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GEOLOGY OF THE PINWARE RIVER REGION, SOUTHEAST LABRADOR

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ABSTRACT

The Pinware River region forms part of the Pinware terrane in southeast Labrador and belongs to the Grenvillian Interior Magmatic Belt. Supracrustal units are among the oldest present and consist of fine- to medium-grained, recrystallized quartzofeldspathic rocks, interpreted to have a felsic volcanic and/or arenite protolith. These are associated with quartzite, muscovite- and sillimanite-bearing pelitic rocks, calc-silicate units and banded amphibolitic rocks, the latter thought to be mafic volcanic in origin. The supracrustal rocks are closely associated with a wide range of alkali-rich granitoid rocks (including minor nepheline-bearing alkali-feldspar syenite) and a range of texturally variable amphibolitic rocks. The supracrustal package, granitoid rocks and amphibolites were thoroughly deformed and metamorphosed to high grade, prior to the emplacement of a texturally and compositionally diverse group of mafic dykes. Larger mafic intrusions in the area, including layered gabbronorite bodies, may have been emplaced at the same time. The later stages of the geological history involve intrusion of monzonitic, syenitic and granitic plutons, which are possibly syn- to late-kinematic with respect to Grenvillian orogenesis. Two massive granitoid bodies are correlated with ca. 960 Ma plutons mapped farther north in the Pinware terrane. Post-Grenvillian events can be broadly related to the formation of Iapetus Ocean. These include brittle faulting, intrusion of a north-northeast-trending Long Range dyke, intrusion of east-trending mafic dykes, extrusion of the Lighthouse Cove Formation basalt, deposition of the arenaceous Bradore Formation and deposition of limestone and shale of the Forteau Formation.

INTRODUCTION

The Pinware River map region is located in the Grenville Province in southeasternmost Labrador (Figure 1). It includes all of NTS 1:50 000-scale map areas 12P/10, 12P/15 and 12P/16, and parts of NTS map areas 2M/13, 12P/6, 12P/7, 12P/9, 12P/11, and 12P/14, collectively embracing an area of about 3,300 km². Mapping in the region was undertaken as part of the Canada–Newfoundland 1990-1994 Cooperation Agreement on Mineral Development.

Much of the area is a barren or sparsely vegetated upland between 150 and 300 m high composed of crystalline granitoid rocks. The elevation increases to the northwest, where there are many hills above 450 m. The highest point in the area is Stokers Hill, which has an approximate elevation of 540 m. The upland is deeply incised by several streams draining southeast toward the coast, and also by the Pinware River and its principal tributaries, Lost River and Beaver Brook. The lower 30 km of the Pinware River is a spectacular gorge, but above this point there is a broad, heavily wooded valley in which rock outcrops are much less common. The topography in southern coastal areas shows a marked contrast to the remainder of the region, as the crystalline basement is capped by flat-lying Lower Cambrian sedimentary rocks. The erosional edges of the sedimentary strata are defined by steep cliffs fringing the upper parts of valleys and along the shoreline.

Access to the southern part of the area is facilitated by a paved highway from the southwest corner of the area, linking up various coastal communities as far northeast as Red Bay. Gravel roads extend inland a few kilometres north of Forteau, northwest of L'Anse-au-Loup and northwest of Country Cat Pond. The coastal areas can be reached by boat, of course, although most of the shoreline lacks sheltered harbours. In winter and early spring, access to the interior can be gained by snowmobile, using well-marked trails that lead to cabins situated adjacent to many of the larger lakes. For the remainder of the year, the interior parts of the region are only accessible using a helicopter or float-equipped fixed-wing aircraft.

PREVIOUS WORK

The most comprehensive previous geological investigation is that of Bostock (1983) and frequent reference to his work is made throughout this report. Prior to his contribution, the coastal geology had been briefly described by Kranck (1939) and Christie (1951), and specific coastal

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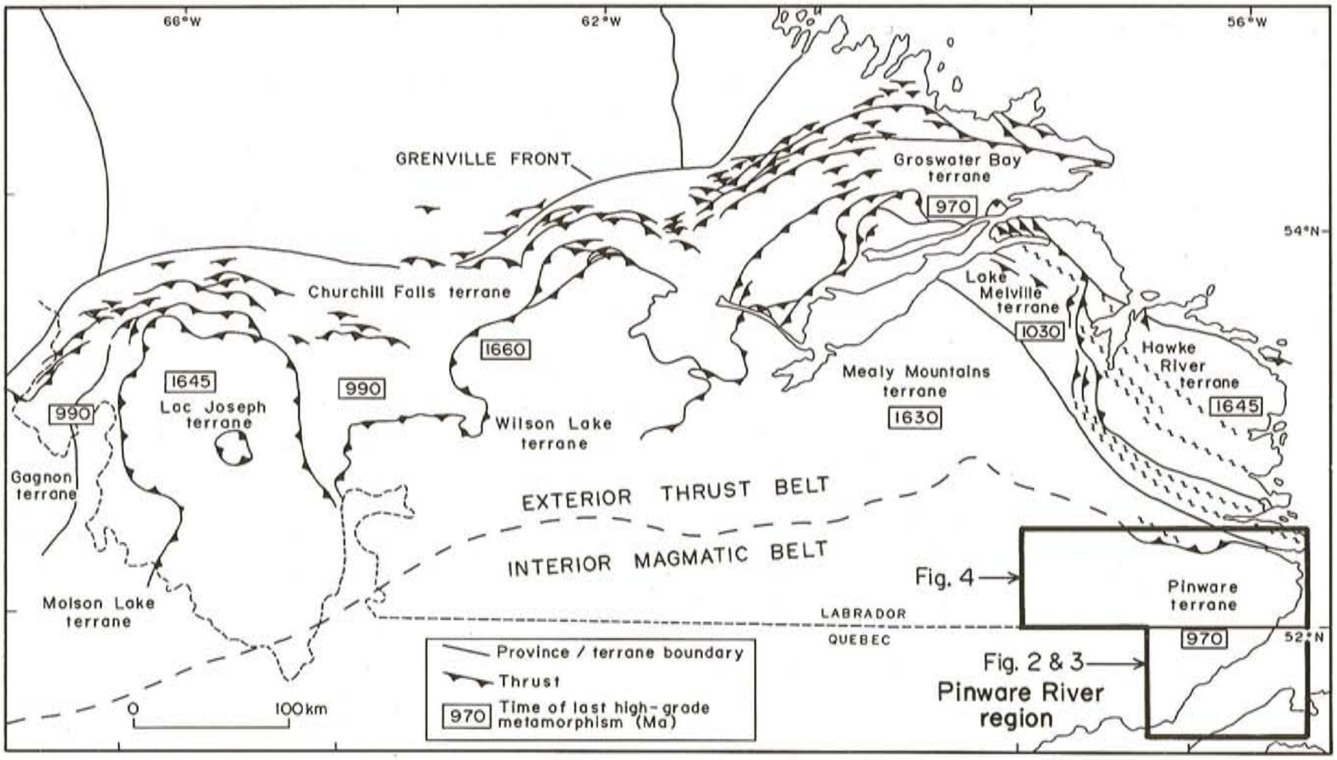

Figure 1. *Location of the Pinware River map region with respect to major structural features of the eastern Grenville Province.*

localities by Douglas (1953). Magnetite-bearing pegmatites had been studied by Hawley (1944); these and additional mineral localities were reported on by Penstone and Schwellnus (1953). A more recent study, mainly concerned with the gneissic rocks in the area, was carried out by Chubbs (1988), and Owen and Erdmer (1989) present geothermobarometric data for some metasedimentary gneisses immediately southwest of the present region. Numerous reports have been published on the Neoproterozoic–Lower Cambrian supracrustal rocks of the Lighthouse Cove, Bradore and Forteau formations, but as these rocks are the subject of a related project by I. Knight of the Newfoundland Geological Survey they are only reviewed briefly in this report.

Geological mapping at 1:100 000 scale by the Newfoundland Department of Mines and Energy has been completed for the St. Lewis River region to the north (Gower *et al.*, 1988b, c) and for the Upper St. Lewis River region to the northwest (Gower *et al.*, 1993). To the west, the mapping of D. Roi (unpublished data) has been compiled at 1:250 000 by Avramtchev (1983). Geochronological information for the Pinware River area consists of Rb–Sr data from one granitoid unit (Chubbs, 1988), two K–Ar whole-rock ages from the Lighthouse Cove Formation at Henley Harbour (Wanless *et al.*, 1974), and four K–Ar whole-rock ages from two mafic dykes (Wanless *et al.*, 1974). The ages are quoted in a subsequent part of the text.

Aeromagnetic maps at 1:250 000 scale and 1:63 360 scale were published in 1968 and 1969 (Geological Survey of Canada, 1968a,b,c; 1969a,b,c,d,e,f). The data have been compiled into a coloured magnetic anomaly map (Map NM-21-22-M) at 1:1 000 000 scale by the Geological Survey of Canada (1985), and a coloured shaded-relief aeromagnetic map at 1:100 000 scale for the map area has been produced by Kilfoil (1993). Bouguer anomaly maps at 1:500 000 scale that include the area are also available (Weaver, 1968). The area has also been included as part of the National Geochemical Reconnaissance Lake Sediment and Water Geochemical Survey (Geological Survey of Canada, 1984). Quaternary geology of the area (south of 51°45') has been reported on most recently by Grant (1992).

REGIONAL GEOLOGICAL SETTING AND MAJOR UNITS WITHIN THE MAP REGION

The region is situated within the Interior Magmatic Belt (Gower *et al.*, 1991) of the Grenville Province (Figure 1). The Interior Magmatic Belt is characterized by Grenvillian (ca. 1000 Ma) granitoid magmatism, which is largely absent in the Exterior Thrust Belt. The area is also an extension of the Pinware terrane (cf. Gower *et al.*, 1988b).

The rocks in the region are divided into 6 major groups, listed in order of inferred decreasing age: (i) supracrustal rocks, (ii) recrystallized, foliated to gneissic granitoid rocks, (iii) mafic rocks, including both layered mafic intrusions and mafic dykes, (iv) syn- to late-Grenvillian(?) plutons, (v) late- to post-Grenvillian plutons, (vi) late Precambrian to Early Cambrian rocks. On the basis of regional inferences, the first five groups of rocks probably have Mesoproterozoic ages, although the first two groups could be Paleoproterozoic. The last group is not reliably dated in the area, but we are reasonably confident that it is late Neoproterozoic to Early Cambrian.

Figure 2 is based on observations collected from nearly 2000 data stations, Samples were collected from most localities, and were slabbed and stained (specifically for K-feldspar) during field work. Informal names for granitoid plutons are shown on Figure 3.

DESCRIPTION OF UNITS

Paleo- to Mesoproterozoic

Supracrustal Rocks

The supracrustal rocks across the region have features in common and they are all probably related. The name Pitts Harbour group is recommended as an appropriate name for these rocks, after the locality where they were originally discovered (Gower *et al.*, 1988b). The supracrustal rocks can be classified into five main groups. These are: (i) fine- to medium-grained, commonly inhomogeneous, sugary textured, banded, creamy-, grey-, or pink-weathering quartzofeldspathic rocks, which may have been derived from a volcanic or arkosic protolith, (ii) grey- to white-weathering, medium-grained, finely laminated to thickly banded or bedded quartzite and quartz-rich meta-arkose, (iii) rusty-weathering, generally medium-grained pelitic rocks, (iv) green- or grey-weathering, medium-grained calc-silicate rocks, and (v) amphibolite, interpreted to have been derived mainly from a mafic volcanic protolith. In all areas, the supracrustal rocks are intruded by minor granitic intrusions. The rocks are described below on an area-by-area basis, starting in the southwest.

In the West St. Modeste area, the dominant rock type is felsic and commonly has a streaky or lensy appearance, which is interpreted as indicating a volcanoclastic protolith. Textures in the felsic rocks are not well enough preserved to demonstrate they are volcanic, but their association with other rock types (such as banded felsic rocks, quartzite, banded amphibolite and sillimanite- and(or) garnet-bearing schist) makes a supracrustal protolith, at least, probable.

The associated banded felsic rocks have a layering defined by colour, grain size and mineral assemblage (Plate 1). Colour variations include red, cream, grey, dark grey and green. Some of the associated quartzite is ferruginous and weathers to various shades of orange and brown. The amphibolite is banded and inhomogeneous, mainly due to variations in hornblende / plagioclase ratios.

Of special interest are three localities where sillimanite-bearing rocks are present. In the north, sillimanite- and garnet-bearing schists are intercalated with ferruginous quartzite, calc-silicate-rich layers and banded amphibolite. The orange-weathering colour indicates high sulphide content. In the centre, not far from West St. Modeste, spectacular bundles of sillimanite up to 10 cm long and over 1 cm wide occur in an extremely biotite-rich schist (Plate 2). Nearby, there are other similar schists, almost as biotite rich, in which sillimanite has been retrograded and garnet is scattered throughout. In the south, sillimanite occurs in narrow biotite-rich veneers associated with white-weathering inhomogeneous pegmatite. This rock is interpreted to be an extensively migmatized pelite.

A few scraps of metasedimentary rocks were mapped inland northwest of Pinware, and may be more continuous than shown on Figure 2, as no attempt was made to trace them out. The rocks are grey, pink and white-weathering, fine- to medium-grained, recrystallized, banded quartz-rich rocks with subordinate feldspar and minor biotite, garnet, sillimanite and opaque minerals. Banding is defined by alternating quartzitic and psammitic zones. The rock contains plagioclase-rich lensoid shapes that might be primary clasts. The supracrustal rocks have concordant gradational boundaries with the surrounding syenitic to granitic rocks.

In the Country Cat Pond area, rocks derived from a metasedimentary protolith are best exposed in a quarry north of the road near the west end of the pond, but are also present in small outcrops elsewhere in the vicinity. In the quarry, the rocks consist of interlayered quartz- and calc-silicate-rich rocks. Although many of the rocks appear in the field to be almost pure quartzite, stained slabs show that they contain a significant amount of feldspar. Grey-green-weathering diopside is the dominant mafic mineral in the Ca-rich rocks and is commonly partially retrograded to amphibole. White-weathering pegmatitic patches are probably near in situ melts. No garnet was seen in these rocks.

These metasediments may link up with an isolated exposure of impure quartzite south of the Lower Pinware River alkali-feldspar quartz syenite and other remnants of supracrustal rocks to the north of Country Cat Pond. These remnants comprise: (i) pelitic gneisses containing biotite, garnet, sillimanite, magnetite in restite layers and quartz, plagioclase and K-feldspar in the leucosome, (ii) psammitic and quartzitic layers containing biotite as the dominant mafic phase with minor garnet and sillimanite, and (iii) concordant granitic veins locally enhancing the gneissic texture.

Along the southwest flank of the Upper Beaver Brook quartz monzonite, supracrustal rocks are best exposed on the Pinware River. Rocks present include: (i) very fine-grained, finely laminated, quartzofeldspathic rocks that are tightly folded and show some leucosome development, (ii) banded amphibolite, (iii) schistose, green-buff (chloritic?) rocks containing black euhedral porphyroblasts of amphibole, (iv) calc-silicate rocks, (v) quartzite, (vi) a bouldery-looking rock that might be a felsic agglomerate or a tectonically dismembered metasediment (Plate 3). In places, the supracrustal rocks are present only as abundant enclaves in the granite.

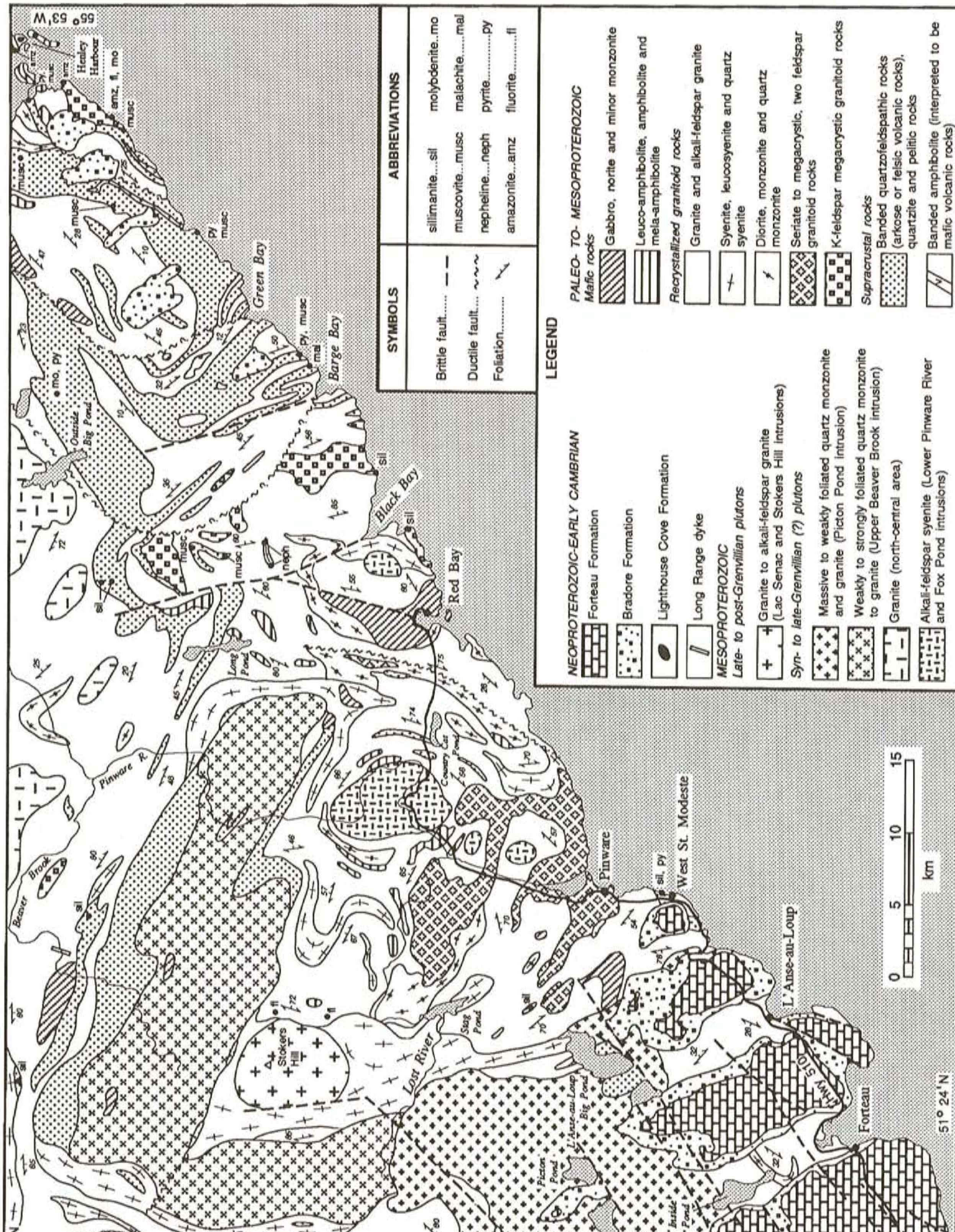

Figure 2. *Simplified geological map of the Pinware River map region.*

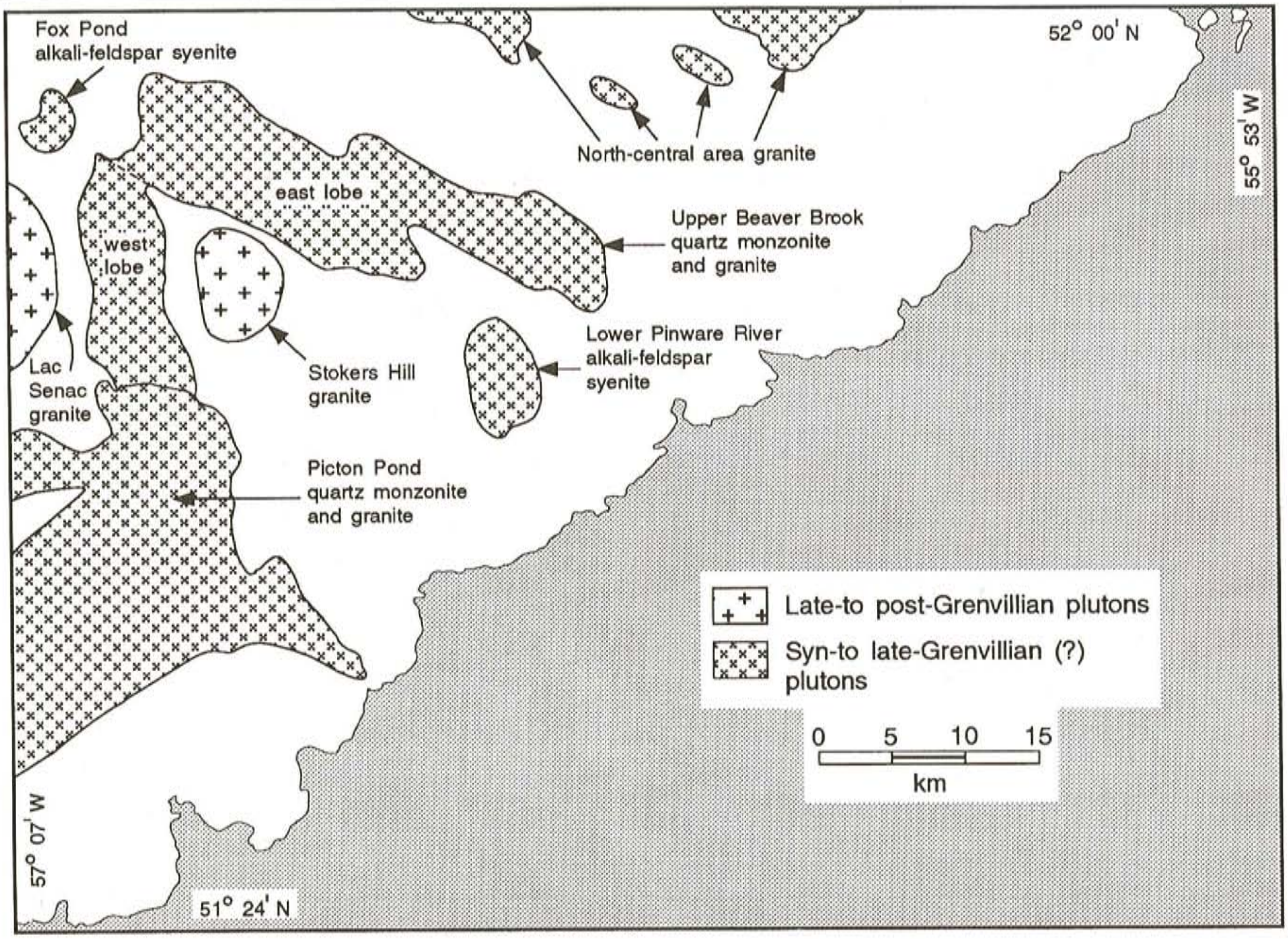

Figure 3. *Names used in text for syn- to late-Grenvillian(?) plutons.*

Plate 1. *Well-banded, multicolored, fine-grained quartzofeldspathic supracrustal rocks metamorphosed from either a metasedimentary or volcanoclastic protolith; West St. Modeste.*

Plate 2. *Giant sillimanite crystals in a biotite-rich pelitic gneiss; West St. Modeste (please do not collect from this locality).*

On strike, to the northwest and southeast are similar quartzites (locally containing garnet), clinopyroxene-bearing calc-silicate rocks, banded psammitic to semipelitic gneisses and arkosic gneisses. The psammitic gneiss is migmatitic in places. More quartzite and quartz-rich sediment are present even farther west, north of Stokers Hill granite. Some

Plate 3. *A bouldery rock consisting of quartzofeldspathic clasts of diverse composition. This unit is part of a package of supracrustal rocks, suggesting that it may be a felsic agglomerate, although a tectonic origin cannot be excluded; Pinware River 15 km northwest of Red Bay.*

micaceous layers within the psammitic gneiss are present that might have been derived from semipelite.

Within the Upper Beaver Brook quartz monzonite, in the vicinity of Pinware River, a large raft of supracrustal rocks is present and is well exposed in the river bed and on a hilltop immediately to the west. In the river bed are fine-grained, very finely laminated quartzofeldspathic rocks and slightly coarser grained felsic rocks, possibly fragmental in origin. These occur as separate small enclaves within the quartz monzonite and also as larger rafts. Some amphibolitic material, also interpreted as supracrustal, is intercalated with rocks of more obvious supracrustal parentage. The hilltop west of the river was previously visited by Bostock and the rocks identified as supracrustal (Bostock, 1983). Thinly to thickly bedded quartzite forms about 90 to 95 percent of the outcrop and is interlayered with fine-grained sillimanite–muscovite schist, which is reddish brown due to hematite staining. Both rock types are intruded by muscovite- and opaque-mineral-rich pegmatitic veins. On the east side of the river, a hilltop outcrop of strongly foliated, streaky textured quartzofeldspathic rock is interpreted to be derived from a felsic volcanic rock.

West of Upper Beaver Brook quartz monzonite, both definite and probable supracrustal rocks occur as narrow bands, generally less than 200 to 300 m wide. Rock types include: (i) fine-grained quartzofeldspathic rock, interpreted as either a felsic volcanic or hypabyssal rock, (ii) quartzite, (iii) garnet–sillimanite–biotite schist, (iv) rather variable dark-grey, micaceous, schistose material that was probably derived from a fine-grained clastic rock.

In the granite northwest of the Picton Pond quartz monzonite, slivers of a narrow schistose garnet-rich rock are interpreted as supracrustal. Most of the garnet is blood red, but some is mauve, typical of that in pelitic gneisses. No sillimanite was seen.

On the northeast side of the Upper Beaver Brook quartz monzonite, Bostock (1983) showed three localities where supracrustal, sillimanite-bearing rocks were identified. These have been interpreted to belong to a regionally extensive supracrustal belt trending parallel to the northern margin of the quartz monzonite. This interpretation relies on regarding the most common rock type—a generally pink-weathering, fine-grained, normally rather structureless, recrystallized K-feldspar-rich quartzofeldspathic rock—as having a supracrustal origin, presumably derived from either an arkosic or felsic volcanic protolith. A felsic hypabyssal origin cannot be excluded, but a supracrustal protolith is preferred because of the association with quartzite and pelite.

Of the three localities indicated by Bostock (1983) as having sillimanite-bearing rocks present in this area, only one was located during the present mapping. It is situated on a hilltop 4 km east of Beaver Brook and is a distinctive, ochreous-weathering, schistose rock. Both sillimanite and garnet are abundant. The garnets are dark red and generally less than 0.2 cm in diameter. An outcrop, about 4 km to the southeast of this locality, indicated by Bostock (1983) as having sillimanite-bearing rocks, was also visited. However, during a very brief helicopter stop, only fine-grained quartzofeldspathic rocks were seen.

In the vicinity of Long Pond, tightly folded quartz-rich arenite and quartzite are interlayered with amphibolite, calc-silicate layers and some thinner mica-rich layers. At the margin of Upper Beaver Brook quartz monzonite, a small outcrop of fine-grained pelitic rock was found and contains porphyroblasts of a bluish mineral that might be cordierite. Farther to the east, quartzite underlies a fairly large area. Some rocks contain appreciable amounts of biotite and magnetite. Diopside-bearing calc-silicate rock and some biotite-rich psammite are also present.

Other shreds and patches of supracrustal rock were found in the surrounding area. It is difficult to link them up into a coherent structural pattern. Neither foliation directions, aeromagnetic patterns, nor trends on aerial photographs provide adequate information from which to infer outcrop distribution, and the pattern shown is partly based on a structural assumption that rock-type distribution is the product of interfering fold trends (see Structure Section).

South of Black Bay, a narrow zone of sillimanite-bearing metasedimentary gneiss is exposed along the shoreline. These rocks are bounded to the south by well-banded granodioritic gneiss and to the north by foliated granite. Minor quartzite and psammite are associated with the pelitic gneiss. The pelitic rocks exhibit a migmatitic banding, defined by biotite, sillimanite, garnet-bearing restitic layers and quartz-plagioclase–K-feldspar leucosome. Garnetiferous bands are common and range from 2 to 10 cm in thickness. Spectacular layers composed of fibrolitic and prismatic sillimanite up to 50 cm wide are present. Muscovite occurs locally as a retrograde product of sillimanite. Psammitic and quartzitic layers are composed of quartz, plagioclase, K-feldspar, biotite, and minor garnet and sillimanite. Intercalated fine-grained amphibolitic layers are interpreted to be of supracrustal origin.

Supracrustal rocks between the Black Bay and Barge Bay faults include the most westerly muscovite-bearing schists. Muscovite is concentrated in 10-cm-thick bands between psammitic layers. Locally, garnetiferous quartzite intercalated with well-banded to schistose, biotite−garnet−sillimanite pelitic gneiss and minor fine- to medium-grained quartzofeldspathic rocks are also present.

A small area of supracrustal rocks are exposed on the shoreline 3.5 km east of the mouth of Black River. These separate coarse-grained granite to the south from K-feldspar megacrystic granitoid rocks to the north; therefore, it is considered to be a septum between two different plutons. Supracrustal rock types present include sillimanite−garnet schists, quartzite, banded amphibolite, and various other more non-descript pale-grey-weathering rocks that may be psammitic or felsic volcanoclastic in origin. The schist is extensively migmatized, but the abundance of sillimanite and characteristic pale mauve garnet confirm its origin as pelitic. At the margin of the banded amphibolite, a 50-cm-wide band of extremely garnetiferous rock (80 to 90 percent garnet) of uncertain protolith is present.

Between Barge Bay and Green Bay faults, there are large areas of generally very fine-grained to fine-grained, locally schistose quartzofeldspathic rocks. Many of the rocks have a 'sandy' feel to them−whether they weather this way because they were originally derived from clastic rocks, or because of some anomalous characteristic in recrystallized felsic plutonic rocks, is not known. Some of the rocks show narrow lensoid shapes, usually less than 1 cm long, that are generally composed of K-feldspar. Many rocks are fairly rich in biotite, which is usually concentrated into particular bands, and a few are muscovite bearing. Locally, hornblende and epidote are also present. In places, an odd, pseudobrecciated appearance is apparent. Although many of the rocks are completely structureless, commonly a lamination, streakiness or wider banding parallel to the prevailing foliation is present, suggesting a volcanic protolith.

Rocks on the coast in this area show distinct colour bands. The bands varying in thickness from a few millimetres to 20 cm, but wider bands are present showing thinner internal laminations. The layers are continuous over tens of metres. Lensoid shapes are present and seem to be confined to particular layers and some very fine-grained 'flinty'-looking material is also present. Intercalated are thin calc-silicate layers containing clinopyroxene and amphibole. Banded, inhomogeneous, concordant amphibolite forms an integral part of the sequence. The mineral assemblage is mainly quartz and feldspar, together with minor biotite, sporadic amphibole and opaque minerals, including pyrite; particular layers are very muscovite rich, and these rocks perhaps have a distal volcanoclastic protolith.

Quartzite and sillimanite-bearing pelite are minor rock types in this area, the quartzite southwest of Outside Big Pond having been previously recorded by Bostock (1983). Also present are fine-grained chloritic schists that might have been derived from mafic volcanic rocks. East of Outside Big Pond, quartzite is associated with fine-grained quartzofeldspathic rocks and some banded amphibolite (possibly of supracrustal origin) that contains epidote and garnet. In addition, Bostock (1983) shows a locality where cordierite, sillimanite and fluorite are present three kilometres southeast of Outside Big Pond; this site was not located.

In this area, limited evidence was found on the coast suggesting that there was a period of mafic dyke injection postdating formation of the supracrustal rocks, but predating emplacement of the foliated granitoid rocks. An enclave of fine-grained, foliated quartzofeldspathic rock, interpreted as probably derived from a felsic volcanic rock, is transected by a band of amphibolite, thought to be a mafic dyke. Both rock types making up the enclave are enveloped by foliated alkali-feldspar granite.

Between Green Bay and Henley Harbour, especially in the immediate vicinity of Wreck Cove, the rocks are dominated by schistose to banded amphibolite, intercalated with banded quartzofeldspathic rocks. Farther north, similar rocks are associated with muscovite-bearing schist. Difficulties in inferring protolith are exacerbated by very strong deformational effects, which have either imparted a well-defined layered appearance or emphasized a previously existing one. In addition to the extremely well-defined layering/foliation, the amphibolites have a very pronounced lineation defined by acicular amphibole and/or aligned feldspars grains and knots of quartzofeldspathic material, which probably represents boudinaged remnants of deformed quartzofeldspathic intrusions. Locally, the schistose amphibolite contains abundant porphyroblasts of a grey euhedral mineral, possibly plagioclase. Although the amphibolite is commonly schistose, it locally has some massive sections. It also has internal layering heterogeneities, which are emphasized by epidote-rich laminations. The quartzofeldspathic rock is fine to medium grained and shows textural contrasts between individual layers and groups of layers. Contacts with the schistose to massive amphibolites are concordant. Outcrops of schistose amphibolite on strike northeast of Wreck Cove are assumed to be correlative. Similar rocks are present south of Wreck Cove, where thinly banded amphibolite is intercalated with biotite−muscovite−garnet psammitic rock and minor thinly bedded quartzite. Locally, rusty-weathering gossan zones are present.

The supracrustal rocks form a 3-km-wide, coast-parallel belt. Inland, the rocks are fine to medium grained, strongly foliated or schistose quartzofeldspathic rocks. Locally, they have an odd mottled appearance, suggestive of either porphyroclastic or pyroclastic origin. In places, they are intensely lineated. Some of the rocks are very micaceous and show well-defined layers.

The belt of rocks can be extrapolated northeast toward Henley Harbour. On the mainland shoreline west of Henley Harbour is a well-exposed section of supracrustal rocks showing considerable lithological variation. At the northwest side, and bounded to the northwest by enclave-rich dioritic rocks, are fine-grained, thinly laminated and compositionally heterogeneous quartzofeldspathic rocks, interpreted as either greywacke or felsic volcanoclastic rocks; some biotite- and/or hornblende-rich layers are present. The banding is even and continuous. Southeast of this is a 1-m-wide layer of rusty-weathering pyritic quartzite interlayered with banded amphibolite. The banded amphibolite was subsequently intruded by a now deformed and metamorphosed mafic dyke. These rocks are succeeded by more fine-grained quartzofeldspathic rock, banded amphibolite containing retrograded garnet, and muscovite-bearing schists. The proportion of mica-rich rocks increases southeast. One distinctive rock, about 1 m thick, is made up almost entirely of biotite, and many of the rocks are extremely muscovite rich. Some quartz-rich rocks are associated, but pure quartzite is not present. The supracrustal rocks are bounded on their southeast side by strongly foliated biotite granite. On the northwest tip of the large island west of Henley Harbour, schistose, well-banded and internally laminated, muscovite-rich quartzofeldspathic rocks are present, interlayered with less mica-rich, but otherwise similar quartzofeldspathic rocks.

Associated rock types, especially those located 4 to 5 km north of Wreck Cove, are muscovite-rich schists, which are interlayered with quartzofeldspathic material, garnet-bearing biotite- or muscovite-rich quartzofeldspathic rocks and quartz-rich rocks. One rock type sampled has a mottled, heterogeneous appearance in hand sample and might be of volcanoclastic origin. Inland, substantial widths of very schistose, muscovite-rich psammitic to pelitic rocks are present, some containing white-weathering pegmatitic melt pods. Accepting a supracrustal origin for the rocks, the amphibolites are interpreted as mafic volcanic rocks, the laminated quartzofeldspathic rocks as greywacke, and the more micaceous rocks as siltstone, originally.

Recrystallized Granitoid Rocks

Granite and Alkali-Feldspar Granite

The granites are white-, pink-, creamy, or red-weathering, medium to coarse grained, weakly to strongly foliated, folded, sugary-textured, and recrystallized (Plate 4). Both texturally homogeneous, equigranular and texturally heterogeneous, inequigranular types are present. Some show a subtle compositional banding, defined by K-feldspar-rich zones, coarser quartz and K-feldspar segregations, more definite leucosome, pegmatites or very narrow mafic mineral-rich veneers. In other places, the banding is quite obvious and the rock can be locally described as a well-banded orthogneiss. As this seems to be merely a lithological end-member variant, it has not been designated as a separate rock type. Within a small area, grouping of the granites into various textural types is possible in the field, but varieties are not extensive enough to be mapped out at 1:100 000 scale.

In the vicinity of West St. Modeste, where Bostock (1983) indicates gneissic bedrock, elongate bands (usually several

Plate 4. *Very strongly foliated and subsequently folded alkali-feldspar granite. Typical of much of the early alkali-rich granitoid suite; Black Bay.*

tens of centimetres wide) of fine-grained, banded quartzofeldspathic rock with some amphibolite, alternating with zones of coarse-grained, homogeneous granite were mapped. Most of the bands are, narrow and extend across the width of the outcrop and it is difficult to distinguish whether they are rafts or minor granitoid intrusions. These bands are interpreted as enclaves, the granite having been injected parallel to pre-existing planes of weakness.

A pluton mapped by Bostock (1983) south of West St. Modeste is included as part of this granitoid unit. The rock is a pink-weathering, coarse-grained, foliated, chloritized biotite granite. It contains enclaves of amphibolite and banded fine-grained quartzofeldspathic rocks. Pegmatites and other minor granitoid intrusions are present but are not abundant. The fabric, folded in places, varies considerably from almost non-existent to strong, and two fabrics are locally evident.

Many of the granitic rocks exposed on the coast west of Carrol Point are very strongly deformed and migmatized. The rocks are intercalated with amphibolite (amphibolite containing plagioclase megacrysts is also common) and minor granitic segregations, and the rocks, overall, are best termed gneisses. The alternating mafic—felsic sequence has been tightly folded into flat-lying, overturned, west-verging folds. Locally, the banding is so well developed and grain-size variation between layers so pronounced that the rocks could equally be interpreted as supracrustal. For the most part, the structures are considered to be the product of intense deformation.

Granitoid rocks in the north central area, especially east of the Pinware River, are atypically coarse grained and less deformed compared to other rocks in this unit. Weaker fabrics and lack of migmatitic structure might indicate that they are younger than foliated granitoid rocks elsewhere in the map area.

On the shoreline southwest of Green Bay, Bostock (1983) isolated an area of granitoid rocks as belonging to his Unit

Hgdn (foliated granodiorite, quartz monzonite, some granite). The rock is a pink-weathering, medium- to coarse-grained, strongly foliated, homogeneous biotite-bearing granite to alkali-feldspar granite. It contains common enclaves of the fine-grained, foliated quartzofeldspathic rocks that are typical of the surrounding area. The central part of the granite is most homogeneous, even lacking enclaves and only intruded by a few flat-lying pegmatitic dykes. This area of granite has no unique features that distinguish it from the surrounding rocks.

A feature that characterizes granitoid rocks in the area between Barge Bay and Green Bay faults is the lack of associated syenitic or monzonitic rocks, in contrast to areas farther west. Most of the granite is pink-, white-, and grey-weathering, medium to coarse grained, moderately to strongly foliated and contains biotite ± hornblende. Some of the granites show oxidation haloes around magnetite grains. In addition, there are small areas of K-feldspar seriate to megacrystic granodiorite, non-megacrystic granodiorite and minor monzonite in the western part of the area.

Between Green Bay and Henley Harbour, are dominantly white-, buff- or pale-pink-weathering, medium- to coarse-grained, recrystallized, strongly foliated, relatively homogeneous, biotite granite. Associated amphibolite defines folds, hence demonstrating the strongly deformed nature of the rocks. West of Henley Harbour, the granite is seen to be internally homogeneous, except in contact with other rocks, especially amphibolite. A distinguishing feature of the granite in this area is the relative lack of minor granitoid intrusions.

Granite on the shoreline in the Forteau area shows vestiges of a seriate or an originally K-feldspar megacrystic texture, but it was not regarded as distinctive enough to group the rock with the megacrystic granitoid unit. The rocks are pink-weathering, medium grained, recrystallized and strongly deformed. The 'megacrysts' now have the form of elliptical polygonal aggregates. Both biotite and hornblende are present and show alteration to greenschist-facies minerals. One feature of these rocks is the high proportion of pegmatitic and microgranite minor intrusions. Some of the pegmatites contain abundant magnetite.

Syenite, Leucosyenite, and Quartz Syenite

The syenitic rocks are white-, pink-, creamy-, grey- or red-weathering, fine to coarse grained, recrystallized, generally homogeneous and foliated. Some have a diffuse, indistinct banding, partly related to deformation and grain-size reduction in zones of high strain. The rocks have been injected by minor granitoid intrusions, show streaky textures, have concordant amphibolite stringers and lenses, and have folded fabrics. Mafic minerals are mostly amphibole and/or biotite.

The largest area of syenitic rocks (more-or-less forming an envelope around the Stokers Hill granite with tongues extending south toward L'Anse-au-Loup Big Pond) includes a wide range of textural types. Among the more distinctive is coarse-grained syenite present just north of L'Anse-au-Loup Big Pond and, broadly along strike, southwest of Stokers Hill granite. This rock is massive to weakly foliated, leading to some doubt that it should be classified as part of this syenite unit. Syenite is shown farther east on Figure 2 as an S-shaped body. There is little that is distinctive about it, the rock being a pink-weathering, medium-grained, moderately to strongly foliated, locally banded hornblende-bearing quartz alkali-feldspar syenite. It may have originally linked up with another body of syenite present on the east side of Pinware River in the same general area.

At Carrol Point, the layering is strongly accentuated by alternations of colour (red to pink to creamy), grain size (fine to coarse grained), and associated rocks (mainly amphibolite). Some of the amphibolite is present as tectonic fish, elsewhere it is present as more continuous parallel-sided layers that are folded into reclined or recumbent structures, verging to the east. Some of the syenitic rocks resemble arkosic sediments, but their overall homogeneity argues against this protolith.

The syenitic rocks northeast of the eastern end of Upper Beaver Brook quartz monzonite are extremely rich in K-feldspar. Other minerals make up less than 5 percent of the rock, and include quartz, albite, and a green mafic mineral thought to be aegerine (hand-specimen identification). The rocks weather salmon-pink to yellow-buff, are recrystallized, medium to coarse grained, and moderately to strongly foliated. Unlike Bostock's (1983) interpretation, these rocks are not correlated with the large late-stage quartz-monzonite intrusions occupying much of the southwest part of the area.

A distinctive nepheline-bearing alkali-feldspar syenite was discovered 10 km north-northeast of Red Bay (Plate 5). It has not been mapped out in detail but appears to be a lenticular body, probably less than 200 m wide and extending at least 2 km along strike. It is white-weathering, medium to coarse grained, recrystallized and weakly to moderately foliated. Nepheline occurs are easily recognizable chalky-white grains associated with K-feldspar, magnetite,

Plate 5. *Nepheline-bearing alkali-feldspar syenite. Chalky-white spots are nepheline, which makes up about 40 percent of the rock; 10 km north-northeast of Red Bay.*

aegerine(?) and garnet. Mafic minerals are not present in the thin sections cut, and their identification is based on hand samples only.

Diorite, Monzonite and Quartz Monzonite

Dioritic and monzonitic rocks were divided into separate units during mapping, but have been grouped together in Figure 2. Diorite is subsidiary to monzonite and is white-weathering, medium grained, strongly foliated and intruded by abundant concordant granitoid dykes. Generally, the diorite is more melanocratic than the monzonite and grades into leucoamphibolitic rocks. The mineral assemblage is orthopyroxene, clinopyroxene, hornblende, biotite, plagioclase, and minor K-feldspar.

A distinctive rock type, provisionally termed a leucodiorite, is present northwest of Forteau, where a hook-shaped body is indicated in Figure 2. This white- to grey-weathering, banded, leucocratic rock consists of plagioclase, with minor quartz and mafic minerals. Bands average 10 cm thick, defined by compositional and grain-size variations. The protolith of the rock is uncertain, it could be a remnant of a layered anorthositic to leucogabbronorite intrusion.

The monzonitic rocks are creamy-, brown-, rusty- or grey-weathering, medium to coarse grained, fairly homogeneous, recrystallized and moderately to strongly foliated. Locally, they tend toward having a megacrystic texture. Generally, they contain both clinopyroxene and orthopyroxene in addition to amphibole and biotite. They have been injected by abundant concordant pink pegmatite and microgranite. The only relatively large area of monzonite crops out west of Red Bay. The rocks include well-banded gneisses, and have interdigitating, gradational contacts with syenite, granite, and amphibolite.

Seriate to Megacrystic, Two-Feldspar Granitoid Rocks

An irregularly shaped body of seriate to megacrystic two-feldspar granodiorite to granite north of Pinware has been distinguished as a separate unit in Figure 2. It is one of the more lithologically uniform units in the basement complex. The shape of the body is interpreted to result from fold interference.

The rocks are white-, grey-, creamy- or pink-weathering, medium to coarse grained, generally strongly foliated and recrystallized. Some rocks have irregular pink felsic segregations. Anhedral, partially to completely recrystallized K-feldspar aggregates up to 3 cm long are interpreted as former megacrysts. They commonly exhibit white (albite?) rims and make up to 20 percent of the rock. Mafic minerals are biotite, hornblende and titanite, and clinopyroxene and orthopyroxene are commonly present. The rocks are intruded by pegmatite.

The granitoid rock that forms Ship Head (at Pinware) and the area immediately to the south as part of the seriate to megacrystic unit are grouped together. This classification is at variance with Bostock (1983), who distinguished these rocks a part of a separate, younger unit, which he referred to as 'foliated granodiorite, quartz monzonite, some granite' (his Unit Hgdn). The rocks are pink-grey weathering, medium to coarse grained, recrystallized and more distinctly megacrystic than much of the remainder of the unit. The megacrysts are, however, recrystallized to polygonal aggregates mantled by white feldspar rims. Both hornblende and biotite are present. Like the surrounding rocks, the megacrystic granodiorite at Ship Head is thoroughly recrystallized, is intruded by mafic dykes, is intruded by later minor granitoid dykes, and has similar fabrics.

Seriate to megacrystic granitoid rocks are well exposed along the shoreline east of the mouth of the Pinware River and reference to them was previously made by Bostock (1983) who termed the rocks augen granodiorite. The rocks are white-, grey- or creamy-weathering, medium to coarse grained, moderately to strongly foliated seriate to megacrystic granodiorite. The K-feldspar megacrysts are up to 2 cm long and make up 10 to 20 percent of the rock. In some areas, hornblende-rich segregations form discontinuous, migmatized zones enriched in granitic melt material. The unit is intruded by amphibolite dykes, which are veined by later granitic minor intrusions. Many of the granitic veins are concordant. Bostock (1983) described the megacrystic granodiorite interlayered with gneiss and discussed the possibility that more than one age of granitoid rock is present. This has not been thoroughly evaluated, but, in any event, the gneissic fabrics are regarded as being the product of subsequent migmatization and deformation.

K-feldspar Megacrystic Granitoid Rocks

The granite on the shores of Diable Bay is distinctive. It is creamy-, grey- or pink-weathering, medium grained (recrystallized from coarse-grained), strongly foliated and relatively uniform. K-feldspar occurs as lensoid aggregates of polygonized grains up to 10 cm long that are interpreted as stretched former megacrysts. The rock is intruded by deformed pegmatites and transected by shear zones showing apparent dextral displacement. On its north side, it has a fairly sharp contact against fine-grained, banded quartzofeldspathic rocks that are interpreted as supracrustal. The contact is intruded by pegmatite.

Between Red Bay and Black Bay, megacrystic granitoid rocks are buff- to pink-weathering, medium grained and very inhomogeneous. Recrystallized megacryst aggregates are up to 3 cm long, and only rarely are kernels of primary K-feldspar preserved. Interbanded pink- and black-weathering, quartzofeldspathic and amphibolitic material gives them a well-banded gneissic appearance. The amphibolitic material clearly represents various dyking events. Early dykes are thoroughly shredded and migmatized, in contrast to later dykes, which, although metamorphosed, are obviously discordant to earlier fabrics. The granodiorite is intruded by minor granitoid dykes, veins and stringers. Included are microgranite and pegmatite that contain a pale green mineral thought to be fluorapatite. Also present are large pegmatites, some of which are extremely rich in magnetite (see Economic Potential Section).

K-feldspar megacrystic granodiorite extending inland from the coast between Black Bay and Barge Bay is white- or pink-weathering, medium to coarse grained, moderately to strongly foliated and contains both biotite and hornblende. K-feldspar megacrysts make up to 20 percent of the rock, are up to 2 cm long, anhedral and recrystallized to polygonal aggregates. Commonly, they are severely attenuated to elongate ellipsoids. Concordant amphibolite layers, possibly the remnants of former dykes, are found in coastal exposures. The megacrystic granitoid unit is intruded by minor granitoid intrusions. Megacrystic units farther inland in this area may be part of the same unit.

A distinctive K-feldspar megacrystic granitoid rock was previously mapped by Bostock (1983, his unit Hgdn) on the coast southwest of Henley Harbour. It is pink- to grey-weathering, coarse grained, moderately to strongly foliated, biotite and/or hornblende bearing and homogeneous. Most of the megacrystic granitoid rocks are plagioclase-poor, and some completely lack plagioclase. The K-feldspar megacrysts are subhedral, commonly not recrystallized, are up to 5 cm long and comprise as much as 40 percent of the rock. In shear zones, especially, the megacrysts are attenuated to polygonized aggregates of small grains, but elsewhere less deformed K-feldspar aggregates, mantled by white rims, are present. Quartz is ribbonform in the more strongly deformed examples. The unit contains enclaves of fine-grained granodiorite, amphibolite and garnet—biotite schlieren. It is also intruded by pegmatite, quartz veins and mafic dykes.

In addition to a generally well-developed penetrative fabric, some rocks have a strong lineation and show a folded fabric. A few granitoid rocks are transected by concordant brittle shear zones.

Mafic Rocks

Leuco-amphibolite, Amphibolite and Mela-amphibolite

Amphibolite and its light- and dark-coloured variants are common minor rock types associated with the foliated granitoid rocks in all parts of the map region. The rocks are black- to grey-weathering, medium to coarse grained, recrystallized, commonly foliated, and very variable in texture. In addition to hornblende and plagioclase, minerals locally present are ortho- and clinopyroxene and, more rarely, garnet. A distinctive textural variant contains ellipsoidal polygonized remnants of large plagioclase crystals probably originally about 1 cm long, interpreted to be former phenocrysts. Typically, the rocks are injected by minor quartzofeldspathic veins. The amphibolites are considered to be the metamorphosed remnants of minor mafic dykes, although discordance cannot be unequivocally determined for most of them because of subsequent deformation. At two localities, amphibolite dykes were noted as discordantly truncating boundaries between two granitoid types. In general, the amphibolite is folded in the same style as the host granitoid rock and dyke emplacement must have preceded high-grade metamorphism. The focus in the remainder of this section is on two areas where several of the largest amphibolitic bodies occur.

East of road bridge over Pinware River, remnants of a layered mafic intrusion are exposed in a 300-m-long section in a roadcut southwest of the Lower Pinware River alkali-feldspar syenite. Rock types include meta-anorthosite, leuco-, meso- and melanocratic amphibolite, as well as abundant leucosome and hornblendite pods. Compositional banding is well developed in places, although locally severely boudinaged and disrupted by leucosome and hornblendite pods. The leucosome pods commonly contain large euhedral clinopyroxene and/or hornblende crystals several centimetres long. The presence of deformed and metamorphosed pegmatite dykes adds further complications to an already complex association of rocks.

On the opposite side of the Pinware River valley (to the north), grey-weathering, medium-grained, recrystallized plagioclase-rich (plus biotite and hornblende) rocks are exposed. These show some layer-to-layer variability, including melanocratic layers up to 15 cm thick. Farther west still, on Lost River and outcrops to the north, grey-, buff- or creamy-weathering, medium-grained, recrystallized, banded (and boudinaged) leucocratic rocks, containing orthopyroxene, clinopyroxene, hornblende, plagioclase, and an opaque mineral, are present. One possibility is that these outcrops represent remnants of a single body folded into a south-plunging synform.

Mafic remnants in the Henley Harbour area, and on the mainland to the southwest, are all thoroughly metamorphosed and, for this reason, have been grouped together. Mafic rocks west of Henley Harbour consist of a black-weathering, homogeneous, strongly foliated, medium- to coarse-grained amphibolite containing abundant garnet (up to about 15 percent). The garnets are up to about 0.5 cm in diameter and are partially retrograded. The garnetiferous amphibolite is itself intruded by amphibolitized mafic dykes. The contact between the amphibolite and its host alkali-feldspar granite is transposed and complex due to interdigitation of the mafic and granitoid rocks, combined with injection and deformation of leucosome material. In the vicinity of Henley Harbour, many of the islands are made up largely of mafic rocks retaining indications of primary igneous layering. The rocks are garnetiferous leuco-, and meso-amphibolite and are strongly deformed and injected by pegmatite veins.

Some exotic-looking mafic dykes containing large (several centimetre long) plagioclase phenocrysts are associated with these mafic rocks. In places, these have been attenuated to pencil-like form exceeded 3 cm long. At one locality, the large plagioclase crystals are concentrated in the western 80 percent of the intrusion (where they comprise about 25 percent of the rock) and are very sparse in the other 20 percent. A curious feature of the large plagioclase crystals is that they are cored by mafic minerals, probably mainly amphibole (Plate 6). A similar intrusion (without core phenocrysts) was illustrated by Bostock (1983, Figure 11), from a coastal locality much farther south.

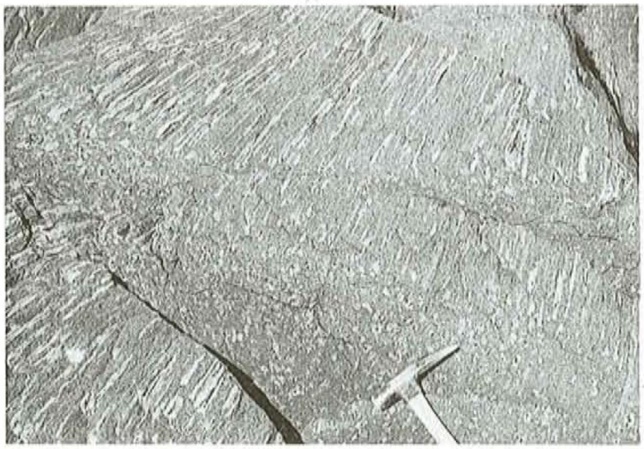

Plate 6. *Amphibolite mafic dyke containing stretched plagioclase phenocrysts. The origin of the black cores (suspected to be hornblende) in the plagioclase phenocrysts has yet to be established; between Wreck Cove and Henley Harbour.*

Gabbro, Norite and Minor Monzonite

Gabbroic and noritic mafic rocks do not form a high proportion of the rocks in the Pinware River area. The crescent-shaped Red Bay mafic intrusion is the largest. From the air, the distribution of the mafic rocks can be inferred from the common occurrence of orange-brown feldspar sands surrounding weathered outcrops. The shape is interpreted to be due to folding of a tabular intrusion into a syncline, followed by faulting at a narrowly oblique angle to the axial trace. The syncline plunges steeply northeast having its eastern limb truncated by the coastline.

Rock types in the Red Bay intruson include anorthositic gabbronorite, leucogabbronorite, gabbro and pyroxene-bearing monzonite, as previously noted by Bostock (1983). The anorthositic gabbronorite and leucogabbronorite are white-, grey-, green-, buff-, or brown-weathering, coarse grained and generally massive, or weakly foliated. Plagioclase crystals exceed 1 cm in length, in places. The mineral assemblage in the anorthositic gabbronorite and leucogabbronorite comprises euhedral cumulate plagioclase, intercumulus clinopyroxene and orthopyroxene and an opaque mineral. Some coarse-grained patches have interstitial K-feldspar and, in these areas, a few quartz segregations occur. Magnetite and pyrite are present. The rocks are most modified close to the margins of the intrusion. Some of the clinopyroxene is uralitized and fringes of plagioclase grains typically show some evidence of minor recrystallization.

Layering is obvious in many outcrops (Plate 7). In coastal outcrops, igneous crossbedding and graded bedding defined by concentrations of amphibole, are common. Enclaves of

Plate 7. *Layered gabbronorite of the Red Bay layered intrusion, subsequently intruded by a parallel-sided mafic dyke and then a minor granitic dyke; Red Bay.*

similar material to the host gabbroid rocks are also common, and range from a few centimetres across to several metres in diameter. The margins of the intrusion are complex. Hematite alteration of the granitoid rocks marginal to the gabbronorite is one indication that the Red Bay intrusion is younger than the surrounding foliated granitoid rocks.

Monzonite, adjacent to the Red Bay layered mafic intrusion, is distinguished from previously described monzonitic rocks by a relative lack of deformation and coarser grain size, and it may be genetically related to the Red Bay body. The rocks are pink-, buff- or red-weathering, coarse grained, equigranular and weakly foliated. Generally, they lack quartz and contain biotite, hornblende and pyroxene. Recrystallization is extensive, but incomplete.

The Red Bay mafic intrusion is intruded by planar, or less regular, microgranite, aplite and pegmatite dykes. It is also intruded by planar plagioclase-porphyritic and non-porphyritic mafic dykes, in turn intruded by minor granitoid dykes (Plate 7).

A small leucogabbronorite intrusion is located west of Pinware and was previously mentioned by Bostock (1983), who termed the rock mangeronorite. Its shape is not known in detail as it was only crossed on one traverse and has no distinctive topographic or aeromagnetic expression. On the ground, it is easy to identify from a distance because of brown feldspar-rich sands fringing outcrops. The boundaries have been modified slightly from those of Bostock (1983) based on data collected during the 1993 field program. It is creamy-, grey- or brown-weathering, massive, medium to coarse grained and homogeneous. There is a hint of layering in some outcrops defined by subtle grain size and mineral content variations. The dominant mineral, plagioclase, occurs as subhedral to euhedral crystals up to 1 cm long and is possibly aligned parallel to layering. Pyroxene is interstitial and traces of interstitial K-feldspar are also present. The texture of the rock is fairly similar to one of the gabbronorite bodies in Upper Beaver Brook quartz monzonite, and perhaps belongs to the same generation of mafic intrusions.

An elliptical mafic body, northwest of Pinware, less than 1 km long, was previously mapped by Bostock (1983), who termed it amphibolite. The body is exposed as a group of three small, well-exposed black-weathering knolls in the centre of a valley that are easily distinguished at a distance from the flanking granitoid rocks. The rock grades from medium to coarse grained toward the core of the body. It is massive (except for a fracture cleavage) and homogeneous and, although metamorphosed, retains vestiges of igneous texture. The mineral assemblage is orthopyroxene, clinopyroxene, hornblende, plagioclase and an opaque mineral and the name mafic granulite might be more appropriate. The rock is intruded by pegmatite.

A relatively large body of grey-, green- or black-weathering, medium- to coarse-grained, recrystallized mafic rock is exposed along Beaver Brook for about 2 km. Layering is evident in several places, defined by 1- to 3-cm-wide mafic and plagioclase bands. The mineral assemblage is plagioclase, clinopyroxene, orthopyroxene, hornblende and an opaque mineral. Some primary igneous textures can be recognized. The body is intruded by large pegmatites.

South of the southeast tip of Upper Beaver Brook quartz monzonite, a body of monzonitic gabbronorite was previously mapped by Bostock (1983), who grouped it as part of his 'norite, augite-bearing amphibolite' unit. The rocks are mostly light-weathering, medium to coarse grained and relatively homogeneous. Parts of the body are not extensively recrystallized, so primary lath-shaped plagioclase grains, with interstitial mafic minerals and K-feldspar, can be clearly seen. A smaller occurrence immediately to the west is very similar and it seems likely that either the two areas were originally part of one body, or that the intervening unexamined area is also monzonitic gabbronorite. The rock type is somewhat similar to a small mafic body south of the Picton Pond quartz monzonite, and maybe both are peripheral mafic intrusions co-genetic to the adjacent quartz monzonite plutons.

Leucogabbro is exposed on the east flank of the Lower Pinware River alkali-feldspar quartz syenite (along the forestry road north of the highway east of the Pinware River). Most of the rocks are dark-brown, grey-weathering, coarse grained and massive. Both fine- and coarse-grained textural types occur together as irregular, intermeshed patches. A few small quartz-feldspar veinlets intrude the leucogabbronorite. The mineral assemblage is plagioclase, clinopyroxene, orthopyroxene and an opaque mineral. Plagioclase occurs as laths up to 4 by 0.3 cm and is slightly recrystallized. The grains show a strong preferred orientation, taken to indicate alignment during magma emplacement. Pyroxene is interstitial.

Two elliptically shaped bodies of mafic rock are present in the northeast part of the map area and were previously mapped by Bostock (1983). The rocks are black-weathering, medium to coarse grained, and massive. Primary layering, accentuated by olivine-rich layers, is evident in places and, although partially recrystallized, igneous textures and minerals are well preserved overall. Both olivine and primary pyroxene are present and coronal textures mantling olivine can be seen. Apart from a few quartzofeldspathic stringers, the rocks lack minor granitoid intrusions.

Mafic Dykes

Numerous approximately planar mafic dykes truncate fabrics in the recrystallized, foliated granitoid rocks. As these dykes were not found in the plutons described subsequently they are interpreted as predating them. Although the dykes truncate the host-rock fabric (folded in some instances), many of them also carry their own fabric, which is consistent with them having been emplaced before the foliated plutons. Some of the dykes are slightly boudinaged and many are offset along late-stage faults.

The dykes range in thickness from about 30 cm to several metres. Trends are extremely variable, but east-northeast and north-northeast trends are dominant. Judging from the way one discordant mafic dyke branches in various directions, it is unlikely that any particular direction is characteristic. Texturally distinct types include: (i) net-veined dykes, (ii) plagioclase-phyric dykes, (iii) plagioclase- and mafic mineral-phyric dykes, (iv) fine-grained, even-textured dykes, (v) dykes containing abundant xenoliths.

The net-veined dykes contain irregular, anastomosing white-weathering, medium- to coarse-grained, quartz-feldspar veins and segregations. The feldspar is dominantly plagioclase, but K-feldspar is common in some dykes and may also be pervasive into the mafic rock adjacent to the veins. In places, the net-veining looks like a later migmatitic effect, and the higher proportion of biotite adjacent to some of the net-veined dykes might be attributed to potassium metasomatic effects. Elsewhere, the net-veining is clearly a primary feature that developed at the time of dyke emplacement. A good example occurs on the north shore of Black Bay where the mafic rock forms pillows enveloped by the felsic component and both are contained within a parallel-sided intrusion sharply truncating the previously strongly deformed host rocks (Plate 8). Enclaves of the host granite are commonly caught up in the felsic component. The mafic

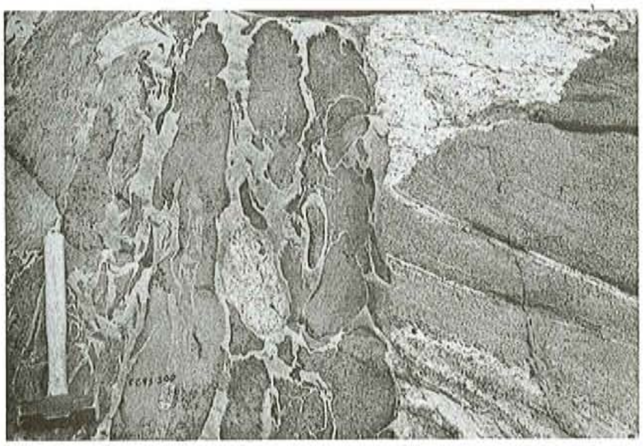

Plate 8. *Net-veined mafic dyke containing rounded enclaves of granite (left) discordantly intruding granite (top right) and amphibolite (bottom right). The amphibolite is a pre-metamorphism mafic dyke; Black Bay.*

pillows do not show a homogeneous texture, instead exhibit variations in grain size and plagioclase phenocryst abundance. In at least two cases, net-veined mafic dykes have been strongly deformed and an almost schistose fabric developed, accentuated by the net-veining.

In the plagioclase-phyric dykes, the matrix is generally fine grained, black- or grey-weathering, and uniform. Some of the dykes are intruded by granitoid veinlets. The phenocrysts are euhedral, white, and range from not much larger than the matrix grain size to over 1 cm long. Locally, the phenocrysts occur in clusters. A noteworthy feature, evident in many hand samples, is that the plagioclase grains show quench textures. One east-trending dyke having plagioclase phenocrysts up to 3 mm long in a fine-grained amphibole–feldspar matrix has an age of 931 ± 32 Ma (K–Ar whole-rock, Wanless *et al.*, 1974). This age is the average (recalculated) of two dates quoted in the original reference as 915 ± 32 Ma and 926 ± 32 Ma.

The dykes having mafic mineral phenocrysts are provisionally considered to be an ill-defined subset of the plagioclase-phyric type, as most of the dykes having mafic mineral phenocrysts also have plagioclase phenocrysts. The dark phenocrysts are mostly less than 0.5 cm across, subhedral to anhedral and locally look somewhat recrystallized. One dyke grouped in this category is 3 m wide, discordantly intrudes mylonitized supracrustal rocks, has distinct chilled margins and, in addition to plagioclase and mafic-mineral phenocrysts, also contains abundant pyrite.

Fine-grained mafic dykes lacking phenocrysts are also commonly narrower.

The xenolith-rich dykes are the most interesting, and rarest. One well-exposed example, although only about 30 to 50 cm wide, is packed with a wide range of mafic and felsic plutonic rocks that are very similar to those in the immediately surrounding area. Matrix material is minor. The sides of the dyke are straight and parallel sided. It is difficult to imagine how so many xenoliths became so tightly crowded.

Mesoproterozoic

Syn- to late-Grenvillian(?) Plutons

Lower Pinware River Alkali-Feldspar Syenite and Similar Bodies

An elliptical body straddling the Pinware River in the central part of the map area is here named the Lower Pinware River alkali-feldspar syenite. It was termed mangerite by Bostock (1983) and has been studied by Chubbs (1988). Chubbs reported Rb–Sr whole-rock geochronological data for the intrusion (obtained by R.F. Cormier) indicating an age of 1090 ± 190 Ma, with an initial Sr ratio of 0.7134 ± 0.0077.

The most common rock type in the body is coarse-grained alkali-feldspar quartz syenite, but other rock types are present, especially a finer grained variant of the syenite, which is present at some exposures north of the Pinware River. A fine-grained alkali-feldspar syenite, with the typical coarse-grained syenite as veinlets through it, occurs on the west side of the body in roadside outcrops.

On fresh, blasted roadside outcrops, the rock is dark, greasy green and appears massive and homogeneous. On weathered surfaces, in dramatic contrast, the unit is white, creamy or brown and is rather crumbly, degenerating to a feldspar sand. It is difficult to obtain fresh samples from natural outcrops, as weathering penetrates several tens of centimetres. The syenite consists overwhelmingly of K-feldspar. Other minerals include amphibole, biotite, pyroxene, an opaque mineral and olivine. Locally distinct pods are present, comprising almost entirely hornblende. In places, the shape of the outcrops suggests a crude layering. The 'layering' seems to be parallel to the foliation. In one fresh roadside outcrop at the eastern margin of the body, an indistinct banding can be seen, which may represent flowage at the intrusion margin.

Enclaves in the body vary from small pods to large rafts (one of which is at least 2 by 1 km in plan). The rock types in the enclaves include migmatized amphibolite, granodiorite to quartz diorite gneiss, foliated granitoid rocks of various compositions, and metasedimentary gneiss. A good example of screens of metasedimentary gneiss can be seen at the east side of the body. Especially noteworthy here is a sillimanite- and garnet-bearing, ochreous-weathering schist and an extremely garnetiferous rock having a green matrix. A concordant contact with country-rock orthogneiss and foliated granitoid rocks is exposed at the same locality.

The mineral assemblage in the Lower Pinware River pluton has been described by Bostock (1983) as mesoperthitic alkali-feldspar (about 75 percent), sodic-plagioclase, minor quartz, pale green clinopyroxene, orthopyroxene, hornblende, opaque minerals, biotite and accessory zircon, apatite, carbonate, and rare titanite and allanite.

Bostock (1983) considered, but rejected, the possibility that the Lower Pinware River pluton unconformably underlies the surrounding gneisses. In rejecting the unconformity hypothesis, he reasoned that the body had experienced a less complex metamorphic history than the surrounding gneisses. To this argument can be added the fact that the body lacks minor granitoid intrusions, suggesting that it postdates other granitoid intrusive activity in the area. Where K-feldspar is the only mineral, the rock appears massive, but if ferromagnesian minerals are present a foliation is obvious. In places, mafic minerals are elongated to thin veneers, attesting to a significant deformation parallel to the prevailing north-northwest regional trend. Such a foliation is absent from the 966 to 956 Ma plutons in the Interior Magmatic Belt, and it seems probable that the Lower Pinware River pluton is earlier. Despite the large error reported, the nominal 1090 Ma Rb–Sr date reported by Chubbs (1988) may be close to correct.

Fox Pond Alkali-Feldspar Syenite

A syenite body in the northwest part of the area, previously mapped by Bostock (1983), is here termed the Fox Pond alkali-feldspar syenite and depicted in Figure 2 as a crescent-shaped intrusion. The northeast and southeast boundaries are constrained from field data and aeromagnetic patterns, but there is very little control on the outline of the remainder of the body. The rock is very distinctive, forming bouldery, buff-brown, very weathered outcrops fringed by white- to yellow-feldspar sand. The rock consists almost entirely of alkali feldspar, up to about 1 cm across, where not recrystallized. Interstitial minerals include green pyroxene (aegerine?), amphibole, and an opaque mineral. Quartz in an accessory mineral in a few outcrops. The unit is moderately to strongly foliated and, where recrystallized, has a fine- to medium-grained granular appearance.

Other Alkali-Feldspar Syenite Bodies

Two smaller bodies of lithologically similar alkali-feldspar syenite were mapped south of the Lower Pinware River intrusion and are assumed to be satellites of the main body, but they may be unrelated. A small body of alkali-feldspar syenite is shown west of Black Bay. It has been included with this unit for want of a better choice, but it need not be closely related.

North-Central Area Granites

Coarse-grained, pale-pink or creamy-buff-weathering, medium- to coarse-grained, weakly to moderately foliated granite to alkali-feldspar granite in the northern part of the map area has been distinguished as a separate unit because: (i) there are textural differences, (ii) the rocks appear to be only slightly recrystallized, and (iii) enclaves of foliated, fine- to medium-grained granitoid rocks were found in the granite at some outcrops, indicating that these rocks postdate some deformation. The elliptical body of this unit indicated 8 km west of Outside Big Pond is largely pegmatite and is assumed to be a late differentiate of the granite, but may be unrelated.

Upper Beaver Brook Quartz Monzonite to Granite

The Upper Beaver Brook quartz monzonite to granite consists of two lobes of differing composition. The northerly trending western lobe is largely alkali-feldspar granite, in contrast to the northeast lobe, which is mostly quartz monzonite. Both lobes show similar textures and deformational effects, and for these reasons are grouped together under a single pluton name; however, two bodies may exist, and so the two lobes have been described separately below.

Bostock (1983) shows a much larger area to be underlain by these rocks, mainly because the Stokers Hill granite (see below) was also grouped with the Upper Beaver Brook intrusion. More detailed mapping, this year, suggests that the Stokers Hill granite is not part of this unit. The Stokers Hill granite is unrecrystallized and massive, whereas the Upper Beaver Brook intrusion is partially recrystallized and weak to moderately foliated. Fine- to medium-grained, recrystallized quartzofeldspathic rocks also separate the two bodies.

The western lobe of Upper Beaver Creek quartz monzonite consists mostly of granite to alkali-feldspar granite, but there is gradation to quartz monzonite in places, especially on the eastern side of the body. The rocks are white-, pink-, buff-, red- or brown-weathering, massive to moderately foliated, homogeneous, coarse grained (locally medium grained), and recrystallized in part. K-feldspar ranges up to 3 cm long and may be euhedral, subhedral or anhedral. Mantled feldspar textures are locally evident, commonly shown as plagioclase cores surrounded by K-feldspar. Mafic minerals are hornblende and biotite. Enclaves of dark-weathering, medium-grained, recrystallized leucoamphibole were observed at one locality. A few narrow granitic veins intrude the unit, especially in its northern part.

Fabric ranges from non-existent to obvious and is mostly north trending. It is defined by alignment of mafic minerals and/or elongation of feldspar and quartz. It is perhaps more marked adjacent to the margins of the body.

The eastern lobe of the Upper Beaver Brook intrusion is mostly quartz monzonite (Plate 9), but, rarely, is granite or quartz syenite. The rocks are white-, creamy-, pink-, buff- or brown-weathering, weakly to strongly foliated, generally homogeneous, mostly coarse grained and partly recrystallized. Locally, there are zones of alternating coarse and medium grain size. K-feldspar is up to 3 cm long and generally subhedral. In places, the texture verges on megacrystic. Mantled feldspar textures are present in places, characterized by plagioclase cores and narrow to wide

Plate 9. *Upper Beaver Brook quartz monzonite. Overall the body is homogeneous, but weakly to moderately foliated and recrystallized, and is suspected to be a syn- to late-Grenvillian intrusion; on Pinware River 16 km northwest of Red Bay.*

K-feldspar rims. Some more complex mantling is locally evident, involving up to five alternations of plagioclase and K-feldspar. Hornblende is the dominant mafic mineral and is invariably accompanied by biotite, but clinopyroxene and possibly also orthopyroxene may be present. Most of the rocks are weakly foliated but, especially near the margins of the intrusion, foliations are better developed. Some minor medium- and fine-grained granite intrusions occur sporadically.

Enclaves, ranging from large rafts over a kilometre long down to being almost equal in grain size to the host quartz monzonite, are common and include supracrustal rocks, foliated granitoid rocks and medium- to coarse-grained mafic rocks. The large raft of supracrustal rocks straddling the Pinware River was described earlier. Enclaves of supracrustal rocks were also found where traverses crossed the northeast border of the body, and are well exposed where the northern margin is transected by the Pinware River. Supracrustal rock types present include calc-silicate rocks, amphibolite, fine-grained quartzofeldspathic rocks and rare pelitic rocks. Lensoid shapes in one sample are particularly suggestive of a felsic volcanic protolith. The enclaves of foliated granitic rock are generally fine grained, rather structureless and generally non-descript.

Two large bodies of mafic rock and one smaller body are associated with the eastern lobe of the Upper Beaver Brook quartz monzonite; only the two larger bodies are shown on Figure 2. One is shown by Bostock (1983) and our information is based on the same two outcrops (west of Beaver Brook) that are indicated on his map. The rock is a brown- to black-weathering, homogeneous, medium-grained, foliated metagabbronorite composed of orthopyroxene, clinopyroxene, hornblende and large poikilitic biotite crystals, although foliated, primary, subhedral to euhedral plagioclase is still evident. K-feldspar occurs in the cores of some of the large plagioclase grains. The gabbronorite is intruded by minor granitoid dykes.

The mafic body about 10 km to the east shown on Figure 2 consists of white-, grey-, brown- or black-weathering, medium- to coarse-grained, homogeneous, partially recrystallized leucogabbronorite. Most of it is massive to weakly foliated but, in contact with the Upper Beaver Brook quartz monzonite, the rock is fairly strongly foliated. An impression is gained in the field that the quartz monzonite—leucogabbro contact probably is sharp, but irregular and complex. Primary texture is well preserved, especially euhedral plagioclase laths between 0.5 and 1.0 cm long. Mafic minerals are pyroxene, amphibole, and biotite. K-feldspar is present as interstitial grains. The rock is intruded by minor granitoid dykes.

The small body of mafic rock is at the southeast end of the Upper Beaver Brook quartz monzonite and is texturally distinct from the other two mafic rock occurrences. It is black-weathering, massive to weakly foliated, medium grained, has a felted ophitic texture and contains orthopyroxene, clinopyroxene, amphibole and plagioclase.

Picton Pond Quartz Monzonite and Granite

The Picton Pond quartz monzonite and granite forms a large body underlying at least 300 km^2 in the southwest part of the area. It is partly obscured by unconformably overlying Lower Cambrian sediments and the intrusion extends an unknown distance into Quebec. This investigation has broadly confirmed the outline of the intrusion as mapped by Bostock (1983), but did not substantiate his internal lithological divisions.

Most of the body consists of hornblende quartz monzonite, grading into granite in places. Apart from compositional variation between monzonite and granite, the body is uniform. The hornblende quartz monzonite is pink-, white- or buff-weathering, coarse grained and generally massive. Grain size of the major minerals usually ranges between 0.3 and 1.5 cm, but some feldspar crystals reach about 3 cm long. A particularly distinctive textural feature is the presence of anhedral mantled feldspars. These either have the form of a plagioclase core, mantled by K-feldspar, or have a K-feldspar core, an internal mantle of plagioclase and a rim of K-feldspar. Quartz and mafic minerals are interstitial to feldspar. Hornblende is the dominant mafic mineral, but biotite, chloritized in part, is also common. The granitic variant of the intrusion is texturally similar.

Although most of the intrusion is coarse grained and massive, feldspar grain boundaries are locally recrystallized to fine- to medium-grained white aggregates (suspected to be albite). A weak to moderate northwest-trending foliation is evident sporadically. The mantled feldspar textures suggest that the Picton Pond quartz monzonite should be grouped with the late- to post-Grenvillian intrusions, but it has been included with the syn- to late-Grenvillian intrusions on the basis of its slight recrystallization and local fabric.

Minor intrusions are generally rare in all parts of the Picton Pond intrusion, being confined to a few medium-grained quartz monzonite dykes or quartz-rich veins. Some of the quartz monzonite dykes show a weak foliation. Enclaves are common in some parts of the body and consist mainly of either foliated amphibolite or fine-grained foliated syenitic to granitic rocks, typical of those in the surrounding country rocks.

Late- to Post-Grenvillian Plutons

Lac Senac Granite

The name 'Lac Senac granite', taken from a lake in Quebec, is informally given here to a massive, unrecrystallized pluton at the western edge of the map region. The pluton is estimated to be about 20 km wide, of which only the eastern fringe is in Labrador. The outline of the remainder of the body in Quebec is shown on the map of Avramtchev (1983). Bostock (1983) mapped the eastern third of the body and divided it into an 3- to 4-km-wide exterior zone of quartz monzonite to granite, and a core of granodiorite to quartz monzonite.

In Labrador, the Lac Senac granite consists of white- to pink-weathering, coarse-grained quartz monzonite, locally grading into granite. The rock is homogeneous; it lacks minor intrusions, but does contain a few fine-grained quartzofeldspathic and amphibolite enclaves. A noteworthy feature of the body is the presence of a very obvious horizontal fracture set (Plate 10). Feldspar crystals are up to 3 cm long and quartz grains up to about 1 cm across. The rock shows well-developed, mantled-feldspar textures having K-feldspar cores, a middle zone of plagioclase and a rim of K-feldspar. The texture is very similar to that seen in the Picton Pond quartz monzonite and the Upper St. Paul River (east and west) quartz monzonites (Gower *et al.*, 1993). The rock contains both biotite and hornblende and has a higher abundance of opaque minerals than is typical for quartz monzonite.

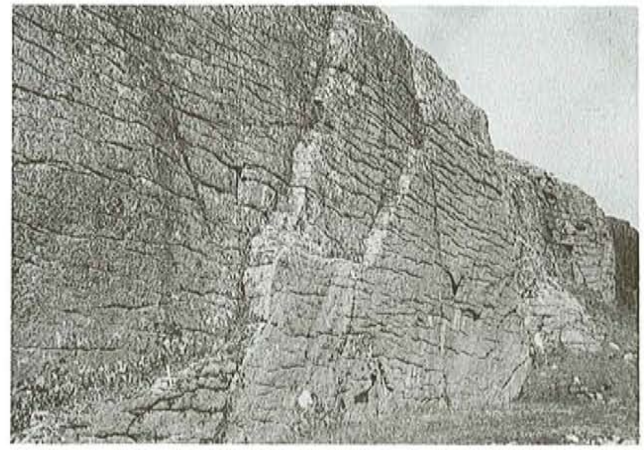

Plate 10. *Spectacular horizontal jointing in the posttectonic Lac Senac granite, perhaps indicating proximity to the roof of the intrusion; 15 km west of Stokers Hill.*

Plate 11. *Stokers Hill granite; a coarse-grained, massive late- to post-Grenvillian granite; Stokers Hill.*

Stokers Hill Granite

Stokers Hill granite is a new informal name given to a small granite pluton underlying the high ground in the west-central part of the map area (Figure 2). It was not separately identified by Bostock (1983), who included as part of his Unit Hqm-h. On the basis of foliation attitudes in the surrounding rocks, the walls of the pluton dip outward. The west side of the body is interpreted as faulted because of a distinct, straight photolineament in the area and breccia seen at the contact of the body. That the granite is a discrete body is evident from mapping out its contacts and from its circular aeromagnetic signature, as it forms a distinct high, contrasting with the surrounding rocks.

The granite (grading to alkali-feldspar granite) is pink- to buff-weathering, massive, coarse to very coarse grained, and completely homogeneous within individual outcrops (Plate 11). There is an increase in grain size toward the centre of the body. The rock consists mostly of K-feldspar and quartz with lesser plagioclase. Biotite is the main mafic mineral, but minor hornblende is also present. In places, K-feldspar grains are up to about 2.5 cm and quartz grains up to about 1 cm, although more commonly both minerals are about half this size. The granite lacks enclaves and minor granitic intrusions.

Neoproterozoic to Lower Cambrian

Long Range Dykes

Only one Long Range dyke was located in the area. It is exposed on Beaver Brook. The rock is a rusty-weathering, medium- to coarse-grained, massive, fresh gabbro. The dyke trends at 032° and is at least 3 m wide. The dyke is regionally on strike with a major Long Range dyke mapped in the Port Hope Simpson map region by Gower *et al.* (1987, 1988a) and is presumably an extension of the same intrusion, although the next known outcrop to that on Beaver Brook is over 100 km to the northeast. Plagioclase occurs as euhedral, unrecrystallized crystals and clinopyroxene forms anhedral grains interstitial to plagioclase. The dyke is intruded by a fine-grained dykelet that trends west-northwest, is 3 to 4 cm wide and is grey- to rusty-weathering.

Lighthouse Cove Formation and Feeder(?) Dykes

The Lighthouse Cove Formation is spectacularly exposed in the Henley Harbour area, where it forms flat-topped hills known locally as the Devil's Dining Table. Bostock (1983) described the formation as consisting of a single flow about 20 m thick divisible into a lower columnar part and an upper hackly fractured part. He also recorded the presence of 12 m of red-brown, horizontally bedded, arkosic sandstone in the area. Wanless *et al.* (1974) report K–Ar whole-rock ages of 411 ± 17 Ma and 421 ± 17 Ma. The averaged, recalculated age is 424 ± 17 Ma. It has been assumed that the Henley Harbour flows are correlative with basalt at Canada Bay. As the latter are overlain by fossiliferous Cambrian strata, it is implied that the Henley Harbour ages are too young (Bostock, 1983).

A group of 8 dykes was mapped on the coast halfway between Wreck Cove and Henley Harbour. These dykes are much finer grained than any of the previously described mafic intrusions and are provisionally considered to be unrelated to them. The dykes are straight-sided, consistently east trending, and dip to the north at about 70°. In the field, although locally having hematite- and epidote-filled fractures, they appear to be fresher than any of the previously described dykes. Two dykes dated by the K–Ar method from this area (Wanless *et al.*, 1974), yielded ages of 566 ± 22 Ma and 553 ± 21 Ma to give an average age of 569 ± 22 Ma (recalculated). A dyke found at the northern tip of the island on which Henley Harbour is situated is petrographically similar, east-trending and steeply north dipping. Given the close proximity of these dykes to the volcanic rocks of the Lighthouse Cove Formation at Henley Harbour, and the petrographic similarity of the dykes to the mafic lavas, it seems likely that these dykes as feeders to the Lighthouse Cove basalt. That the Lighthouse Cove basalt might have been fed from east-trending dykes, rather than the north-northeast-trending Long Range dykes swarm is a new interpretation, and one that requires further examination.

Bradore Formation

The most thorough study of the Bradore Formation in Labrador completed to date is that of Hiscott *et al.* (1984), who include a comprehensive bibliography. They subdivide the Bradore Formation into three members. The Blanc-Sablon member forms the basal 30 m and is a pebbly, subarkosic, trough and planar-tabular crossbedded sandstone and pebble conglomerate. This is succeeded by the Crow Head Member, which comprises 20 m of texturally similar sandstone, but containing abundant vertical burrows that obliterate all primary structures. The upper 10 m is termed the L'Anse-au-Clair member and comprises quartzose coarse sandstone with polymodal trough and planar-tabular crossbed orientations. They conclude that the Blanc-Sablon member represents braided-fluvial deposits and the succeeding members are esturine and nearshore sandstones. The sedimentary rocks are the product of rapid denudation of a barren interior under tropical conditions.

Forteau Formation

The following information on the Forteau Formation is taken from James and Kobluk (1978), but, for more recent references and regional tectonic context, the reader is referred to James *et al.* (1989). The Forteau Formation comprises flat-lying limestones, siltstone and shales. The lower 3 to 4 m consist of poorly bedded to nodular dolomitized calcarenite and interlaminated shale, grading up into archaeocyathid-rich patch reefs, calcarenites and silty shales averaging about 20 m thick. This is overlain by 18 to 20 m of interbedded calcareous and dolomitic siltstone and shales, characterized by abundant ichnofossils. The uppermost sequence is a complex of oolite shoals and mounds up to 12 m thick. On the basis of paleonotological evidence, the Forteau Formation is latest Early Cambrian.

STRUCTURE

The structural geometry of the area is the product of multiple deformation. Clearly, there was an early period of severe deformation and high-grade metamorphism that generated the fabrics and migmatitic textures in the metamorphosed supracrustal rocks and the foliated, recrystallized granitoid units. These fabrics are truncated by various types of mafic dykes that are themselves metamorphosed.

The Upper Beaver Brook quartz monzonite and several other plutons have northwest- to west-trending foliations of varying intensities, and it is suggested that the intrusions were emplaced syntectonically at different stages during the event. A low angle of obliquity between this fabirc and the earlier one makes discrimination between them difficult. The inverted V-shape of the Upper Beaver Brook quartz monzonite may mean that it has been folded. Late west-northwest-trending fabrics may be linked to this folding. Note also that there is little petrographic difference between the southwestern part of Upper Beaver Brook quartz monzonite and the part of Picton Pond quartz monzonite northwest of a major northeast-trending fault through the latter body. It is possible, therefore, that this part of Picton Pond intrusion is really part of the Upper Beaver Brook body, giving it an S-shape overall.

Closer to the coast, northwest trends are less apparent, being replaced by northeast directions. The complex trends in a broad swath through Pinware, Country Cat Pond and Outside Big Pond may be the result of fold interference. In the district north of the coast between Black Bay and Green Bay, foliation trends are consistently northwest in some areas and northeast in others. This suggests the presence of arcuate ductile faults. The faults are located within major, steep-sided valleys and their existence derives some support from aeromagnetic patterns. Our traverses, apart from along the coast, were done in the high, barren areas away from the wooded and less well-exposed valleys, reducing opportunities for direct observation of any fault structures that might be present. Given the relatively shallow southeast- and northeast-dipping foliations on the southeast or northeast sides of the interpreted faults, the faults may be west-verging thrusts. The coastal outcrops attest to severe deformation and northwest-verging, tight, overturned folds (Plate 12), but broad zones of mylonite, forming obvious domain boundaries, were not observed.

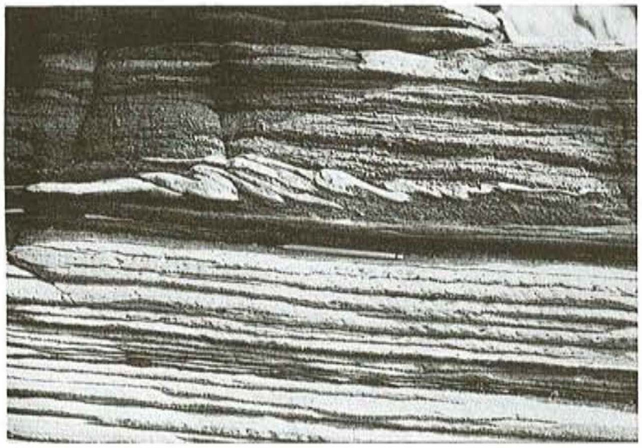

Plate 12. *Flat-lying, fine- to medium-grained quartzo-eldspathic rocks. Although thought to be derived from a sedimentary protolith, the intense deformation, as indicated by the overturned, isoclinal folds, makes this interpretation equivocal; Green Bay.*

Fabric orientations in foliated to gneissic granitoid rocks have clearly been modified by the emplacement of later plutons. The most obvious example is marginal to the Lower Pinware River alkali-feldspar syenite, where units, and their foliations, surrounding the syenite are concentric to the margin of the body. A similar re-orientation of foliations is evident marginal to the Stokers Hill and Lac Senac intrusions although much less marked, probably because they were emplaced into higher level, less ductile crust.

The geometry of the region has been modified by brittle faults, mainly having north-northwest and northeast trends. In some cases, fault breccia associated with the faults is well exposed. A good example is on the south side of Red Bay, where angular blocks of heavily jointed mafic rock characterized by hematite-filled veins with slickensided margins are common. Chlorite alteration, silicification, hematite and epidote are abundant throughout. The greenschist-facies assemblage indicates relatively shallow level. As indicated by offsets along pegmatite veins, the brittle movement was sinistral along discrete shear planes.

Bostock (1983) interpreted numerous faults transecting the Bradore and Forteau formations. A simplified pattern of faults, taken from their map, is shown on Figure 2.

METAMORPHISM

Bostock (1983), on the basis of thin-section studies, subdivided the region into a granulite-facies terrane west of a north-northwest-trending line passing just to the east of Red Bay, and an amphibolite-facies terrane farther to the east. Hypersthene was recognized as a sporadic mineral in some of the gneissic rocks, which are also characterized by mesoperthite. Our field observations have broadly confirmed that pyroxene-bearing foliated to gneissic granitoid rocks are most common in the western part of the region. On the basis of many new discoveries of pelitic rocks made during the present mapping, it appears that the facies boundary of Bostock (*op. cit.*) is also roughly the boundary between sillimanite (to the west) and muscovite-bearing assemblages.

ECONOMIC POTENTIAL

The Pinware map region offers several previously unrecognized mineral exploration targets, namely (i) supracrustal rocks, (ii) alkalic recrystallized granitoid rocks (iii) layered mafic intrusions, (iv) posttectonic granites, and (v) pegmatites. In addition, there is potential for industrial-mineral resources.

The supracrustal rocks include both felsic and mafic volcanic units, the felsic rocks being by far the more abundant. Apart from two specks of molybdenite and minor malachite staining (locations given on Figure 2), no mineralization was found. As our objective was mapping rather than mineral exploration, this should not be regarded as discouraging. The metasedimentary rocks are commonly pyritic. In addition to malachite staining seen within the map area, similar staining was seen in correlative rocks north of Henley Harbour (Gower *et al.*, 1988b,c) that were revisited during the 1993 field season. Disseminated pyrite showings of note were found: (i) north of West St. Modeste, (ii) on the coast between Barge Bay and Green Bay, and (iii) on the mainland coast west of Henley Harbour. The showing north of West St. Modeste was briefly described by Penstone and Schwellnus (1953). They record three mineralized zones about a metre wide contain traces of arsenopyrite, chalcopyrite and molybdenite in addition to pyrite.

High lake-sediment Cu values spatially correlate with the mapped distribution of the supracrustal rocks in the northeast part of the area. Peak values occur south of Outside Big Pond—in the same area as a molybdenite occurrence. These supracrustal rocks also correlate with high U, Ag, Mo, Pb and, to a lesser extent, arsenic lake-sediment values.

Recent discoveries of nepheline- and aegerine-bearing alkali syenites in the Pinware terrane (Gower *et al.*, 1993; *this report*) offer a previously unsuspected mineral-exploration target in the eastern Grenville Province for rare-earth elements and radioelement mineralization. Admittedly, scintillometer readings taken so far are not encouraging, but, as no systematic surveys have ever been carried out, the spot readings may not be representative. Some of the high U lake-sediment values may be linked to alkali-rich granitoid rocks.

Layered mafic intrusions are not extensive in the Pinware region, but those that do exist should not be overlooked. Bostock (1983) reported that specimens, shown to him by local people, of chalcopyrite and ilmenite, were claimed to have been found in the drift near Red Bay. The Red Bay mafic intrusion is an obvious potential source, although lake-sediment Cu anomalies are north of, rather than over the body (in contrast to Co, Ni and V anomalies, which correlate directly with it).

Although there seems little reason to consider the syn- to late-Grenvillian(?) plutons to have significant mineral potential, this cannot be said of the posttectonic bodies. Bostock (1983) recorded fluorite in two samples of granite 25 km north-northwest of Red Bay. The locations, which correlate with a F lake-sediment anomaly, appear to be just to the east of the Stokers Hill granite, but are very close to its boundary. Also of interest are markedly anomalous Zn and Hg lake-sediment values over the Stokers Hill granite.

Pegmatites were the first rock type to attract prospectors interest in the Pinware area because many of them contain very high concentrations of magnetite. Hawley (1944) describes pegmatite dykes 8 km southwest of Red Bay containing pockets of magnetite up to about 1 m in diameter, and having individual grains of magnetite about 2 cm across. We did not examine this occurrence, but did collect samples from a similar pegmatite on the coast 6 km northeast of Red Bay. Although magnetite in pegmatite is not uncommon, these two localities (and many others in this area) are unusual in their high concentrations of the mineral. Another atypical pegmatite occurs at Red Bay, that is characterized by abundant, large allanite and titanite crystals.

Several pegmatites in the northeast part of the map region contain appreciable amounts of amazonite, a green alkali feldspar. The deepest-coloured and most abundant amazonite occurs in a coast-parallel, fluorite- and molybdenite-bearing pegmatite located halfway between Barge Bay and Wreck Cove, but several smaller showings were found farther north, especially in the Henley Harbour area. Gower *et al.* (1988b) reported that amazonite is also common in muscovite-bearing pegmatites along the coast between Henley Harbour and Battle Harbour.

Examples of possible non-metallic resources are as follows: (i) the short distance of the Picton Pond quartz syenite from existing infrastructure, its homogeneity, attractive colour and its mantled feldspar textures are reasons for evaluating it as a potential dimension stone, (ii) several parts of the shoreline in the northeast part of the area (e.g., north of Wreck Cove) expose well-cleaved, fine-grained quartzofeldspathic rocks that might be exploitable as slate, (iii) large sand and gravel deposits exist on the flanks of the lower part of the Pinware River valley, (iv) the Forteau Formation is a source for large quantities of building stone and road stone.

REGIONAL CONTEXT

Figure 4 places the study region in context with two previously mapped areas of the Pinware terrane. The following comments extend the discussion of Gower *et al.* (1993).

A point emphasized by Gower *et al.* (1993) was the lack of pelitic rocks in the Pinware terrane, especially when compared to the Labradorian (1710–1620 Ma; Gower *et al.*, 1992) terranes farther north. Mapping in the Pinware River region shows that, although this contrast is not so sharp as previously thought, it is still valid. Of particular interest are rocks suspected to be of felsic volcanic origin in the Pinware terrane, as such rocks are rare in Labradorian terranes.

Gower *et al.* (1993) noted that K-feldspar megacrystic rocks associated with pelitic gneisses are characteristic of the Lake Melville terrane, whereas this association is not seen in the Pinware terrane. Small areas of megacrystic rocks exisit in the Pinware region, but the megacrystic rocks are neither obviously associated with pelitic rocks nor do they show close textural resemblance to those farther north, and there is little reason to suggest a temporal correlation.

One of the most diagnostic features of the Pinware terrane is the vast amounts of alkali-rich granitoid rocks, including newly discovered nepheline- and aegerine-bearing alkali-feldspar syenite. Such rocks are not present in the Labradorian terranes to the north. Some Pinware terrane deformed granitoid rocks have been dated between 1500-1470 Ma (Tucker and Gower, *in press*), but it is not clear if this age span brackets all the severely recrystallized granitoid rocks in the Pinware terrane.

Mafic intrusive rocks are not an important element of the Pinware terrane in contrast to Labradorian terranes. The large Kyfanan Lake layered mafic intrusion described by Gower *et al.* (1993) is an exception, but so is its tectonic position (at the probable interface between the Pinware and Mealy Mountains terranes).

Finally, the Pinware terrane is also characterized by abundant relatively weakly deformed plutons. Some of these are known to be posttectonic with respect to Grenvillian orogenesis, having been emplaced between 966 and 956 Ma. It is also clear, however, that earlier plutons are present that experienced some deformation, but escaped the high-grade metamorphic event responsible for the recrystallization, migmatization and strong fabric development in the alkali-rich granitoid rocks. Collectively, the plutons are relatively weakly deformed, but there are differences in fabric between adjacent plutons, which suggests that they were not all emplaced at the same time. Tucker and Gower (*in press*) present data indicating granitoid magmatism at ca. 1145 Ma, but it remains to be determined if this is a generally applicable age.

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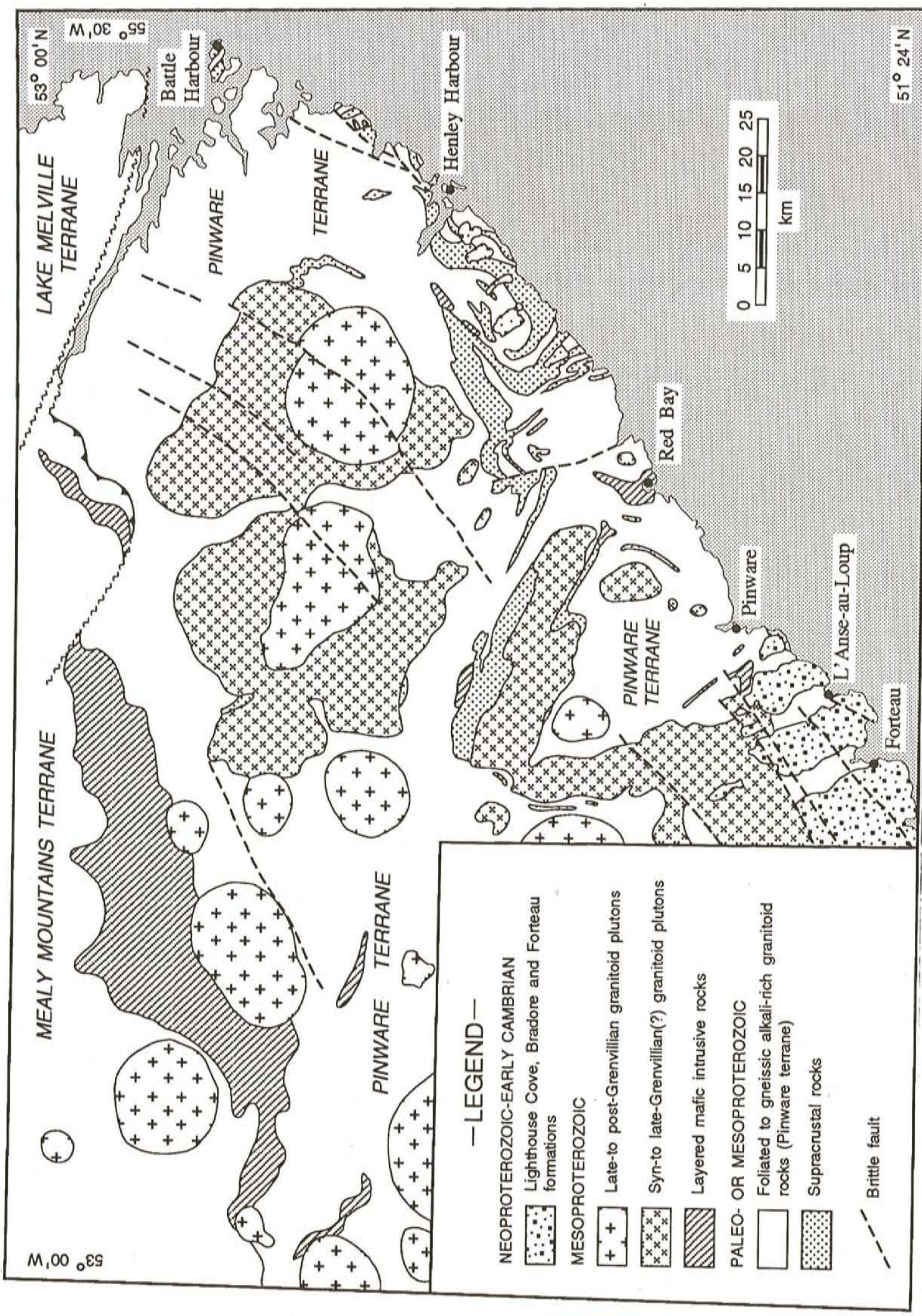

Figure 4. *Regional geological map of part of the Pinware terrane in southeast Labrador.*

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