre-Middle Ordovician mafic meta-igneous complexes, representing vestiges of either the crust of an ocean basin or the roots of a remnant arc. These rocks form the substrate to a thick succession of silicic volcanic and sedimentary rocks, most of which are of Middle Ordovician age. During the Silurian, the Hermitage Flexure area was affected by a tectono-thermal event, marked by large scale recumbent folding and greenschist to amphibolite facies metamorphism and migmatization. Major synkinematic, multiphase batholiths, containing significant proportions of hornblende-biotite tonalite and granodiorite, were intruded at this time. The granitoids are essentially deformed throughout, and are affected by major D_1 mylonite zones. Thermal relaxation of thickened crust resulted in the production of post D_1, syn D_2 muscovite-bearing granites, possibly by progressive partial melting of peraluminous parental material. The area is host to a variety of mineral occurrences, including volcanogenic base metals and uranium, and granite-hosted uranium, molybdenum, tin and tungsten. The potential for epithermal-fumerolic gold mineralization in the volcanic and comagmatic intrusive rocks is high.

INTRODUCTION

This paper presents a brief overview of the geology of the central portion of the Hermitage Flexure. The major results of the 1:50,000 scale mapping of the Burgeo (11P) map area are summarized (Chorlton, 1980; O'Brien, 1983; Blackwood, 1983, 1984, 1985a; Dickson and Tomlin, 1983; O'Brien and Tomlin, 1984, 1985a, 1985b; Dickson and Delaney, 1984; Dickson *et al.*, 1985; Poole *et al.*, 1985). Related petrochemical studies are in progress and the results of this work will be published at a later date.

The Burgeo map area (Figure 1) is situated on the southwest coast of Newfoundland, bounded by north latitudes 47° 00 and 48° 00' and west longitudes 56° 00 and 58° 00. The physiography of the region is characterized by a peneplain with an average elevation of 330 m, which is disrupted by scattered monadnocks with elevations of 450 to 700 m. The coastal region is dissected by north-south trending fiord-like bays. The area's major rivers - Grandy's Brook, White Bear River, Grey River and Dolland Brook - follow this north-south grain. Elsewhere drainage is controlled by the regional, east-west, structural grain. Much of the Burgeo map area is readily accessible only by aircraft. The town of Burgeo is the largest population centre, with approximately 3000 inhabitants; it is connected to the Trans-Canada Highway by a 160 km all-weather road. From spring to early autumn, Burgeo and the coastal communities of Ramea, Grey River, Francois and McCallum are serviced daily by C.N. Marine and Newfoundland Government ferries.

The Burgeo map area is underlain by early to middle Paleozoic rocks that are structurally dominated by the Hermitage Flexure (Williams *et al.*, 1970), a sinuous Z-shaped configuration of rock units on the south coast of Newfoundland (Figure 2). These rocks are continuous along strike with the metamorphic and granitoid rocks of the Gander Zone of northeastern Newfoundland (Williams, 1976; Blackwood, 1978), and have a similar structural and metamorphic history (Blackwood, 1978, 1985b). In terms of their stratigraphy, facies associations and tectonic affiliation, rocks of the

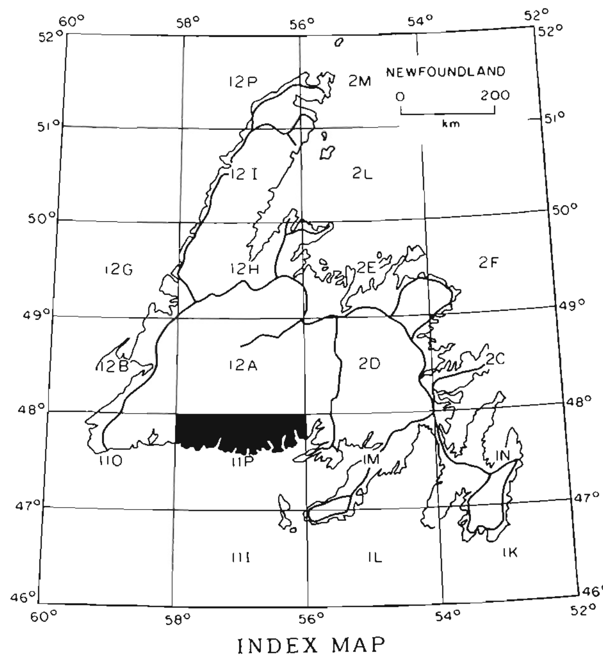

Figure 1: *Location of the Burgeo (11P) map area.*

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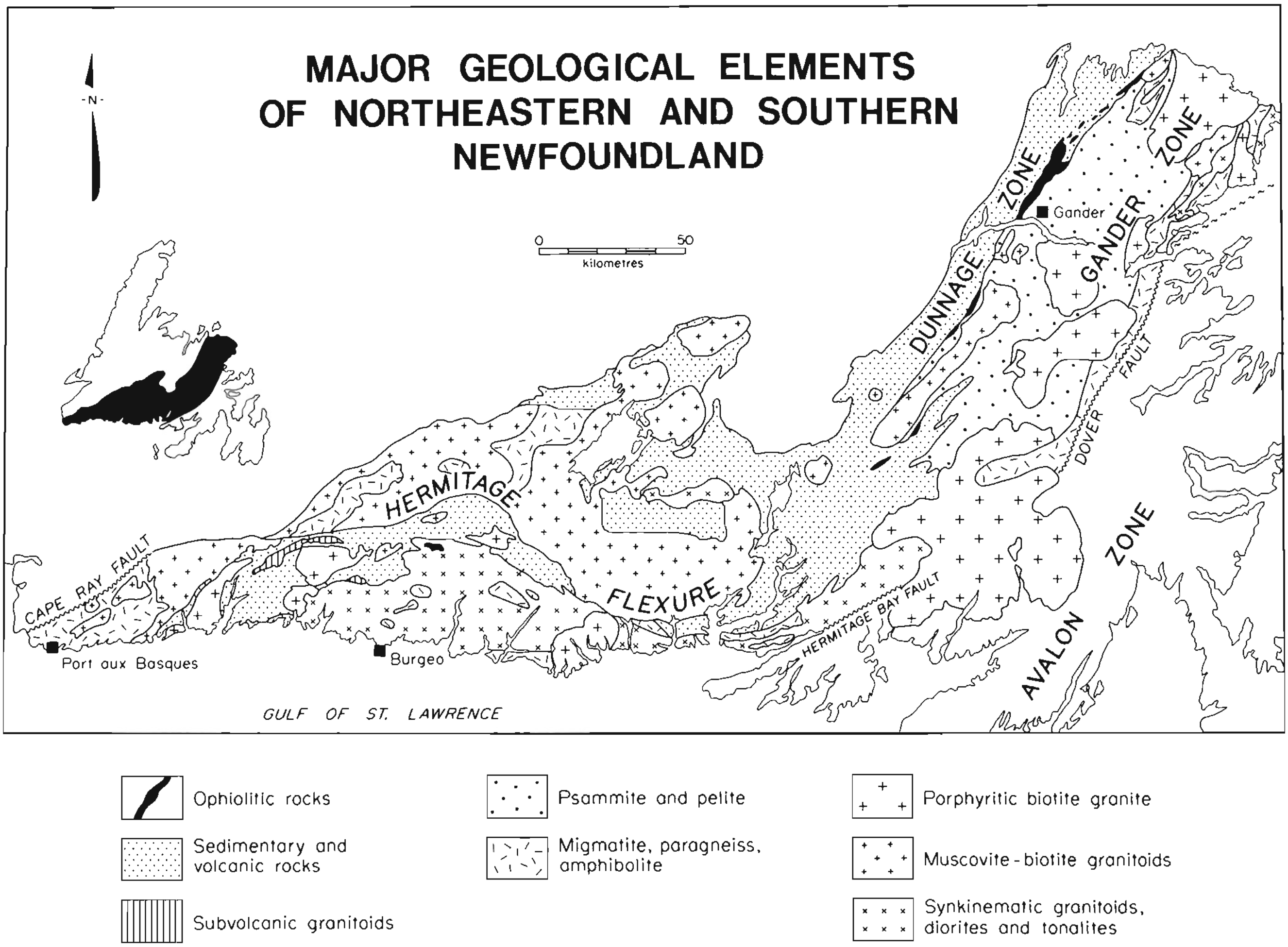

Figure 2: *Major geological elements of northeastern and southern Newfoundland.*

central Hermitage Flexure area are comparable to the Ordovician successions in the Dunnage Zone (e.g., Williams, 1976; Dean, 1978) of central Newfoundland.

The principal stratigraphic components of the region are Lower (?) to Middle Ordovician volcanic and sedimentary rocks of the Bay du Nord and Baie d'Espoir groups. A third unit of regional extent, the volcanic-sedimentary La Poile Group, may include rocks that are either equivalent to, or significantly younger than, the Ordovician rocks. The Bay du Nord and Baie d'Espoir groups are interpreted to have been deposited, at least in part, on an oceanic basement, vestiges of which occur in the western parts of the Burgeo map area. Mafic migmatite-tonalite complexes, which form isolated enclaves within and adjacent to the granitoid plutons, may contain remnants of this basement. The stratified rocks were polydeformed and metamorphosed under middle greenschist to upper amphibolite facies conditions, mainly during the Silurian. The principal phase of deformation produced southward facing, overturned, isoclinal folds. In general, metamorphic grade increases from north to south, culminating in zones of migmatite. The major synkinematic granitoid intrusives, e.g., Burgeo Granite, share the early foliations of the country rocks; locally, the regional foliation intensifies, grading into major D_1 mylonite zones. The second deformation produced upright open folds and associated strain-slip fabrics. In places, the second-phase folds control the regional outcrop pattern of the stratified rocks (e.g., Dolland Brook area; Blackwood, 1984). Syn D_2 granitoids of the North Bay Granite comprise a large, composite batholith that forms the northern margin of the Hermitage Flexure area. Smaller syn D_2 and posttectonic granitoid plutons, e.g., Peter Snout and Cochrane Pond granites, are confined to the metasedimentary and metavolcanic belts. The youngest granitoid rocks are a suite of high level, silica-rich granites (Francois and Chetwynd granites) that intrude the syn D_1 granitoids adjacent to the coast.

The area hosts numerous mineral occurrences, including significant showings of base metals, granitoid-hosted uranium, molybdenum, tin and tungsten mineralization, and uranium in volcanic and sedimentary rocks. The metavolcanic successions of the La Poile, Bay du Nord and Baie d'Espoir groups are important potential hosts for epithermal-fumerolic gold mineralization.

GEOLOGY OF THE BURGEO (11P) MAP AREA

Probable Ophiolitic Rocks

Mafic meta-igneous rocks, interpreted as vestiges of pre-Middle Ordovician ophiolitic crust, are preserved in the western parts of the Burgeo map area (Figure 3). In the Blue Hills of Couteau, Chorlton (1980) described a large, mafic, igneous complex, which occurs as rafts in Ordovician silicic intrusive rocks. It is composed mainly of gabbro cut by diabase and basalt dikes, all intruded by trondhjemite veins. Gabbro massifs, associated with tonalite, occur as xenoliths in the Burgeo Granite (O'Brien, 1983; O'Brien and Tomlin, 1984). The gabbros are correlated with the ophiolitic gabbros of the Blue Hills of Couteau. In the White Bear River area, layered gabbros, cut by diabase and trondhjemite, are associated with pyroxenite and peridotite (O'Brien and Tomlin, 1984) (Plate 1).

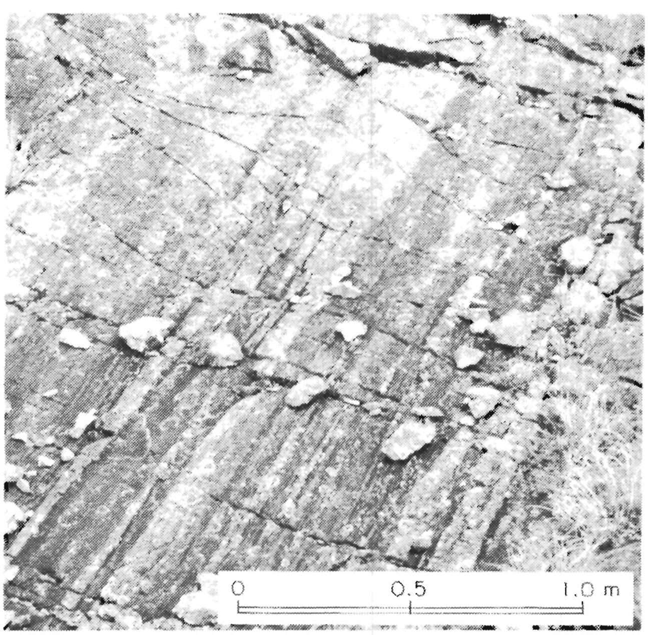

Plate 1: *Layered gabbro injected by diabase, White Bear River (11P/14) map area.*

Similar gabbro bodies shed detritus into the Middle Ordovician Bay du Nord Group, supporting the interpretation that gabbros in the Burgeo map area represent basement rocks. Also, the mafic meta-igneous complexes are thought to be equivalents of the more complete ophiolite successions of the Annieopsquotch ophiolite belt to the north (Dunning and Chorlton, 1985), the Long Range Mafic-Ultramafic Complex of the southern Long Range Mountains to the west (Chorlton and Knight, 1983), and the Coy Pond, Great Bend and Gander River Ultrabasic Belt ophiolites to the northeast (Blackwood, 1982; Colman-Sadd and Swinden, 1982).

Stratified Rocks

Polydeformed, middle greenschist to amphibolite facies metavolcanic and metasedimentary rocks of Ordovician age are the principal stratigraphic components of the central parts of the Hermitage Flexure. The rocks have been named Bay du Nord Group (Cooper, 1954) in the west and Baie d'Espoir Group (Jewell, 1939; Anderson, 1967) in the east. A third group of dominantly subaerial, greenschist facies metavolcanic rocks, the La Poile Group (Cooper, 1954), is faulted against the Bay du Nord Group. The stratigraphic relationship between these two groups is equivocal, although it has been suggested that parts of both may be equivalent (Chorlton, 1978, 1980; O'Brien, 1983). Initial results of U-Pb isotopic studies of zircon indicate that parts of the La Poile Group may be significantly younger than the Bay du Nord Group (G. Dunning, written communication, 1985; unpublished data). The volcanic successions of both groups are intruded by small plugs of comagmatic felsic plutonic rocks.

The *Baie d'Espoir Group* is exposed mainly in a large overturned syncline-anticline pair in the Facheux Bay area (Blackwood, 1983; 1985b). The succession consists of pelitic sedimentary rocks with intercalated felsic volcanic rocks (Isle Galet Formation) that are conformable with psammitic and semipelitic schist (Riches Island Formation). The rocks are progressively metamorphosed southward and are gradational into migmatites (Little Passage Gneiss) in the deeper structural levels. North of the Facheux Bay map area, psammites, pelites and semipelites, correlated with the Salmon River Dam Formation (Colman-Sadd, 1976), are exposed. The Baie d'Espoir Group contains Middle Ordovician fossils (Colman-Sadd, 1976); its isotopic age is unknown.

The *Bay du Nord Group* includes the volcanic and sedimentary rocks in the Burgeo map area that are continuous with rocks in the group's type area near La Poile Bay (Cooper, 1954). The group is bounded in the north by the North Bay Granite and in the south by the Bay d'Est Fault and the Burgeo Granite. The Bay du Nord Group forms an eastward-thinning belt that consists of felsic metavolcanic rocks intercalated with, and overlain by pelitic and psammitic metasedimentary rocks. The volcanic succession is most extensive in the Peter Snout area, where it includes a lower unit of highly strained, felsic, crystal-lithic tuffs. The tuffs contain rare interbeds of psammite and a coarse grained boulder-conglomerate (Plate 2) unit, rich in gabbroic detritus (O'Brien, 1983). The upper part of the volcanic sequence consists of rhyolite, densely welded rhyolitic tuff and felsite; it is overlain locally by a distinctive unit of buff, waterlain tuff associated with minor graphitic pelite (O'Brien, 1983; O'Brien and Tomlin, 1984). The rhyolitic unit is exposed discontinuously as far east as the Dolland Brook area, where it outcrops on both limbs of a large scale F_2 syncline (Blackwood, 1984). In the western part of the Burgeo map area, a rhyolite-bearing pebble conglomerate separates felsic volcanic rocks from overlying graphitic schist, phyllite and semipelite of the Bay du Nord Group (O'Brien, 1983). Elsewhere, a quartz-rich sandstone unit intervenes between volcanic rocks and similar metasedimentary rocks (O'Brien and Tomlin, 1984; Blackwood, 1984). The dominant sedimentary rock types of the Bay du Nord Group are bedded gray sandstone, shale and their metamorphic equivalents (Plate 3). These rocks contain rare interbeds of matrix-supported pebble conglomerate and slump breccia, felsic tuff and tuffaceous sandstone.

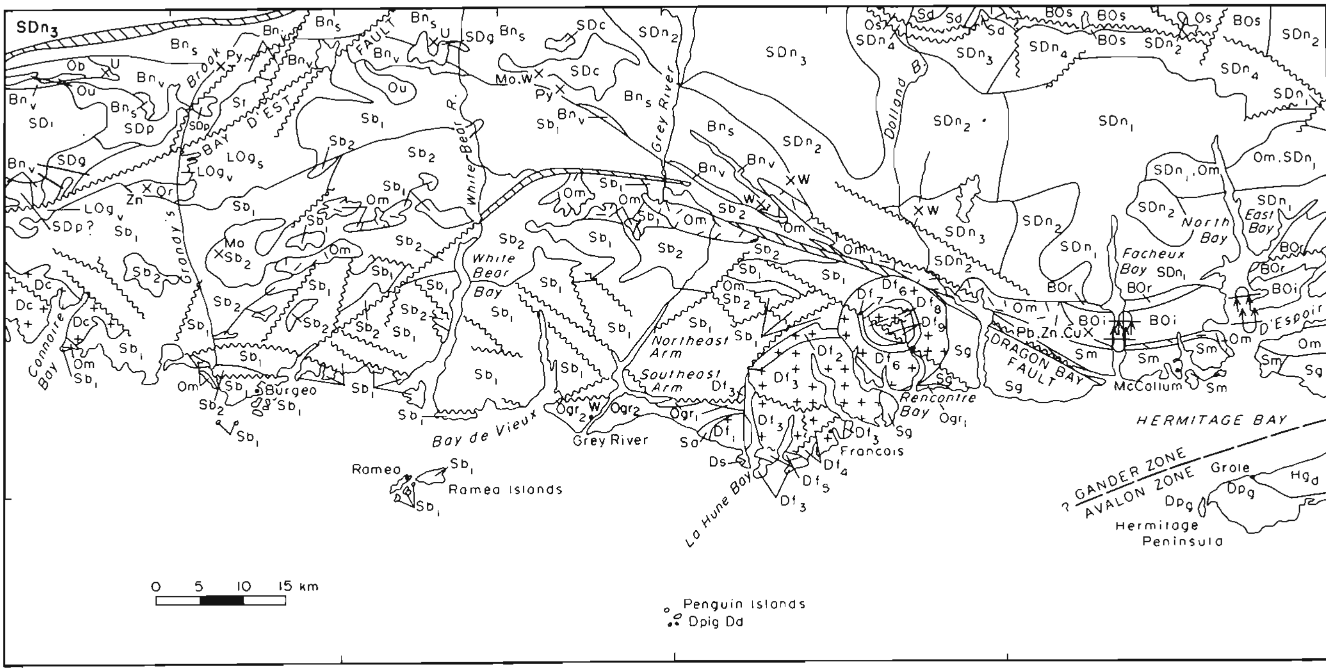

Figure 3: *Geology of the Burgeo (llP) map area.*

LEGEND

DEVONIAN

Ds Red and green conglomerate, sandstone, shale and limestone.

Dd Undivided early and late, massive diabase dikes.

Df FRANCOIS GRANITE: pink, massive, biotite granite; Df_1, buff, medium grained, feldspar porphyritic granite; Df_2, coarse grained equigranular granite; Df_3, Df_6, coarse grained, K-feldspar porphyritic granite; Df_4, Df_8, buff, medium grained, feldspar porphyritic adamellite and granite; Df_5, pink to white, fine grained, quartz-feldspar-biotite porphyritic granite; Df_7, medium grained, K-feldspar porphyritic granite; Df_9 medium grained equigranular granite.

Dc CHETWYND GRANITE: medium to coarse grained, equigranular to K-feldspar porphyritic, biotite granite.

Dpg PASS ISLAND GRANITE: pink, medium to coarse grained, K-feldspar porphyritic, biotite-hornblende granite.

Dpig PENGUIN ISLANDS GRANITE: pink, medium grained, K-feldspar porphyritic, biotite granite.

Dg Undivided, medium to fine grained, biotite ± hornblende granite.

SILURIAN - DEVONIAN

SDg Medium grained muscovite granite and felsite.

SDI IRONBOUND MONZONITE: massive to locally foliated, medium grained, plagioclase porphyritic, biotite ± hornblende monzonite with minor granodiorite and granite.

SDp PETER SNOUT GRANITE: massive to weakly foliated, fine to medium grained, equigranular, biotite ± muscovite granite.

SDc COCHRANE POND GRANITE: massive to weakly foliated, fine to medium grained, muscovite ± biotite granite.

SDn SDn_1, weakly foliated, medium grained, equigranular to porphyritic, biotite ± muscovite granodiorite, with minor garnet-muscovite granite; SDn_2, massive to weakly foliated, medium to coarse-medium grained, K feldspar porphyritic, biotite granite; SDn_3, massive to weakly foliated, medium to coarse-medium grained, K-feldspar porphyritic, biotite-muscovite granite; SDn_4, strongly deformed to mylonitic, medium to coarse grained, K-feldspar porphyritic, biotite granodiorite, and medium grained equigranular muscovite-garnet granite.

LEGEND *(Continued)*

SILURIAN

Sd *Dolland Pond Formation:* cleaved pebble conglomerate and breccia, interbedded with shale and sandstone.

Sa Fine to coarse grained, hornblende gabbro, including hornblendite, diorite and amphibolite.

Sb BURGEO GRANITE: Sb_1, coarse-medium to coarse grained, massive to foliated, feldspar porphyritic, biotite ± hornblende granodiorite and granite; Sb_2, medium grained, equigranular to porphyritic, biotite ± muscovite ± garnet granodiorite and granite, locally containing abundant migmatite inclusions.

Sm McCALLUM GRANITE: foliated to mylonitic, medium to coarse grained, equigranular to feldspar porphyritic, biotite granite and granodiorite.

Sg GAULTOIS GRANITE: mainly coarse grained, strongly foliated to mylonitic, feldspar porphyritic, biotite granodiorite and granite, including minor, medium grained, equigranular granite.

St TOP POND TONALITE: foliated, medium grained, equigranular, hornblende ± biotite tonalite.

ORDOVICIAN?

Om Migmatite, agmatite, paragneiss and associated granitoids; locally includes migmatized metasedimentary rocks of known Ordovician age.

Ogr GREY RIVER ENCLAVE: Ogr_1, felsic tuff and minor metasedimentry rocks; Ogr_2, migmatized pelitic and psammitic schist, mafic schist and amphibolite; minor gabbro, peridotite and granitoid gneiss.

LA POILE GROUP

LOg *Georges Brook Formation:* LOg_V, rhyolite flows, ash-flow tuffs, agglomerate, reworked volcaniclastics, minor mafic flows, pyroclastics and dikes; LOg_S, fine to coarse grained, locally cross-stratified sandstone, including quartz-pebble and quartz-cobble conglomerate.

Or ROTI GRANITE: foliated, equigranular, medium grained, biotite granodiorite and quartz-feldspar porphyry.

Ob BAGGS HILL GRANITE: massive to weakly foliated, quartz-feldspar porphyritic granite, granodiorite and quartz-feldspar porphyry.

ORDOVICIAN

Os *Spruce Brook Formation:* strongly foliated psammitic and semipelitic schist and minor schistose felsic volcanic rocks; locally extensive, cleaved, quartz-pebble conglomerate and quartzite.

BAY DU NORD GROUP

Bn Bn_V, felsic pyroclastic rocks, rhyolite, and welded tuff associated with mafic volcanic rocks and clastic sedimentary rocks; Bn_S, psammite, semipelite and pelite, including quartz-rich sandstone and quartz-pebble conglomerate.

BAIE D'ESPOIR GROUP

BOr *Riches Island Formation:* semipelitic schist, including thin to thick bedded psammitic schist and minor quartzite.

BOi *Isle Galet Formation:* felsic volcanic rocks and overlying graphitic pelite, arenite and minor tuff, conglomerate, limestone and ampbibolite.

BOs *Salmon River Dam Formation:* psammite and pelite containing minor calcareous psammite and limestone.

ORDOVICIAN OR EARLIER

Ou Layered metagabbro and metadiabase; minor pyroxenite and peridotite; rare mafic volcanic rocks.

HADRYNIAN

Hgd GROLE DIORITE: medium to coarse grained, hornblende-pyroxene gabbro and hornblende-biotite diorite, and quartz diorite.

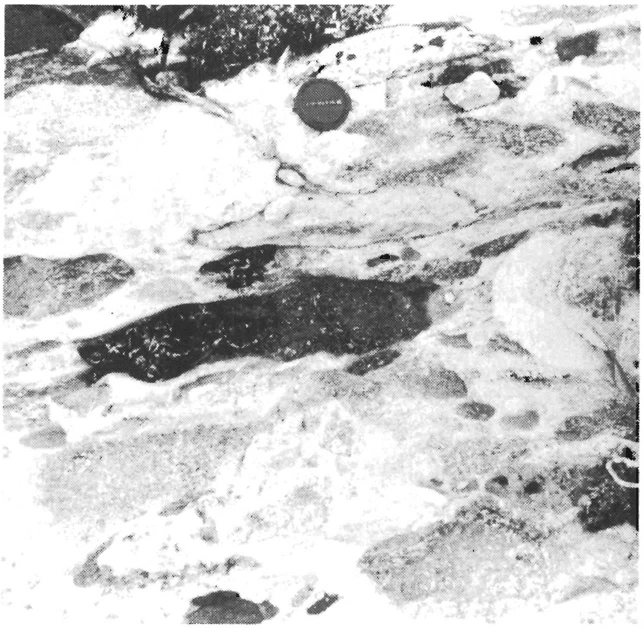

Plate 2: *Flattened, boulder conglomerate containing gabbroic detritus, Bay du Nord Group.*

Plate 3: *Interbedded shale, sandstone and quartzose granule conglomerate, Bay du Nord Group.*

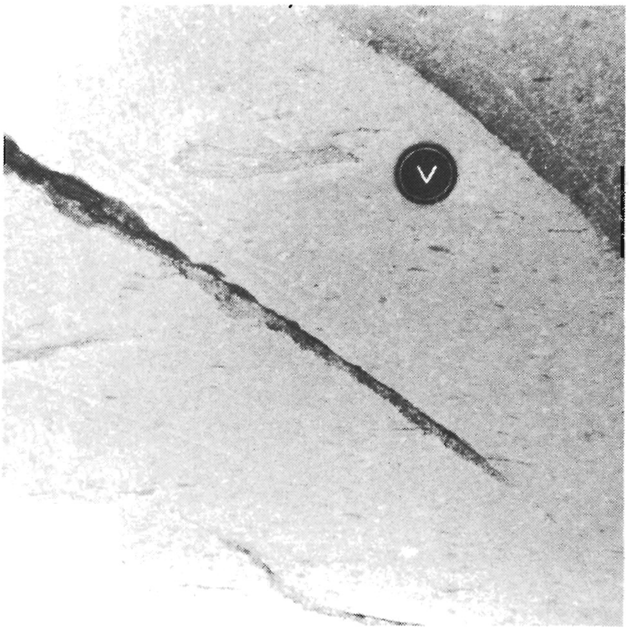

Plate 4: *Coarse, pumice-bearing, ash-flow tuff, La Poile Group.*

Plate 5: *Epiclastic volcanic breccia (lahar), La Poile Group.*

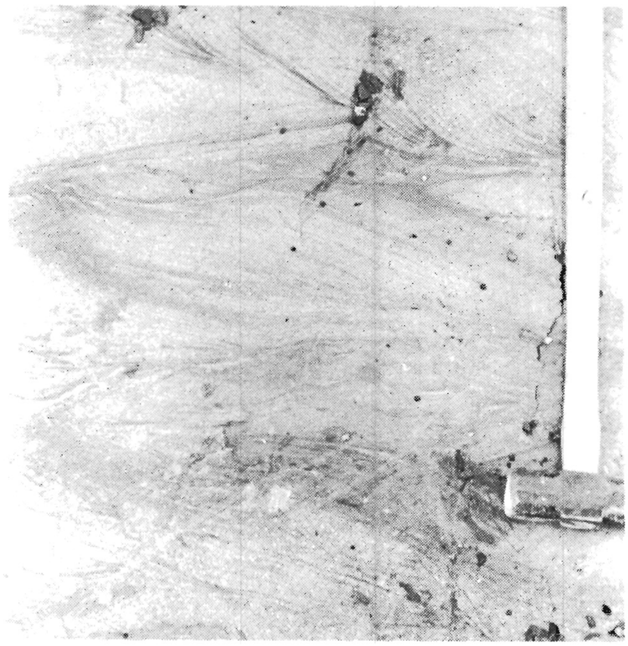

Plate 6: *Cross-bedded sandstone, La Poile Group.*

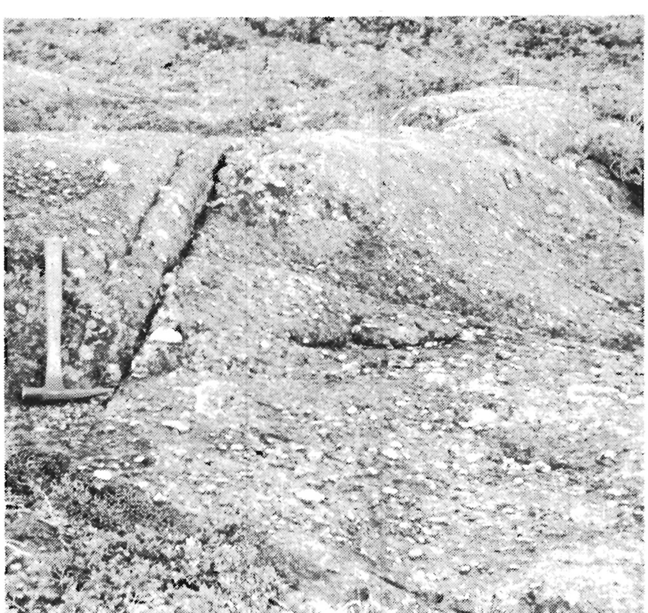

Plate 7: *Quartz-pebble conglomerate, La Poile Group.*

No fossils have been found in the Bay du Nord Group. However, a recent U-Pb age determination from felsic volcanic rocks in the Dolland Brook area of 468 ± 2 Ma (T. Krogh, written communication, 1985) is taken as evidence of a Middle Ordovician age, and supports the correlation of the Bay du Nord and Baie d'Espoir Groups.

The *La Poile Group*, as defined in La Poile Bay in the Port aux Basques (110) map area (Chorlton, 1978), consists of a structurally lower succession of metabasic dikes, tuffs and flows that is intruded by a polyphase tonalitic to granodioritic intrusion, an intervening unit of sandstone and boulder conglomerate, and an upper succession of rhyolite flows and ash-flow tuffs (Chorlton, 1978; Swinden, 1981). In the Burgeo map area, the La Poile Group consists of felsic pyroclastic and associated epiclastic rocks, interdigitated with, and overlain by fluvial, cross-bedded, quartzose sandstone and quartz-pebble conglomerate (O'Brien, 1983).

The main volcanic rock types are ash-flow tuffs, lahars and related, finer grained, epiclastic rocks (Plates 4 and 5). The ash flows are variably welded and quartz-phyric, and are of rhyolitic and rhyodacitic composition. They are associated with an eastward-fining sequence of laharic breccias, presumably related to volcanic activity to the west, where the ash-flow tuffs predominate (e.g. Chorlton, 1979). The welded ash flows are not extensively developed to the east of Grandy's Brook, where the volcanic rocks are mainly of airfall and epiclastic origin (O'Brien, 1983).

The lower half of the La Poile Group clastic succession consists of medium and coarse grained, immature quartz arenite, feldspathic lithic arenite, pebbly sandstone and granule conglomerate, all of which are rich in blue quartz (O'Brien, 1983). The sandstones are massive to thickly bedded, internally cross-bedded (Plate 6) and very rarely planar-bedded. Interlayered with the sandstones are 1 to 5 m thick beds of angular, poorly sorted, locally cross-bedded, granule and cobble to boulder conglomerate (Plate 7). Conspicuous angular clasts of vein quartz, up to 15 cm in diameter, occur in a quartz-rich sandy matrix; the detrital assemblage of the conglomerate includes up to 90 percent vein quartz.

The remainder of the La Poile Group clastic succession is mainly gray, fine to medium grained, cross-bedded, feldspathic sandstone. It is finer grained, less quartz-rich and more mature than the lower parts of the group, and does not contain the thick conglomerate lenses and beds that are common elsewhere.

The stratigraphic relationship of the La Poile and Bay du Nord groups is problematic. Cooper (1954) suggested that the La Poile Group unconformably overlies the Bay du Nord Group, whereas Chorlton (1978, 1980) proposed that the La Poile and Bay du Nord groups were time-stratigraphic equivalents. The general similarity in composition and facies of the volcanic rocks of the La Poile and Bay du Nord groups, coupled with the U/Pb and Rb/Sr isotopic data reported in Chorlton (1980) and Loveridge and Chorlton (1985), support the interpretation that both groups are time-stratigraphic equivalents. However, recent precise U-Pb geochronology (G. Dunning, written communication, 1985), together with contrasts between the groups in sedimentary facies (O'Brien, 1983) and metallogeny (Swinden, 1981) could be taken as evidence against such a correlation. Data resulting from ongoing and proposed geochronological and petrochemical studies, together with detailed mapping in the groups' type areas (east of La Poile Bay), are expected to resolve this problem.

It is important to note that Chorlton's (1978) definition of the La Poile Group differs from that of Cooper (1954) in that the former includes the metabasic rocks and associated granitoids structurally beneath the conglomerate unit, which Cooper (1954) had excluded from the group. The nature of the metabasic unit and its relationship to adjacent units and the felsic volcanic succession are outstanding problems that need to be addressed.

Near Grey River, a conformable sequence consisting of felsic metavolcanic rocks, pelitic to psammitic metasedimentary rocks and migmatites forms an isolated west-trending belt named the Grey River enclave (Blackwood, 1985a). These rocks are faulted against the Burgeo Granite (Blackwood, 1985a). Because of similarities in lithology and structural style, these rocks have been tentatively correlated with the Ordovician rocks that occur elsewhere around the Hermitage Flexure (Blackwood, 1985a).

Rocks of the Ordovician Spruce Brook Formation are found in the northern margin of the area, near Dolland Brook. Exposures include clast-supported pebble to boulder conglomerate, rich in orthoquartzite clasts (Dickson, *in preparation*). These rocks are in fault contact with the Salmon River Dam Formation of the Baie d'Espoir Group.

At Dolland Pond, sedimentary rocks of possible Silurian age are exposed. The succession consists of gray to black shale and siltstone, interbedded with, and overlain by pebbly sandstone, polymictic pebble conglomerate and sedimentary breccia. The conglomerate contains clasts of vein quartz, rhyolite, basalt, chert and clastic sedimentary rocks typical of the North Steady Pond Formation of the Baie d'Espoir Group (Colman-Sadd, 1984).

A small area of gently dipping, upward facing, pale-green, gray, and reddish brown granule to pebble conglomerate occurs at the entrance to La Hune Bay. The conglomerate is interbedded with sandstone and siltstone which grade into white weathering carbonate-rich layers. The contact between the sedimentary rocks and the Francois granite was originally interpreted as intrusive (Williams, 1971), but it appears to be a nonconformity (Blackwood, 1985a). These rocks are posttectonic with respect to the deformation in the Grey River enclave and may be Devonian or later in age (Williams, 1971).

Migmatites and Associated Rocks

Migmatite, together with metasedimentary and granitoid rocks, is spatially associated with the Bay du Nord Group and syn D_1 intrusive rocks in a discontinuous band that extends from Long Island, Bay d'Espoir, westward to Grandy's Brook. The migmatites commonly occur as enclaves of variable size, mainly within the equigranular granitoid phases of the Burgeo Granite. Individual zones may be as large as 50 km^2; their areal distribution reflects the general structural trend of the Hermitage Flexure. In general, migmatites in the southern portion of the region have a mafic meta-igneous component, whereas those in the north and east are mainly higher-grade metamorphic equivalents of the metavolcanic and metasedimentary stratified succession.

In the Facheux Bay map area, migmatite, amphibolite and recrystallized metasedimentary rocks (Little Passage Gneiss) represent the deepest structural levels of the Bay d'Espoir Group; these rocks are exposed on the overturned limb of a major F_1 anticline (Blackwood, 1985b). The high-grade rocks are gradational, structurally upward, into less metamorphosed psammite and semipelite (Isle Galet Formation). In the White Bear River map area (O'Brien and Tomlin, 1984), migmatite, amphibolite and recrystallized pelitic, semipelitic and psammitic schists, together with refolded, cataclastically deformed granite, occur in large rafts within equigranular granite phases of the Burgeo Granite. The protoliths of the metamorphic rocks are assumed to be parts of the Ordovician stratified successions, and perhaps even the earliest phases of the synkinematic granitoids. In the Peter Snout map area, migmatized quartz-pebble conglomerates are gradational, through a zone of granitoid injection, into recrystallized metasedimentary rocks that pass into greenschist grade quartzose conglomerate and sandstone of the La Poile Group (O'Brien, 1983).

Migmatite and associated metamorphic rocks are a major component of the Grey River enclave (Blackwood, 1985a). At Grey River, metavolcanic, metasedimentary and pretectonic mafic and ultramafic rocks exhibit a southward increase in metamorphism and degree of migmatization within the enclave. The metasedimentary migmatites have concordant contacts with a major amphibolite unit, which is gradational into mafic migmatite. Granodioritic gneiss, rich in mafic inclusions, occurs south and west of the mafic migmatite. It is interpreted to be the result of progressive deformation of an agmatite that was produced by granitoid-intruded amphibolite (Blackwood, 1985a).

Similar mafic migmatite (Plate 8), associated with plagiogranite, is exposed as inclusions in the Chetwynd Granite. These metamorphic rocks form the eastward extension of Chorlton's (1980) Cinq Cerf Complex, an Ordovician(?) metamorphic complex of mainly mafic composition, which is here considered to be correlative with parts of the Grey River enclave.

Agmatite and mafic migmatite form a 2 km wide belt adjacent to the Burgeo Granite along the coast near Burgeo (O'Brien and Tomlin, 1985a). The agmatites are gradational into the migmatitic rocks and consist of massive to banded gabbro and diorite xenoliths in a granodioritic host. The proportion of matrix varies greatly within the agmatitic rocks, and mafic inclusions show varying degrees of assimilation. Banding in the migmatites is variable; the migmatites are characteristically nebulitic or schlieric, and are rarely well layered. The protolith of the mafic component of the migmatite, and of the mafic blocks in the agmatite, is layered gabbro of uncertain origin; the gabbro may represent either early mafic phases of the Burgeo Granite or Ordovician

Plate 8: *Mafic migmatite; large inclusion within the Chetwynd Granite.*

ophiolitic rocks. O'Brien and Tomlin (1984) have suggested that the agmatite-migmatite zone was genetically related to early plutonic activity associated with intrusion of the Burgeo Granite.

Within the Dolland Brook and D'Espoir Brook map areas, migmatitic metasedimentary rocks occur mainly as xenoliths of extremely variable size within the North Bay Granite (Dickson and Tomlin, 1983; Dickson and Delaney, 1984). The origin of the migmatites is uncertain. They appear to be the result of high-grade metamorphism and *in situ* melting of country rocks. However, some may be the product of granitoid injection of metasedimentary rocks at the margin of the North Bay Granite.

The main area of migmatite occurs immediately to the east and west of North Bay and is commonly cut by dikes of North Bay Granite and pegmatite veins. The neosome of muscovite-biotite granodiorite, which comprises up to 50 percent of the migmatite, is equigranular and exhibits a variably developed foliation. The paleosome is dominantly a sillimanite-bearing, quartz-plagioclase-biotite psammite. Commonly, biotite-muscovite (± sillimanite) semipelitic schist forms isolated xenoliths within the migmatite.

The migmatites are considered to be derived from the Riches Island and Salmon River Dam formations, as there is a pronounced increase in the abundance of xenoliths within the North Bay Granite along its southern and northern contacts with the Ordovician country rocks. Along the southern contact, in particular, there is an essentially transitional zone, 2 to 4 km wide, between the granite and the metasedimentary rocks. The belt of migmatite in the central North Bay area may represent a roof pendant in the North Bay Granite.

Migmatite is locally abundant in the area south and southeast of Dolland Pond where it is mainly associated with the elongate belt of deformed granitoids. The protolith of these migmatites is enigmatic. The nearest exposed source of migmatite is the Ordovician Spruce Brook Formation to the north of the Dolland Brook (11P/15) map area. Xenoliths of non-migmatitic psammitic schist are similar to the psammites which form part of the Spruce Brook Formation (Colman-Sadd and Swinden, 1982).

Plutonic Rocks

Plutonic rocks underlie a major part of the central Hermitage Flexure area. On the basis of radiometric data and regional structural considerations, the granitoids in the Burgeo map area can be divided into four main groups. These include: pretectonic, syntectonic, late-syntectonic, and posttectonic granitoids.

Pretectonic Granitoids

Roti Granite. Chorlton (1980) correlated a small area of granodiorite and quartz-feldspar porphyry, west of Grandy's Brook, with the Roti Granite near Grand Bruit, in the La Poile (11O/9) map area (Cooper, 1954; Chorlton, 1979). In the latter locality, Chorlton (1979) described dikes of Roti Granite intrusive into La Poile Group rocks, which contained clasts of the same granite. On the basis of this relationship, Chorlton (1979, 1980) suggested that the La Poile Group and the Roti Granite were comagmatic. Recent examination of the Roti Granite west of Grandy's Brook (J. Tuach, personal communication, 1985) suggests that a significant part of the Roti Granite is actually highly altered felsic volcanic rocks. The main rock type of the Roti Granite is medium to coarse grained, plagioclase porphyritic, biotite granodiorite.

In the Peter Snout map area, intrusive contacts between the Roti Granite and the La Poile Group have not been documented. O'Brien (1983) described foliated clasts of Roti Granite within the upper, clastic portion of the La Poile Group. Similar evidence presented by Chorlton (1980) indicates that the upper part of the La Poile group is younger than the Roti Granite. Evidence for an intrusive contact is based on an assumption that the Roti Granite at Grand Bruit is equivalent to the granite west of Grandy's Brook.

Baggs Hill Granite. The eastern extension of the Baggs Hill Granite (Cooper, 1954) is exposed in the northwest corner of the Burgeo map area, where it intrudes the Bay du Nord Group (Chorlton, 1980). Quartz-plagioclase porphyry forms its most extensive phase, associated with equigranular, biotite granodiorite. Chorlton (1980) has interpreted the granite to be a synvolcanic intrusion, genetically related to volcanic rocks of the Bay du Nord Group.

Syntectonic granitoids

Gaultois Granite. The dominant rock type of the Gaultois Granite within the Burgeo map area is strongly foliated to mylonitic, coarse grained, feldspar porphyritic, locally hornblende-bearing, biotite granodiorite. The pluton is mylonitic along the Dragon Bay Fault and along its contact with strongly sheared felsic volcanic rocks in the Devil Bay-

Hare Bay area. Correlatives of this granite have been isotopically dated (Rb-Sr whole rock) at approximately 448 Ma (R. Cormier, written communication to S.P. Colman-Sadd, 1973). An Rb-Sr age of 350 ± 18 Ma from the Gaultois area (Elias, 1981; Elias and Strong, 1982) conflicts with an Rb-Sr age (Bell *et al.*, 1977) and an $^{40}Ar/^{39}Ar$ age (Dallmeyer *et al.*, 1983), both 350 ± 10 Ma, on the Ackley Granite, which intrudes the Gaultois Granite.

Plate 9: *Banding in granite defined by variations in grain size and the amount of biotite, McCallum Granite.*

McCallum Granite. The McCallum Granite consists predominantly of variably banded granitoid which locally grades into zones of homogeneous porphyritic granite. The banded variety (Plate 9) is generally grayish white weathering, medium to coarse grained, variably porphyritic, biotite granite-grandiorite. For the most part, the banding (interpreted as primary) is defined by variations in grain size, the amount of biotite, and the number of feldspar phenocrysts. Bands are 1 cm to 1 m wide and locally persist in three dimensions with straight, approximately parallel, boundaries; contacts are abrupt but not intrusive. Individual bands consists of equigranular, minor biotite granite, biotite-rich granite, coarse grained, feldspar porphyritic granite, fine to medium grained granodiorite and, rarely, dark gray diorite. Some textural and compositional variations are lensoid and pinch out along strike. Locally elliptical inclusions of granodiorite occur in granite and vice versa.

The contact of the McCallum Granite with the Baie d'Espoir Group is marked by a several metre wide zone of partially assimilated xenoliths of metasedimentary rocks in the granite. The granite is finer grained near the contact; veins of equigranular biotite granite locally intrude the metasedimentary rocks north of the contact. A moderate to strong foliation, parallel to the trend of layering, is developed throughout the McCallum Granite. West of Facheux Bay, the regional D_1 foliation in the McCallum Granite culminates in a northwest trending mylonite zone known as the Dragon Bay Fault (Blackwood, 1983). The mylonite zone is approximately 1 km wide and separates the McCallum and Gaultois granites west of Facheux Bay; both granite protoliths are recognizable on either side of a 100 to 200 m wide central zone of ultramylonite. Every gradation from protomylonite to ultramylonite occurs within the fault zone.

The highest grade rocks of the Baie d'Espoir Group are spatially related to the McCallum Granite. This observation, together with the fact that the banding in the granite mostly parallels the regional foliation in the country rocks, is considered evidence for the synkinematic nature of the granite. Garnet-muscovite dikes post-date the initial onset of deformation since, locally, xenoliths of McCallum Granite contain an internal foliation that has been rotated slightly in leucogranite dikes, which contain the same strong regional foliation as the rest of McCallum Granite.

Burgeo Granite. The Burgeo Granite is an extensive, composite, granitoid intrusion with compositions ranging from hornblende gabbro, quartz diorite and biotite tonalite to muscovite-biotite granite and biotite alaskite. Most units contain at least one variably developed regional foliation, although a tectonic fabric is not everywhere obvious. Ongoing geochemical studies indicate that the Burgeo Granite (on Figure 3) includes several individual plutons, some of which may be of significantly different ages, and petrogenetically unrelated.

The dominant rock types of the Burgeo Granite are medium-coarse to coarse grained, K-feldspar porphyritic, locally hornblende-bearing, biotite granodiorite, and coarse grained, K-feldspar porphyritic, biotite granite (Plate 10).

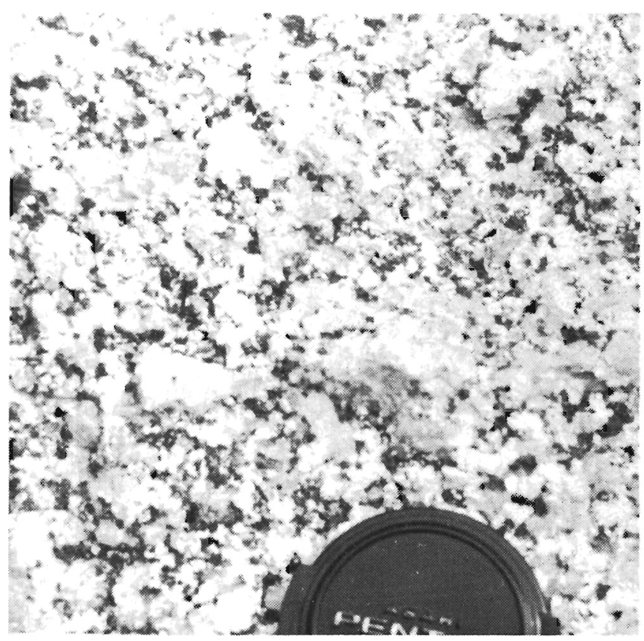

Plate 10: *Coarse grained, K-feldspar porphyritic, biotite granite, Burgeo Granite.*

These intrude the more mafic granitoids and gabbroids, and are intruded by the medium grained, equigranular to K-feldspar porphyritic, locally muscovite-bearing, biotite granodiorite and granite (Plate 11). Thus, a general intrusion sequence from mafic to leucocratic granitoids is apparent, although there may be no genetic link between the earlier granodiorites and the younger muscovite-bearing phases.

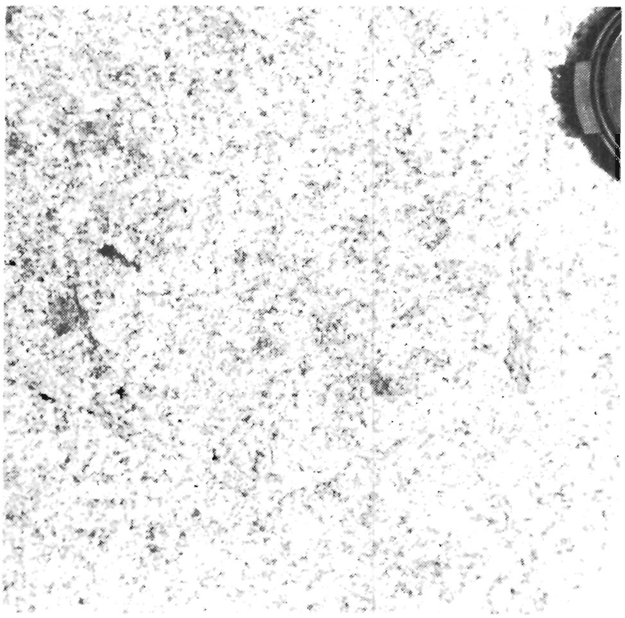

Plate 11: *Equigranular granite phase of the Burgeo Granite.*

The Burgeo Granite intrudes the Ordovician metasedimentary and metavolcanic rocks of the Bay du Nord Group, and sedimentary and volcanic rocks of the La Poile Group. The granite contains the regional D_1 foliation but locally granite dikes crosscut the D_1 structures, indicating the syntectonic intrusive history of the Burgeo Granite. A major D_1 mylonite zone occurs within the granite near its contact with the Bay du Nord Group in the Hare Bay-Dolland Brook area (Blackwood, 1983; Dickson and Delaney, 1984; Dickson *et al.*, 1984). The mylonite zone curves southwestward within the Burgeo Granite west of the Dolland Brook map area (O'Brien and Tomlin, 1984), where it merges with a late brittle fault southwest of White Bear Bay (Dickson *et al.*, 1985). The southern contact between the Burgeo Granite and probable Ordovician sedimentary and volcanic rocks of the Grey River enclave is also a mylonite zone. (Blackwood, 1985a; Dickson *et al.*, 1985).

T. Krogh (written communication, 1985) has reported a probable age of 428.5 $\pm$ 4 Ma on zircons from coarse grained, foliated, K-feldspar porphyritic, biotite granite. Similarly, an approximate age of 421 Ma was obtained from weakly foliated, medium grained, equigranular, biotite granite, which intrudes the coarse grained, porphyritic biotite granite. Although these ages appear to bracket the main intrusive activity, field evidence indicates that still younger and older phases, undivided on Figure 3, exist within the Burgeo Granite.

Top Pond Tonalite. The Top Pond tonalite is a black and white, medium grained, equigranular, hornblende-biotite tonalite that occurs within and to the north of the Bay d'Est Fault in the Peter Snout map area (O'Brien, 1983). The tonalite is interpreted to intrude the Bay du Nord Group, although no evidence of an intrusive contact is exposed. It is foliated in most areas and mylonitized along the Bay d'Est Fault. Locally, the tonalite contains xenoliths of gabbro and diorite. This intrusion may be genetically related to rocks of similar composition in the Burgeo Granite, and in the tonalite-ophiolite terrane to the north (e.g., Dunning and Chorlton, 1985).

Late-syntectonic granitoids

North Bay Granite. The North Bay Granite (Jewell, 1939) is an extensive, composite batholith underlying an area of approximately 3000 km^2. Dominant rock types include medium-coarse to coarse grained, K-feldspar porphyritic, locally muscovite-bearing, biotite granite, and medium grained, equigranular to feldspar porphyritic, muscovite and/or biotite granodiorite and granite. Locally,extensive areas of garnetiferous, muscovite granite and pegmatite are associated with the granodiorite.

The granodiorite phase of the North Bay Granite is dominant in the Facheux Bay (11P/9) and D'Espoir Brook (11P/16) map areas. The granite phase dominates in the Dolland Brook (11P/15) map area and continues to the north into the Burnt Pond (12A/3) and Wolf Mountain (12A/2) map areas. Smaller plutons of K-feldspar porphyritic, coarse grained, biotite granite intrude the granodiorite phase. This suggests that the coarse grained granite,in general, is younger than the medium grained granodiorite.

The northern contact with the Baie d'Espoir Group is either intrusive or faulted. Cataclastic to mylonitic granitoids occur along the northern contact and these are less deformed away from the contact, for a distance of 1 km. The southern and eastern contact with the Baie d'Espoir Group is an intrusion zone of granite and metasedimentary screens; the latter are more abundant toward the contact with country rocks. An extensive thermal aureole is developed, defined by prominent staurolite, garnet and biotite porphyroblasts that overprint the S_1 and S_2 foliations in the Baie d'Espoir Group (Plate 12); locally, porphyroblasts form augen in S_2 fabric planes. Granitoid dikes from the North Bay Granite are deformed by subsequent D_2 structures. These relationships demonstrate the syn D_2 nature of the North Bay Granite.

Xenoliths of migmatite are common within the granodiorite phase of the North Bay Granite. The migmatite is interpreted to be a high-grade metamorphic equivalent of the Ordovician metasedimentary rocks of the Baie d'Espoir Group.

The coarse grained granites of the North Bay Granite are much less deformed than the granodiorites. Xenoliths of migmatite are also far less abundant than in the granodiorite, and are generally found only near the contacts with the Bay du Nord and Baie d'Espoir groups. An S-type affinity has been indicated for the equivalent rocks in the Granite Lake area (Dickson, 1982).

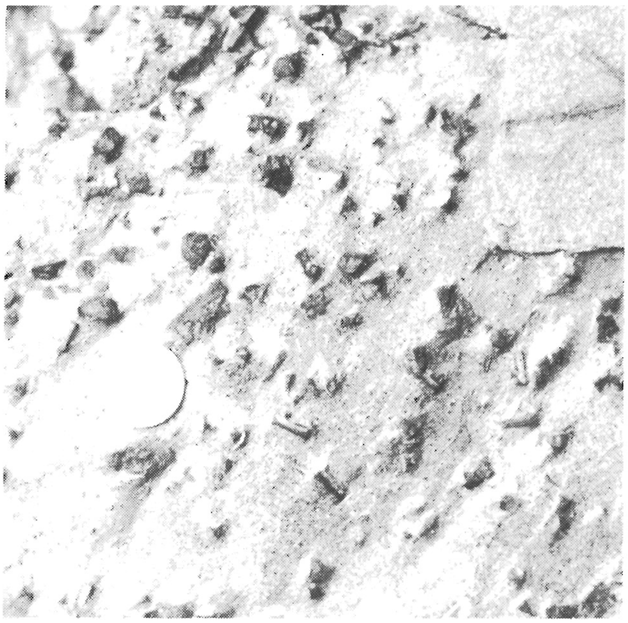

Plate 12: *Staurolite porphyroblasts in semipelite within metamorphic aureole of the North Bay Granite.*

U-Pb zircon dates have been obtained from the North Bay Granite (T. Krogh, written communication, 1985; Dickson *et al.*, 1985). The samples were obtained from massive, coarse grained, K-feldspar porphyritic, biotite granite at Dolland Brook. Two zircon fractions have identical $^{206}Pb/^{238}U$:$^{207}Pb/^{235}U$ ages of 396 Ma and this age is interpreted to be the age of crystallization of the granite phase of the North Bay Granite. A 390 $\pm$ 2 Ma date for cooling below 600°C was obtained from monazites extracted from the samples that gave the zircon date.

Penguin Islands granite. The Penguin Islands are underlain by weakly foliated, pink K-feldspar porphyritic granite, which is intruded by two suites of diabase dikes. The earlier dikes have chilled irregular margins. They are veined by the granite and, in places, form inclusions within the granite; dike emplacement clearly resulted in granite remobilization. Later, massive, fine grained dikes intrude both the granite and the earlier dikes. The Penguin Islands granite (informal name) is lithologically similar to the Pass Island Granite on the Hermitage Peninsula.

Cochrane Pond Granite. The Cochrane Pond Granite (O'Brien and Tomlin, 1984) intrudes metasedimentary rocks of the Bay du Nord Group. Its characteristic rock type is quartz-rich, leucocratic, fine to medium grained, equigranular, muscovite-biotite granite. The granite is either undeformed or weakly foliated, and locally it is sericitized and saussuritized. The granite is intruded locally by tourmaline-bearing, quartz-rich, pegmatite dikes. Associated with the leucogranite are aplite dikes containing lepidolite, tourmaline and garnet. Locally, the equigranular phase is associated with slightly porphyritic granite.

Ironbound monzonite. The Ironbound monzonite (informal name) is an extensive, late syntectonic to posttectonic, composite pluton, which intrudes the Bay du Nord Group. $^{40}Ar/^{39}Ar$ dates of 350 Ma from biotite and 361 Ma from hornblende have been reported from the monzonite (Chorlton and Dallmeyer, 1986). The Ironbound monzonite is composed mainly of medium grained, plagioclase porphyritic, monzonite and quartz monzonite; gray, medium grained, locally hornblende-bearing, biotite granodiorite is the subordinate phase. The monzonite phases are unusually rich in apatite, and contain biotite, hornblende and augite. The relationship between the monzonite and granodiorite is not known; Chorlton's (1980) observation that the monzonite is massive and the granodiorite is variably foliated possibly indicates that the monzonite is younger and posttectonic. A feature of the entire Ironbound monzonite is its anomalously high gamma radiation.

Peter Snout Granite. The Peter Snout Granite (O'Brien, 1983) is an unfoliated, medium grained, equigranular, leucocratic, locally garnet- and tourmaline-bearing, biotite-muscovite granite. Chorlton (1980) described foliated, garnet- and muscovite-bearing phases associated with the massive granite. The Peter Snout Granite is intrusive into undivided, syntectonic tonalite and granite in the south (Chorlton, 1980); its contact is gradational and is marked by a wide zone of dikes. The granite contains numerous inclusions of Bay du Nord Group metasedimentary and metavolcanic rocks.

Posttectonic granitoids

Chetwynd Granite. The Chetwynd Granite (Cooper, 1954) is a posttectonic pluton composed of equigranular to K-feldspar porphyritic, medium to coarse grained, biotite granite. The granite is characteristically pink to red, quartz-rich and leucocratic.

Tuffisite veins, which occur near the eastern contact, and miarolitic cavities indicate the high-level nature of the Chetwynd Granite. Numerous related dikes of rhyolite and microgranophyric quartz-sanidine porphyry intrude the Burgeo Granite and occur up to 15 km from the Chetwynd Granite contact (O'Brien and Tomlin, 1984). Inclusions of the older granites, migmatites and amphibolites are common around the margins of the Chetwynd Granite, with some zones up to 1 km in width.

The Chetwynd Granite intrudes the Burgeo Granite and the Bay du Nord Group, and has yielded zircons dated at 377 $\pm$ 20 Ma (Dallmeyer, 1980). $^{40}Ar/^{39}Ar$ spectra for biotite from the granite in the Burgeo area indicate a cooling age of 372 $\pm$ 5 Ma for the Chetwynd Granite (Dallmeyer, 1980).

Francois Granite. The Francois Granite is a complex, composite, quartz-rich granite, which is lithologically and, in part, chemically similar to the Chetwynd Granite. The Francois Granite is composed of six major rock types, which form ten mappable units in two, overlapping, variably developed, ring complexes (see Dickson *et al.*, 1984; Poole *et al.*, 1985). The rock types include 1) leucocratic and mesocratic, coarse grained, K-feldspar porphyritic, biotite $\pm$ muscovite granite, 2) medium and coarse grained equigranular, biotite granite, and 3) fine grained, quartz-feldspar-biotite porphyritic granite. Dikes that intrude the country rocks vary from fine grained, equigranular, biotite granite to very fine grained, quartz-sanidine-biotite rhyolite porphyry. These dikes occur up to 8 km from the northern contact of the Francois Granite.

The Francois Granite is intrusive posttectonically into the synkinematic Burgeo and Gaultois granites and the late syntectonic North Bay Granite. Major shear zones, such as the Dragon Bay Fault, are intruded by undeformed dikes of Francois Granite.The only tectonism to have affected the Francois Granite is reflected in the numerous west- and northwest-trending fractures and minor faults.

The presence of 1) miarolitic cavities, 2) extensive, fine grained, granophyric, quartz-feldspar porphyritic margins to units, 3) probable greisens, and 4) a narrow metamorphic aureole indicates that the pluton was intruded at a high structural level. The well developed ring complex suggests that the Francois Granite was probably emplaced by cauldron subsidence.

STRUCTURAL AND METAMORPHIC HISTORY

The structure of the Baie d'Espoir Group is dominated by upright to recumbent F_1 folds in the Burgeo map area (Blackwood, 1983, 1985). The regional penetrative D_1 foliation is axial planar to these larger scale folds; dips mimic the attitude of their axial surfaces. The S_1 foliation is most intense on the overturned limb of the large scale Manual Arm Anticline (Blackwood, 1985), in the Facheux Bay map area. Fold geometry and regional stratigraphy indicate that the highest grade rocks (Little Passage Gneiss) are exposed on the lower limb of the anticline, and are the metamorphic equivalents of higher structural levels of the Baie d'Espoir Group. The Little Passage Gneiss is intruded by foliated biotite granite of the McCallum and Gaultois granites; both intrusions display a penetrative, locally cataclastic, foliation which corresponds to S_1 in the Baie D'Espoir Group. In the Facheux Bay area, S_1 culminates in a major zone of protomylonite marking the Dragon Bay Fault (Blackwood, 1983). Early structures are refolded by upright F_2 folds; a strain-slip cleavage of varying intensity is superimposed upon the S_1 schistosity. Locally, the second fabric is composite, having completely transposed S_1.

The main regional metamorphism, which accompanied the first deformation of the Baie d'Espoir Group, occurred under middle to upper greenschist facies conditions. In highest structural levels, oriented sericite and biotite, with rare garnet augen, define the first schistosity. Metamorphic grade increases structurally downward, culminating in amphibolite facies rocks that have a foliation defined by coarse grained muscovite and biotite, and quartz and granitoid segregations. At still deeper structural levels, increased recrystallization, partial melting and *lit-par-lit* injection characterize migmatites of the Little Passage Gneiss (Blackwood, 1985).

A second deformation cleavage is superimposed on S_1 throughout much of the Baie d'Espoir Group, and is locally axial planar to upright F_2 folds. The axial trace of these structures is generally subparallel or parallel to F_1 structures. Where superimposed on overturned F_1 structures, the F_2 folds face downward. The Baie d'Espoir Group is overprinted by a hornblende-hornfels facies metamorphic assemblage (Blackwood, 1983; Dickson and Tomlin, 1983) within the aureole of the North Bay Granite. The S_2 crenulation cleavage locally contains augen of granite-related porphyroblasts (Blackwood, 1985b).

The Bay du Nord Group was polydeformed and metamorphosed by the same regional tectonic events that affected the Baie d'Espoir Group. The regional, closely spaced, penetrative D_1 foliation is pervasive throughout the Bay du Nord Group. Many of the pyroclastic rocks are highly strained and lineated, and although the more massive flows rarely display macroscopic flattening, the porphyritic varieties contain flattened feldspars with well developed tails. Metasedimentary units typically display a fine penetrative foliation that is generally coplanar to bedding and, in places, axial planar to small scale isoclinal F_1 folds. The early phases of the Burgeo Granite share the regional D_1 foliation of the Bay du Nord Group; veins of the granite also define F_1 folds that are locally overprinted by the S_2 cleavage. Within the granitoids, fabric intensity is variable; this is due in part to the synkinematic nature and variable age of certain phases of the Burgeo Granite. Locally, the regional foliation intensifies and culminates in zones of protomylonite and ultramylonite (Plate 13). In places, these zones terminate within the granitoids they deform, further indicating the synkinematic nature of these granites.

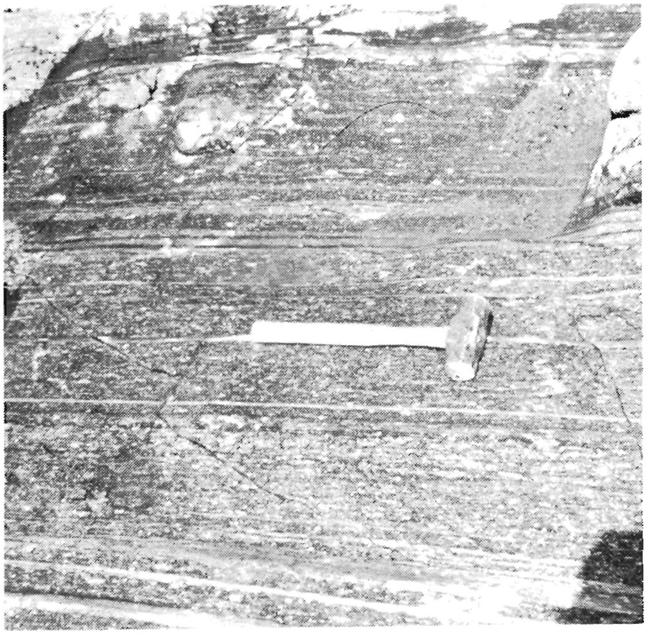

Plate 13: *Protomylonite and mylonite from shear zone in the Burgeo Granite.*

The regional metamorphism of the Bay du Nord Group accompanied the D_1 deformation, and occurred under greenschist to upper amphibolite conditions. In general, metamorphic grade increases with proximity to the synkinematic granites, and, in several areas, a structurally downward gradation occurs from middle greenschist facies metasedimentary rocks into sillimanite-bearing paragneiss and migmatite (O'Brien and Tomlin, 1984; Blackwood, 1984).

The second deformation locally produces large scale F_2 folds that are upright and plunge to the west and northwest (Blackwood, 1984). Smaller scale F_2 folds (Plate 14), parasitic on larger structures, are common. Axial planar to these folds is a regional foliation, which varies in intensity from a weak crenulation cleavage to a strong composite fabric produced by transposition of S_1. The S_2 strain-slip fabric in the Bay du Nord Group adjacent to the North Bay Granite post-dates the thermal metamorphism within the aureole; locally, fine grained biotite is developed along S_2 (Blackwood, 1983).

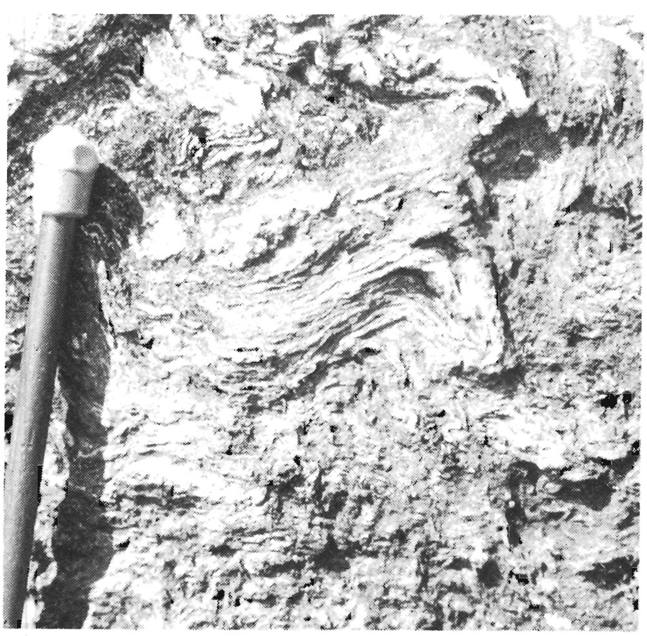

Plate 14: *F_2 refolding of isoclinal F_1 folds producing Type 3 interference patterns in quartz-injected pelite, Bay du Nord Group.*

The structural and metamorphic history of the La Poile Group is not clearly understood, and its structural style is variable within the Burgeo map area (Chorlton, 1980; O'Brien, 1983). The structure of the eastern, dominantly clastic portions of the La Poile Group is relatively simple, with few regional-scale folds and only a weakly developed fracture cleavage; metamorphic grade varies from lower to middle greenschist facies. The sedimentary rocks are progressively metamorphosed with proximity to the synkinematic granite terrane. A gradation is developed from quartzose sandstone and quartz-pebble conglomerate, through biotite-grade recrystallized psammite and quartz-rich conglomerate, into sillimanite-bearing paragneiss, (containing recognizable quartz clasts) and migmatite. Westward, the La Poile Group narrows to a 2 to 3 km wide belt that intervenes between the synkinematic granite terrane to the south and a major mylonite zone to the north (Chorlton, 1980). In this region, Chorlton (1980) described the development of second-generation folds of an early foliation and also tight third-generation folds. The Bay d'Est Fault, a major mylonite zone, separates amphibolite facies rocks of the Bay du Nord Group in the north from greenschist facies rocks of the La Poile Group.

MINERALIZATION

Mineralization within layered and massive gabbros of probable ophiolitic origin appears to be of minor significance. Two small pyrite showings consist mainly of mineralization along fractures in the gabbro; another showing contains minor malachite and associated arsenopyrite. All occurrences are within gabbros near Pig's Head, in the White Bear River (11P/14) map area (O'Brien and Tomlin, 1984).

Volcanic rocks of the Bay du Nord Group are host to a significant sulfide occurrence in altered massive rhyolite near Grey Lake, in the western part of the White Bear River map area (Barry, 1980; O'Brien and Tomlin, 1984). The largest occurrence contains disseminated chalcopyrite, pyrite and arsenopyrite. Rhyolite tuff approximately 500 m north of this occurrence also contains traces of pyrite. These showings are significant in that they occur at the same stratigraphic level as the Strickland massive sulfide deposit to the southwest (Cooper, 1954; Swinden, 1981), namely, within the uppermost part of the Bay du Nord volcanic succession, immediately below graphitic pelites and slates. Other very minor pyrite showings also occur along strike at a similar stratigraphic level in the White Bear River map area, and northeast of Top Pond (O'Brien and Tomlin, 1984). In the Peter Snout (11P/13) map area, felsic volcanic rocks, intercalated with pelitic schist and phyllite, are host to several small pyrite showings and a more significant occurrence of disseminated chalcopyrite, galena and sphalerite (O'Brien, 1983). In light of the recent gold discovery by BP Selco in lithologically similar rocks at Cinq Cerf Brook (McKenzie, 1985), areas underlain by the felsic volcanic rocks of the Bay du Nord Group should be considered as important targets for gold exploration. Gold potential may also exist within and adjacent to the Baggs Hill Granite (Tuach, *this volume*) and other subvolcanic intrusions in the area.

The Bay du Nord Group sedimentary rocks, especially the slates and pelitic schists, contain numerous minor pyrite occurrences (Scott and Conn, 1950; Barry, 1980; O'Brien, 1983). Pyrite, with minor scheelite and arsenopyrite, is reported to occur in quartz veins in sedimentary rocks from the northern parts of the White Bear River map area (see Scott and Conn, 1950; Smyth, 1979).

Extensive silicification, with minor associated sulfide mineralization in the contact zone of the Roti Granite (Chorlton, 1980) in the Peter Snout map area, is hosted by both the LaPoile Group and the granite (J. Tuach, personal communication, 1985). It may be part of a large epithermal-fumerolic system (cf. Tuach, *this volume*) similar to that seen in the Cinq Cerf Brook area.

Mineralization within the Baie d'Espoir Group is most extensive within the Isle Galet Formation. Mineralization is stratabound and consists of Pb-Zn-Cu massive sulfide occurrences in felsic tuff within pelite. These occurrences are discussed in some detail by Swinden (1980) and Colman-Sadd and Swinden (1982). The felsic volcanic and altered units within the Bay d'Espoir Group are currently the subject of active gold exploration. This activity is based mainly on a correlation of the Baie d'Espoir Group with the La Poile Group to the west. Gold has been discovered in the Baie D'Espoir Group, along strike to the northeast at Kim Lake and Le Pouvoir (McHale, 1985).

Recently discovered uranium mineralization in the Bay du Nord Group is stratiform in nature and is interpreted to be essentially syngenetic (O'Brien and Tomlin, 1985). The mineralization is present, locally, where felsic volcaniclastic rocks are interbedded with fine grained pelitic metasedimentary rocks. In places, the uranium appears to have been remobilized from the volcanic rocks into the overlying pelites. Within the unwelded tuffs, uranium is concentrated in the coarser grained, more porous zones. Some of the uranium has been remobilized during subsequent deformation and metamorphism of the pelitic rocks. It is possible that further remobilization of uranium has occurred during intrusion of the nearby late syntectonic granites.

In the Peter Snout map area, Shell Canada Resources discovered uranium mineralization in the Baggs Hill Granite and in numerous boulders and outcrops of fine grained metasedimentary rocks and feldspathic schist of the Bay du Nord Group. The company has reported radioactivity up to 30,000 c.p.s. (Urtec UG-130) from the Bay du Nord Group in that area, and several samples contain greater than 2,000 g/t U (Wells, 1981). It was thought that the uranium mineralization was related to the intrusion of the Devonian Peter Snout Granite, and that uranium was remobilized from originally uraniferous sediments by heat associated with the intrusion (Wells, 1981). Recent investigations indicate that although some of the mineralization is granite related, still more is stratabound and may be originally syngenetic (O'Brien and Tomlin, 1985).

The late-syntectonic to posttectonic granitoids in the Burgeo map area, such as the Ironbound monzonite, Cochrane Pond Granite, North Bay Granite, Chetwynd Granite and Francois Granite, locally display granophile element mineralization (Sn, W, U, Mo) or indications of enrichment in such elements.

The Ironbound monzonite is highly radioactive throughout. Whole rock geochemistry samples have been collected,using a grid system, and analyses are currently in progress. The uranium potential is greatest in this pluton, it being the most radioactive of all granites in the Burgeo map area. The Cochrane Pond Granite contains minor scheelite mineralization (Scott and Conn, 1950; Barry, 1980). The muscovite-tourmaline-lepidolite-garnet granite phase is relatively radioactive and also contains molybdenite mineralization. The granite is an obvious exploration target for tin-tungsten mineralization; extensive glacial drift has so far hindered a thorough examination. The North Bay Granite contains small scheelite showings within the Burgeo map area. These occur as joint fillings associated with tourmaline, and in pegmatite veins northeast of East Bay.

Numerous tungsten showings were discovered by the Buchans Mining Company during the 1950's in the contact zones between the Bay du Nord Group and the North Bay and Burgeo granites. The mineralization apparently occurs within the metasedimentary rocks as disseminated scheelite.

The Francois Granite and Chetwynd Granite are high-level, high-silica granites with a good potential for granophile element mineralization. McConnell (1984) has reported anomalous tin, lead and tungsten values from the Francois Granite. An airborne gamma-ray survey (Geological Survey of Canada, 1983) has indicated that the entire Francois Granite is highly anomalous, with the greatest anomaly in the ring complex north of Rencontre Bay. Unpublished whole rock analyses by the Department of Mines and Energy in this area indicate a high background U content of over 20 g/t. Minor greisen veins occur within the Francois Granite, but these apparently lack tin and tungsten mineralization.

The Chetwynd Granite is currently being examined geochemically and the potential for mineralization should be clarified following completion of the analyses. Although the Chetwynd Granite can be classified as a high-silica granite (SiO_2 = 70 to 78 percent, unpublished data), it does not exhibit the overall extreme differentiation seen in the Francois Granite. However, the lithological and tectonic similarities between the Chetwynd Granite and the Francois and Ackley granites to the east indicate a high potential for tin, tungsten and molybdenite mineralization.

Tungsten with minor fluorite, barite and base metals is hosted by quartz veins at Grey River (Bahyrycz, 1957). The mineralized hydrothermal vein system, apparently related to late granitoids (Higgins, 1980), is developed mostly in an amphibolite unit of the Grey River enclave. The veins vary in width from 2 cm to 1 m; the larger veins can locally be traced for 400 m. They follow north to northeast-trending fissures, which cross-cut the regional foliation in the country rocks. Wolframite is the most important tungsten mineral; scheelite is subordinate. Other ore minerals include pyrite, chalcopyrite, arsenopyrite, molybdenite sphalerite, galena, bismuth and marcasite. Fluorite and calcite occur as gangue minerals along with quartz. The vein system was offset by several east-trending normal faults, and later was cut by a series of tensional veins containing fluorite, calcite, barite, sphalerite, galena, apophyllite and harmotome (Higgins, 1980). The central portion, some 600 m in length, is considered to be potential ore with an average grade of 1 percent WO_3 over 1 m (Fogwill, 1970).

TECTONIC EVOLUTION AND SYNTHESIS

The earliest stage in the evolution of the region involved the generation of massive and layered gabbro associated with pyroxenite and peridotite. The present chemical database is not yet sufficient to establish their exact tectonic affinity. These rocks may be vestiges of either an ocean basin, a small marginal basin, or the roots of an immature remnant arc.

A major episode of Middle Ordovician volcanism and accompanying sedimentation is manifested by the Bay du Nord and Baie d'Espoir groups. The volcanism was almost exclusively silicic in nature, possibly indicating the involvement of continental crust in magma generation. The subaerial volcanism and fluvial sedimentation of the La Poile Group may represent not only Middle Ordovician volcanicity,

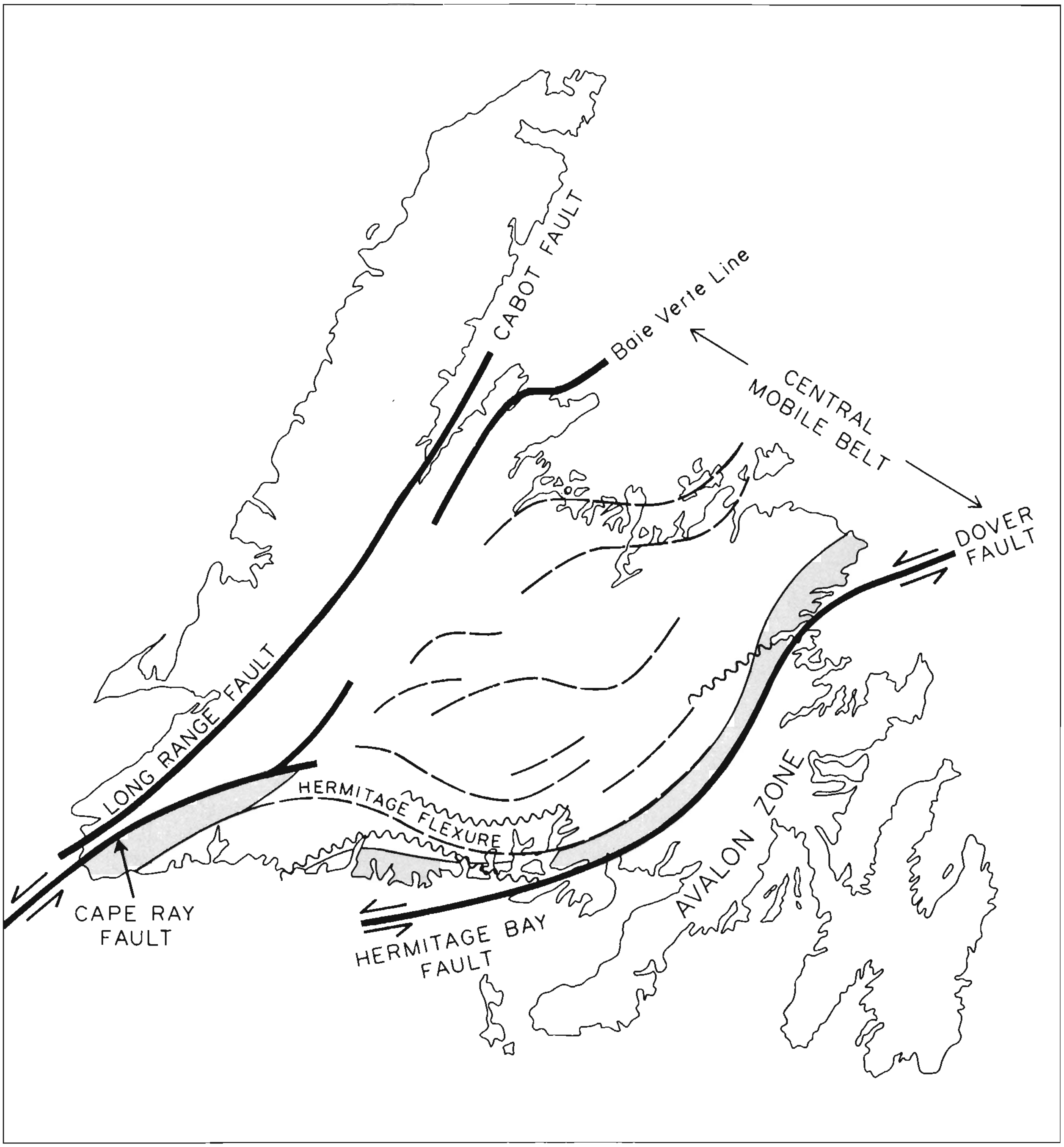

Figure 4: *The Dover-Hermitage Bay Fault and the Cape Ray Fault, interpreted as major, sinistral, wrench-fault systems that resulted in the clockwise rotation of the Central Mobile Belt, producing the Hermitage Flexure and subsidiary flexures in central Newfoundland. The shaded areas represent the general distribution of migmatites in the Gander Zone adjacent to the boundary faults (after Blackwood, 1985).*

but also significantly younger volcanic activity, unrelated to the Bay du Nord and Baie D'Espoir groups. Initial results from ongoing isotopic studies indicate that at least part of the La Poile Group is Silurian in age, and that either Grenville-aged continental crust or sediments derived from it was involved in melting to produce the La Poile magmas (G. Dunning, written communication, 1985).

The Baie d'Espoir Group is dominated by fine grained clastic sediments that were deposited in a quiet marine basin, distal to a volcanic centre (Swinden, 1982; Blackwood, 1985b). Sporadic volcanicity occurred throughout much of the group's depositional history. The Bay du Nord Group records an initial episode of extensive silicic volcanism, of probable submarine origin, followed by widespread, marine, clastic sedimentation (O'Brien, 1983; O'Brien and Tomlin, 1984; Blackwood, 1984). In the west, the proportion of volcanic rocks is higher than in the east; this may reflect westward proximity to a major volcanic centre. Sedimentary facies are variable and locally include rocks deposited in shallow restricted basins, probably contemporaneously with the main volcanic episode. Elsewhere, shelf facies environments pass into deeper water, turbidite-basin environments. Intercalated graphitic pelite and volcanic interbeds indicate intermittent periods of restricted deposition and sporadic silicic volcanism. The presence of debris flows and coarse grained conglomerates, locally containing foliated detritus, indicates relative proximity to an uplifted volcanic edifice. The La Poile Group, in the Burgeo map area, is tentatively interpreted to represent a subaerial volcanic centre, likely a caldera, that has an apron to the east of fluvial sedimentary rocks deposited in a fan-delta environment.

A major tectono-thermal event affected the region in the Silurian. The first period of deformation produced recumbent or locally upright folds. A regional penetrative foliation is developed axial planar to these structures, and in places merges into major D_1 mylonite zones. Throughout most of the volcanic-sedimentary succession of the area, metamorphic grade increases southward (structurally downwards), culuminating in migmatite zones that are intruded by synkinematic granitoids. Upright folds with an axial planar foliation of variable intensity formed in response to the second period of deformation.

The synkinematic (D_1) granitoids are complex, multiphase plutons that locally contain early components of quartz diorite, tonalite and granodiorite, which are rich in gabbroic inclusions. The association of the mafic rocks with these granitoids suggests a genetic link between them. The syn D_1 granitoids could have been produced during early subduction and associated metamorphism and deformation of the lower parts of the Ordovician arc successions in the Hermitage Flexure area. The possible role of continental crust in the production of these granites is uncertain. The syn D_2 granites are mainly muscovite- and biotite-bearing leucogranites, which in places may be related to progressive partial melting of peraluminous parental material, such as the stratified rocks of the Hermitage Flexure area.

Blackwood (1985b) has interpreted the Hermitage Flexure as a fundamental feature of the axial region of the Newfoundland Appalachians that formed in response to wrench faulting along the margins of the Central Mobile Belt. The orientation of the Hermitage Flexure implies a rotation of structural elements consistent with sinistral movements along the Dover-Hermitage Bay Fault and the Cape Ray and Long Range faults (Figure 4). In such a model, the southward-facing convexity of the eastern portion of the Hermitage Flexure would be the result of counterclockwise, external rotation of elements (c.f. Wilcox, *et al.*, 1973) along the Dover-Hermitage Bay Fault. The same sense of movement along the Cape Ray Fault would produce the southward-facing concavity of the western portion of the Hermitage Flexure. The overall effect of counterclockwise rotation along both wrench-fault systems would be to produce a clockwise rotation of structural elements in the medial region. Such a sense of rotation is mirrored by the Z-shaped flexures developed throughout the Central Mobile Belt.

The tectonic and plutonic style of the Burgeo map area is characteristic of the Hermitage Flexure area, and the Gander Zone as a whole. It is possible that much of the structural style is related to compression associated, at least in part, with shearing along the Dover-Hermitage Bay and Cape Ray faults (Blackwood, 1985b). Crustal thickening and associated increase in ambient temperatures, followed by subsequent uplift along the boundary faults, would result in the metamorphic pattern seen along the Hermitage Flexure. Metamorphism associated with the thermal relaxation of a thickened crust and subsequent melting of the lower crust, could have produced granitoids. Since melting in the crust can continue for up to 100 Ma after initial crustal thickening (e.g., Chamberlain and England, 1985), it is possible that the heat source for the younger granitoids could have originated during the Silurian D_1 tectono-thermal event.

The Burgeo map area and the entire Hermitage Flexure area are host to numerous mineral occurrences associated with each of the major stages in the geological evolution of this part of southwestern Newfoundland. Major gold discoveries in the Chetwynd and Cape Ray areas further serve to demonstrate the important economic potential of rocks along the Hermitage Flexure.

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