GEOLOGY OF THE PARADISE RIVER REGION, GRENVILLE PROVINCE, EASTERN LABRADOR

Project J.1.9.2.

by

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ABSTRACT

The Paradise River region is located in the Lake Melville terrane of the Grenville Province, eastern Labrador. Four major lithological associations were mapped, namely (i) orthogneiss, (ii) metasedimentary gneiss, (iii) anorthositic-gabbroic-monzonitic rocks, (iv) granitoid plutons. Orthogneiss is found in discrete belts that flank, or occur within granitoid plutons, and above thrusts. It is, at least in part, the tectonized equivalent of the granitoid plutons. Metasedimentary gneiss is dominated by biotite-sillimanite-garnet bearing pelites, but psammitic gneiss, quartzite and calc-silicate rocks are locally present. Most anorthositic-gabbroic-monzonitic rocks are grouped as the White Bear Arm complex, which shows well preserved primary fabrics in its interior but has a highly tectonized, thrust-bound margin. A sheet of recrystallized anorthosite also occurs in the southwest quadrant of the study area. The granitoid plutons are divided into two groups, namely (i) diorite, monzonite and granodiorite belonging to the Earl Island domain (of the Groswater Bay Terrane), (ii) an intergradational plutonic package of megacrystic and non-megacrystic granodiorite, monzonite, granite and alkali-feldspar granite mostly in the Lake Melville terrane. In addition to these lithological associations, other rocks mapped include mafic intrusions of various ages, including Lower Phanerozoic north-northeast trending mafic dikes.

The regional structure is controlled by two major northwest trending zones of ductile deformation, and the thrust-bounded White Bear Arm complex. The departure of structures in the central and northwest parts of the region from the regional northwest trend is attributed to the collective effects of the strike dip and thrust faults. This interpretation is extended to a regional structural synthesis of the Lake Melville terrane. Faulting related to the newly recognized Sandwich Bay graben has little effect on earlier structural patterns.

Prospects for economic mineralization appear to be confined to sulfide-rich zones in metasedimentary gneiss, radioactive granitoid rocks and mica-rich pegmatite.

INTRODUCTION

A major 1:100,000 scale reconnaissance mapping program in the Grenville Province of eastern Labrador commenced in 1979 in the Makkovik Province and adjacent northern fringe of the Grenville Province and between 1979-1984 regional mapping coverage has gradually advanced southward. Mapping in the Paradise River region in 1984 (outlined in Figure 1), represents an extension of that coverage, and at the same time the start of a new 5-year Canada-Newfoundland joint project that will complete 1:100,000 scale geological mapping of an 80 km wide coastal fringe of the Grenville Province in eastern Labrador.

The Paradise River region comprises four NTS 1:50,000 sheets (13H/3,4,5,6) which encompass an area of approximately 3700 km^2. The only previously published geological map which includes the whole of the map area is that of Eade (1962) at 1:500,000 scale. Eade showed the area to be underlain mainly by granitic gneiss, lesser metasedimentary gneiss, granite to granodiorite plutons, and gabbroic to anorthositic intrusions. More recently, much of the northern part of the area was re-examined by Cherry (1978a,b). Cherry depicted the area as largely underlain by schlieric migmatite gneiss with the distribution of metasedimentary gneiss essentially unchanged from Eade's map.

Mineral exploration has been carried out intermittently by BRINEX Ltd. Initial geological mapping and mineral potential evaluation was carried out in 1954 by (Piloski, 1955) who recommended the area as favourable for U, Cu, Ni and Au mineralization. Airborne magnetic and electromagnetic surveys were flown in 1959 (Wilson, 1959) and a combined geological, lake sediment geochemical, ground electromagnetic and prospecting program was undertaken in 1965. Results are summarized in a report by Sutton (1965) with appendices by Juilland (geology), Meyer (geochemistry), Staub (ground geophysics), and Cote and Anderson (laboratory methods). Active interest by Brinex ceased after further reconnaissance geological mapping by Kranck (1966) although the Ni potential of the region was subsequently reviewed for BRINEX by Westoll (1971).

This project is a contribution to the Canada-Newfoundland Mineral Development Agreement.

The present mapping, benefit from complete aeromagnetic map coverage (Geological Survey of Canada, 1974a,b,c,d,e) and mapping experience gained in similar rocks farther north (Gower et al., 1981, 1983a,c; Owen et al., 1983). Mapping has resulted in considerable refinement of rock type distribution and protolith identification, and has permitted an initial attempt at regional structural synthesis of the Lake Melville terrane.

REGIONAL SETTING

The study area is situated entirely within the Grenville Province and, except for the northeast corner, is an extension of the Lake Melville terrane (Gower, 1984; Gower and Owen, 1984). The northeast corner of the map area, a lithologically distinct part of the Groswater Bay terrane, is informally referred to in this paper as the Earl Island domain. The location of the study area and major (litho) tectonic subdivisions recognized in the Grenville Province of Labrador are shown in Figure 1. Ornamentation in Figure 1 is intended to depict lithotectonically correlative regions, although names of (litho) tectonic subdivisions are those used locally. Further reference is made to these areas with respect to structural synthesis.

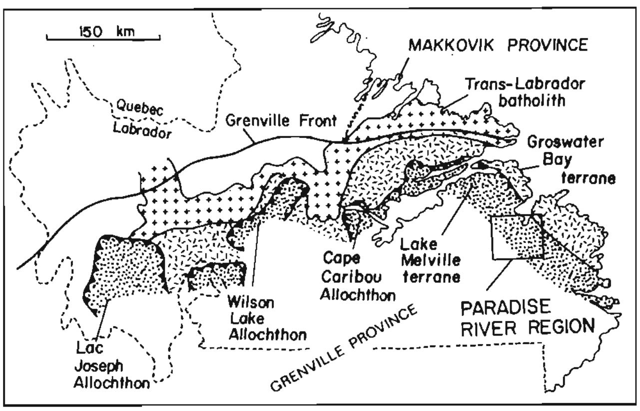

Figure 1: *Major structural features of the Grenville Province, Labrador. Distribution and names of allochthons in central and western Labrador are from Ryan et al. (1982), Rivers and Nunn (in press) and Thomas et al. (in press). Location of paradise River region outlined.*

DESCRIPTION OF ROCK UNITS

Orthogneiss

All rocks mapped as orthogneiss are located in the western half of the study area and occur as narrow belts less than 4 km wide. These are marginal to other rock types, especially granitoid plutons, or to major structures such as thrusts. In Figure 2 the orthogneisses have been subdivided into three units but all have, in part, a well-banded, migmatitic aspect. The units are entirely intergradational, hence no boundaries are drawn on the map. Undoubtedly, in detail, the interfingering of the various orthogneiss types is more complex than shown but even where outcrop permits we do not believe that more detailed mapping will significantly change the regional distribution patterns depicted. These rocks are not necessarily the oldest in the area, as will become clear in the ensuing description.

The biotite hornblende granodiorite-diorite-amphibolite unit is characterized by ubiquitous hornblende. The amphibolites are amphibole-plagioclase±pyroxene rocks with local orthopyroxene bearing leucosome patches (Plate 1). They have a strongly foliated, lensy to well-banded appearance. The most extensive amphibolitic gneiss occurs marginal to a thrust northeast of Crooked Lake (Figure 2). The gabbroid rocks on the hanging wall of the thrust are amphibolite in part and it is quite probable that the underlying amphibolitic gneiss simply represents similar rocks which have experienced more intense strain and migmatization in a series of structurally lower thrust slices. Amphibolitic gneiss elsewhere is mostly restricted to single outcrop; rarely seen local discordance to an earlier fabric demonstrates that these gneisses are highly deformed mafic dikes.

The dioritic and hornblende-bearing granodiorite gneisses are medium grained, migmatitic, variably banded rocks. Northeast of Crooked Lake, these gneisses separate the amphibolites and quartzofeldspathic gneisses and are interpreted to result from the thorough interleaving and migmatization of the amphibolitic and quartzofeldspathic protoliths. Elsewhere, these gneisses occur in areas commonly less than a few km^2 and are interpreted as small deformed plutons or tectonized margins of larger hornblende-bearing intrusions.

Biotite granodiorite gneiss is the most extensive orthogneiss rock type. It is a creamy weathering, medium grained, weakly to well-banded rock, locally with common amphibolite lenses and crosscut by discordant minor granitic intrusions. Garnet occurs sporadically. The unit also includes minor tonalite, quartz diorite and quartz monzondiorite gneiss.

Biotite granite gneiss occurs as a pink to red weathering, fine to medium grained gneiss, locally with biotitic schlieren or amphibolite layers, which occurs principally in the central part of the map area. The unit is probably derived from minor

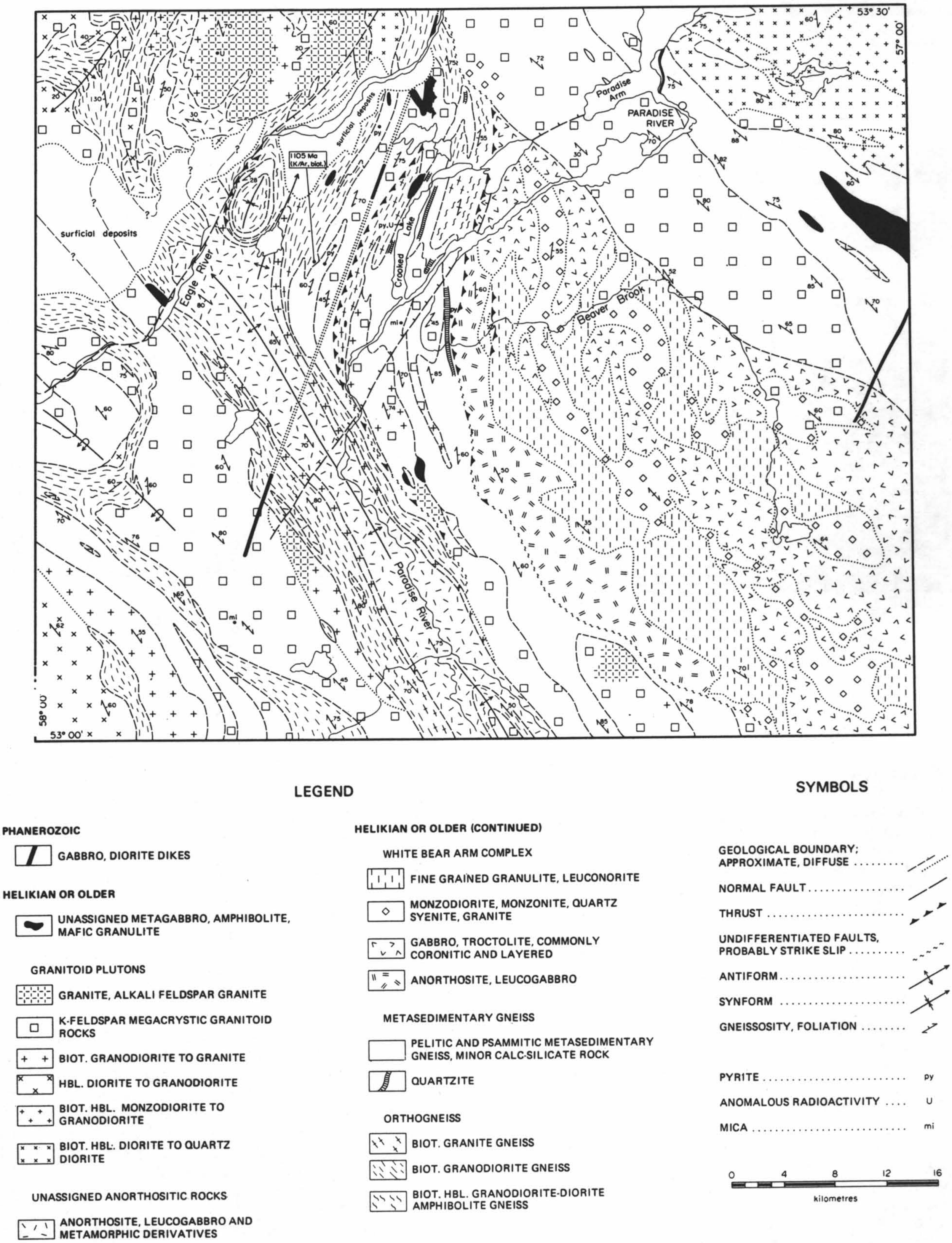

Figure 2: *Geology of the Paradise River region.*

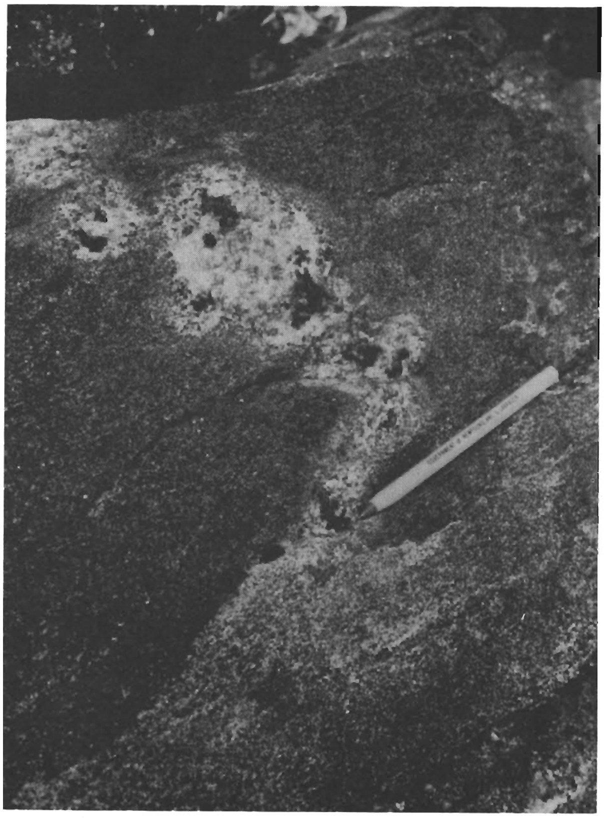

Plate 1: *Orthopyroxene in quartzofeldspathic leucosome patches in amphibolite associated with orthogneiss.*

granitoid intrusions or, less likely, arkosic metasediments.

Metasedimentary Gneiss

Metasedimentary gneiss occurs in three major linear zones in the northeast, central and southwest parts of the map area. All are dominated by sillimanite-garnet-biotite pelitic and semi-pelitic gneiss, but psammitic gneiss, diatexite, quartzite, and, rarely calc-silicate rocks and mafic supracrustal rocks are present. Pelitic gneiss is characteristically rusty, creamy or gray weathering, medium grained and well-banded. It is migmatitic with a restite comprising fibrous or prismatic sillimanite, mauve garnet, biotite, graphite and magnetite and leucosome pods or fine laminations of quartz + plagioclase + K-feldspar (Plate 2). Muscovite, probably retrograde is locally present in the pelitic gneiss (especially north of the community of Paradise River) and may also be found in late discordant pegmatites within the paragneiss. White weathering diatexite with abundant garnet is particularly common in the southwest metasedimentary gneiss belt and is interpreted as a partial melt product from the pelitic gneiss. The psammitic gneisses are closely associated with the pelitic gneiss, differing mainly in having a slightly coarser grained, more sugary appearance and lacking sillimanite. Garnet is typically wine colored rather than the distinctive mauve as in the pelites.

Plate 2: *Sillimanite bearing metasedimentary gneiss showing tight folding and transposition of fold limbs.*

Quartzite is a major rock type in the central metasedimentary gneiss belt east of Crooked Lake (Figure 2). It was first reported by Piloski (1955) and subsequently mentioned by Eade (1962), Kranck (1966) and Cherry (1978a,b). Only Kranck made any attempt to show its distribution. The band shown on Figure 2 east of the south end of Crooked Lake corresponds to one of his mapped quartzite units. It occurs in white weathering, massive to thickly bedded layers interbanded with psammitic and pelitic gneiss. Although much of the unit is pure quartz it also contains magnetite, graphite, garnet, biotite and feldspar, especially in thin beds. Kranck also mapped quartzite just southwest of Crooked Lake. Present mapping indicates that quartzite is a subordinate rock in this area, occurring as thin beds within sillimanite-bearing pelitic gneiss. Quartzite is also found as thin layers associated with pelitic gneiss in the southwest metasedimentary gneiss belt and with probable mafic supracrustal rocks in the northeast belt.

The mafic supracrustal rocks are confined to one shoreline locality 4 km north of Paradise River (community). The rocks are fine grained amphibolites with epidote-plagioclase-diopside-grossularite pods and discontinuous melanocratic seams.

In less intensely metamorphosed and deformed rocks (e.g. some Archean greenstone belts) such calcic material and melanocratic seams can be identified as interpillow mesostasis and pillow margins respectively. A pillow-form mafic lava or hyaloclastite protolith may therefore be applicable to this locality. Similar rocks occur on the southeast shore of The Backway (see Gower et al., 1983b) and at Dead Islands (52°48'N, 55°55'W) (Gower, personal observation). These are the only known mafic supracrustal rock localities in eastern Labrador, and the occurrences appear to be confined to a single metasedimentary belt at the northern fringe of the Lake Melville terrane. As all three occurrences are shoreline outcrops it is possible that this recessive-weathering unit occurs inland and is a characteristic feature of this particular metasedimentary belt.

Fine grained schistose mafic rocks were also observed 4 km east of Crooked Lake, where the thrust crosses Paradise River. A mafic supracrustal protolith is conceivable for these rocks also, but their structural position, adjacent to a thrust, and association with tectonic enclaves of metamorphosed layered gabbro suggest derivation from a highly deformed metagabbro.

Calc-silicate rocks, noted previously by Eade (1962) and Cherry (1978a,b) are not abundant and were only observed on either side of the south end of Crooked Lake. The rocks consist of quartz + grossular/andradite + diopside + calcic plagioclase and most commonly are present as boudinaged pods.

White Bear Arm complex

The White Bear Arm complex (WBAC) is an informal name introduced here for an anorthositic-gabbroic-monzonitic layered intrusion and associated mafic granulite, the northwest end of which underlies much of the eastern part of the map area. The WBAC was first named White Bear Arm gabbro by Piloski (1955) and referred to as White Bear Arm norite and White Bear Arm pluton by Wardle (1976). The type locality is at White Bear Arm on the southeast Labrador coast. The continuity of the WBAC from the coast to the present area (approximately 125 km) was suggested by Piloski (1955). We have not examined the ground between the coast and the Paradise River map area, but by using geophysical data and earlier mapping it appears appropriate to apply the name in the Paradise River area. The WBAC is not well exposed and the distribution of the four lithological subdivisions shown in Figure 2 must be considered tentative.

The anorthosite/leucogabbro unit has been identified only on the southwest flank of the WBAC and is a white or grey weathering, medium grained recrytallized rock. The mineralogy consists of plagioclase, clinopyroxene, orthopyroxene and hornblende with minor garnet and quartz. Locally recrystallized clusters of mafic silicates attest to derivation from a much coarser-grained protolith. However, because of its position adjacent to a major thrust, intense deformation has obliterated original textures.

Gabbro-troctolite rocks were mapped mostly in the center zone of the WBAC and amphibolitic rocks, interpreted as metamorphosed equivalents, have been included under the same ornamentation in Figure 2. Amphibolite is most abundant on the northeast flank of the WBAC and at its northwest tip.

In the center of the complex, gabbroid rocks are massive and primary plagioclase, olivine, clinopyroxene and orthopyroxene are preserved. Well-developed double orthopyroxene-amphibole coronas marginal to olivine also occur. Igneous layering, rhythmic in places, is present, especially in the southeast corner of the study area. Retrogression of pyroxene to amphibole is evident, particularly in rocks injected by either pegmatite or quartz-feldspar veins, and in those rocks having a marked metamorphic fabric.

Rocks grouped in the legend as monzodiorite, monzonite, quartz syenite and granite are creamy-brown to pink weathering, fine to coarse grained rocks and grade into K-feldspar or plagioclase megacrystic varieties. In places the monzonite-syenite clearly intrudes earlier mafic rocks, producing an agmatite with well-defined reaction rims at felsic-mafic interfaces (Plate 3). Elsewhere the monzonites contain irregular mafic enclaves which show K-feldspar megacrysts rimmed by plagioclase and large quartz crystals identical to the host monzonite. Some of the enclaves have chilled margins (texturally distinct from the reaction rims alluded to earlier) and are almost certainly mafic dikes. These apparently contradictory intrusive relationships will be evaluated when petrographic data are available.

The "fine grained granulite, leuconorite" unit is shown as underlying large areas of the WBAC (Figure 2). However, because of the fine grain size and rectiplanar shape of many outcrops we suspect that they may be mafic dikes with a granulite facies mineralogy. As the fine-grained granulites occur as isolated, resistant outcrops without an intervening contrasting rock type we have little choice but to depict distribution as shown.

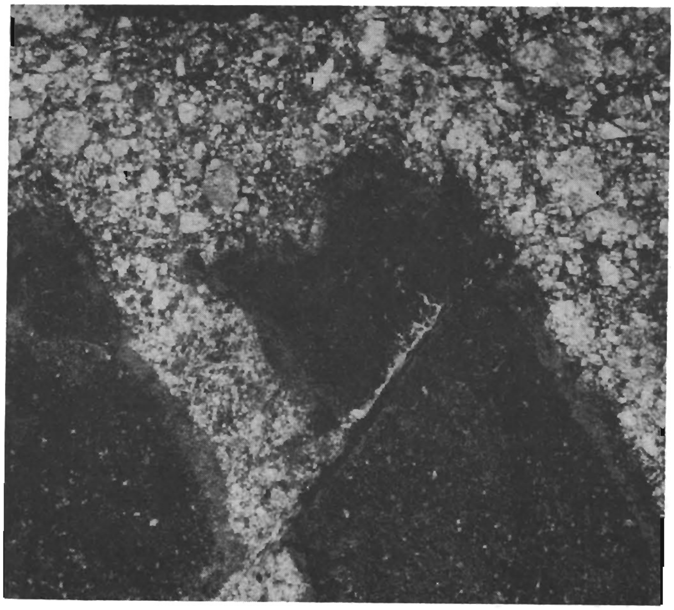

Plate 3: *Monzonite-syenite of White Bear Arm complex intruding earlier mafic rocks producing an agmatite with well-defined reaction rims of felsic-mafic interfaces. Reaction rims 2 cm wide.*

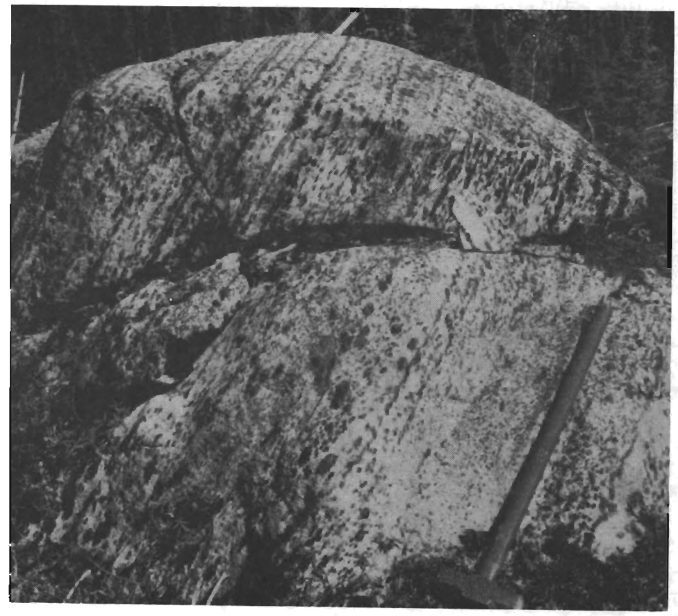

Plate 4: *Well-preserved primary layering in the unassigned anorthosite unit.*

Unassigned Anorthositic Rocks

Distinctive, recessive-weathering anorthositic rocks are well exposed between Eagle River and the southern map boundary. Northwest of Eagle River, because of thick surficial deposits, their distribution is larely conjectural. The rock type is white to grey weathering, medium grained, recyrstallized and commonly strongly foliated. It consists of plagioclase, amphibole, pyroxene, with minor garnet and biotite. Coarse grained to extremely coarse grained primary textures are preserved in places. Poikilitic crystals over a metre in diameter were seen on upper Paradise River and individual pyroxenes over 25 cm long are not unusual. Amphibole in places partially replaces primary pyroxene; elsewhere former primary mafic silicates are now aggregates of amphibole, epidote (rare) and biotite. Primary layering is well preserved at the nose of the antiform near the south boundary of the map area (Plate 4). The presence of biotite granodiorite gneiss and megacrystic granodiorite in the core of the antiform constrain the thickness of the anorthosite to a maximum of 3 km.

Identical rocks outcrop along Alexis River west of Port Hope Simpson (C. Gower, personal observation, 1984) and geophysical data indicate that this unit is continuous between Eagle River and the southeast Labrador coast.

Granitoid Plutons

The granitoid plutons are divided into two groups, namely (i) an association of relatively melanocratic diorite, monzodiorite and granodiorite belonging to the Earl Island domain in the northeast corner of the map area, (ii) an intergradational granodiorite to granite plutonic package subdivided into four units which occurs throughout the remainder of the map area.

The granitoid plutonic rocks of the Earl Island domain are medium grained, hornblende-biotite-plagioclase-quartz rocks with minor garnet and K-feldspar and are subdivided into two groups in Figure 2. Fabric varies from weakly foliated to gneissic, the latter being accompanied by a quartz-feldspar leucosome. Amphibolitic bands, probably representing deformed mafic dikes, are common. Quartz diorite is depicted north of lower Eagle River in Figure 2. These fine to medium grained recrystallized hornblende + biotite ± garnet rocks are mineralogically similar, but not obviously related to those in the Earl Island domain.

We describe the remaining granitoid plutons from northeast to southwest. The Paradise Arm pluton (new informal name), southwest of Paradise River (community), was first mapped on the Sandwich Bay 1:100,000 sheet area (Gower et al., 1983) and, with a length of at least 48 km, is the largest K-feldspar rich pluton mapped within the Grenville Province of eastern

Labrador. It is a medium to coarse grained K-feldspar megacrystic rock with a variable composition including granodiorite, granite, monzogranite or syenogranite. Much of this compositional range is due to variable megacryst abundance which locally exceeds 40% of the rock. Megacrysts exceed 7 cm long in places. Plagioclase also may occur as megacrysts, but rarely larger than 1 cm in diameter. Mafic phases are hornblende and garnet. The northeast side of the pluton is interpreted as a fault, based on a single mylonitized outcrop near Paradise River (community). The southwest side appears to be intrusive in the vicinity of Beaver Brook but close to Eagle River it is tectonic. There appears to be a complete lithological gradation between the monzonite of the White Bear Arm complex and the Paradise Arm pluton. Coupling this fact with their spatial juxtaposition leads us to suspect a genetic link.

The belt of granitoid plutons crossing the central part of the map area comprises dominantly K-feldspar megacrystic rocks. Specific granitoid types include granodiorite, monzogranite, granite and alkali feldspar granite. These rocks differ from the Paradise Arm pluton in having smaller K-feldspar megacrysts and lacking plagioclase megacrysts. The rocks are fine to medium grained, recrystallized, pink, creamy or brownish weathering rocks with biotite ± hornblende ± garnet as mafic phases. At many localities the rocks are strongly deformed, even mylonitic, and some rocks mapped as orthogneiss in the region are almost certainly extremely deformed and migmatized equivalents. For example, we infer that the biotite granodiorite gneiss on the hanging wall of the thrust west of Crooked Lake is correlative with the adjacent granitoid pluton and that the thrust transects a pluton that was formerly continuous across the map area.

The granitoid plutons in the northwest corner of the map area can be divided into two groups, alkali-feldspar granite in the east and amphibole-bearing K-feldspar megacrystic granitoid rocks farther west. The alkali-feldspar granite is a pink weathering, coarse grained rock with biotite schlieren, amphibolite enclaves and a few syenitic to granitic late stage dikes. It has a distinct radioactive element signature with total scintillometer counts usually 3 times normal background (200 cps) for such rocks and on one outcrop 20 times background.

The megacrystic granitoid plutons in the northwest corner consist of buff to pink weathering, medium grained, recrystallized biotite hornblende granodiorite to granite. Similar rocks were mapped in the Sandwich Bay 1:100,000 sheet (Gower et al., 1983) and are probably regionally correlative with those in the Paradise River area.

The large K-feldspar megacrystic granitoid pluton in the southwest part of the map area (Plate 5) is a pink weathering, medium to coarse grained, biotite-bearing granodiorite, granite or alkali-feldspar granite with common amphibolite enclaves. It is particularly characterized by abundant pegmatite with large magnetite crystals and books of biotite exceeding 10 cm across in places. It has a strongly deformed to mylonitic fabric.

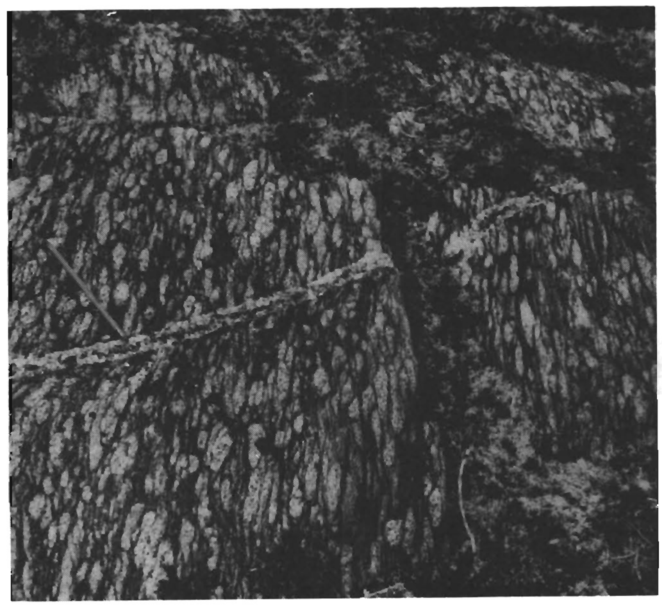

Plate 5: *Strongly deformed K-feldspar megacrystic granitoid pluton and late pegmatite dike.*

The granitoid pluton in the southwest corner of the map area is a pink to rusty-cream weathering medium-grained, recrystallized rock with a biotite-dominant margin and hornblende bearing interior. A gneissic septum separates these two varieties but whether this represents older gneiss or merely a high-strain zone is unclear.

Unassigned Metagabbro, Amphibolite and Mafic Granulite

This variable group of mafic rocks includes fine grained amphibolite, coarse grained garnetiferous amphibolite, two-pyroxene mafic granulite, metagabbro with relict igneous textures and rare melanocratic diorite. Occurrence of the unit vary in size from enclaves within other rock types to the map-scale bodies depicted in Figure 2. The unit was probably derived from mafic intrusions that ranged from minor dikes to small plutons.

Lower Phanerozoic Gabbro, Diorite Dikes.

Three north-northwest trending mafic dikes were mapped in the Paradise River Map

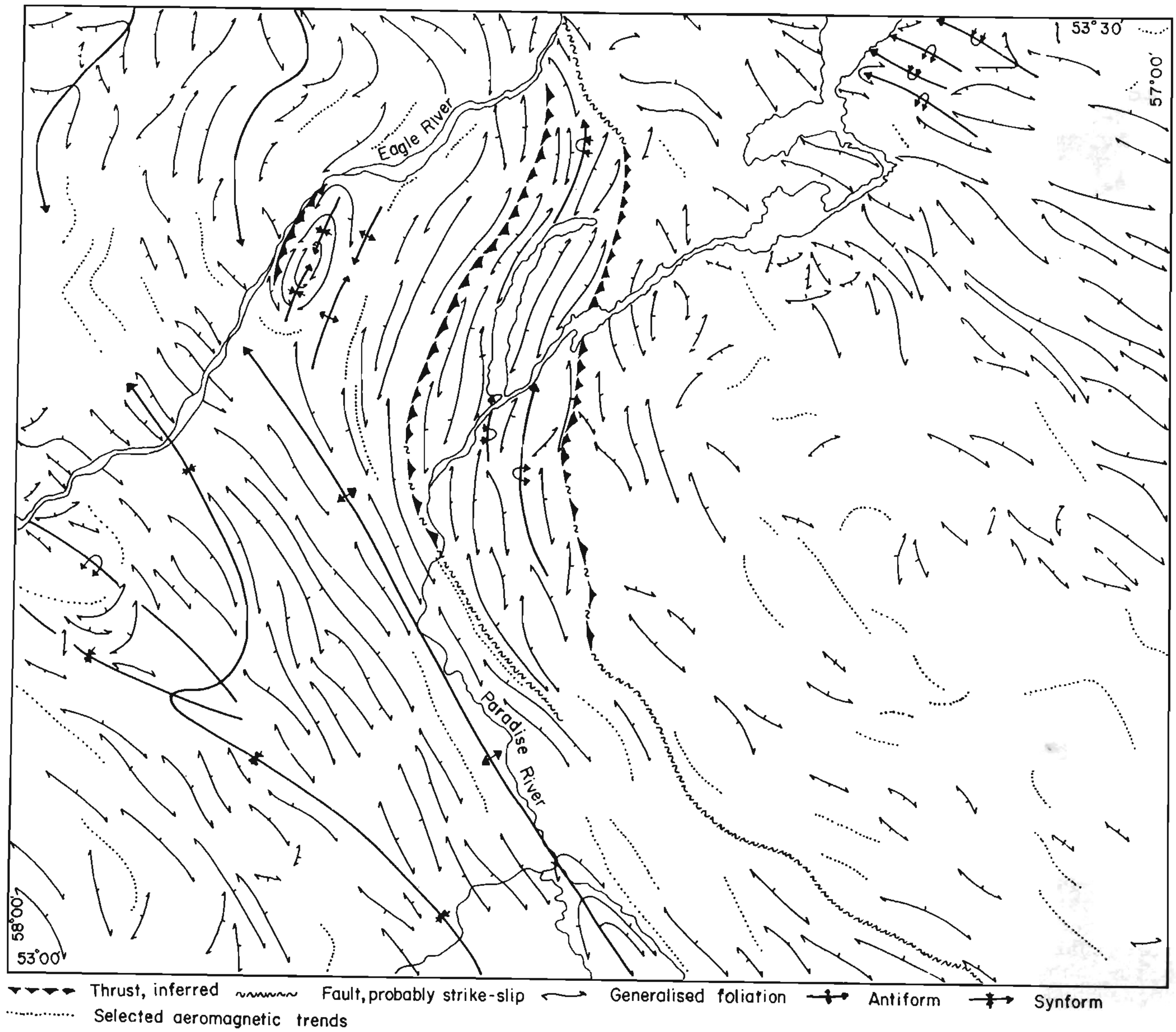

Figure 3: *Generalized foliation trends and other structural features in the Paradise River region.*

area and are extensions to dikes known farther north. The characteristic lithology is a black or brown weathering, coarse grained ophitic-textured gabbro with common interstitial K-feldspar. Typically the mafic silicates have been partially hydrated but primary textures are well-preserved. The westernmost dike extends from north of Cape Porcupine to the southwest quadrant of the map area - a distance of about 100 km. The continuity of the other two dikes is less established but both extend for at least 50 km. K-Ar dates obtained farther north give ages of 514 ± 08 Ma (W.R.) (Grasty et al., 1969) and 553 ± 22 Ma (biotite) (Wanless et al., 1970). These intrusions are correlated with the Long Range dikes of similar trend and age on the Great Northern Peninsula of Newfoundland.

STRUCTURE

For descriptive purposes the region is divided into four northwest-trending sectors. These are, (i) the northeastern area bounded by the southwestern margin of the Paradise Arm megacrystic granodiorite, (ii) the White Bear Arm complex, (iii) the northwestern and central zone, bounded on its southwest side by the unassigned anorthosite unit, and (iv) the southwestern area.

In the northeastern sector regional foliation and gneissosity have a consistent northwest trend (Figure 3). Foliations are steeply dipping (70°) and lineations steeply plunging (50°). Minor folds indicate tight folding, especially in the metasedimentary gneiss; associated lineations define fold axes. The relative dispositions of quartz diorite and metasedimentary gneiss north of Paradise River are interpreted in terms of a regional west-plunging Z fold.

The White Bear Arm complex appears to have a half-basin form. Foliations mostly dip inward (i.e. east or northeast) at angles between 40-70°, although some inward dips of less than 10° were recorded; in the southeast corner, steep outward dips exist. Lineations also plunge radially inward and are interpreted as stretching lineations related to thrusting at the margins of the WBAC. The nature of the thrusting is not known in detail but there are probably several more thrust surfaces present than indicated on Figure 3. Broad zones of mylonite were mapped along Beaver Brook and locally noted elsewhere (Plate 6). Rotated K-feldspar megacrysts indicate that the hanging wall of the thrust has been transported westward. No field evidence for a fault was found between the WBAC and the Paradise Arm pluton despite their linear boundary which appears to truncate regional structural trends in the WBAC.

Plate 6: *Ultramylonite at strike-slip faulting flanking internal thrust.*

The northwest and central zone is characterized by north-northeast structural trends which gradually curve round into a northwest trend in the southern part of the sector. In the vicinity of Crooked Lake, dips are mostly steeply to the east and lineations consistently plunge moderately to the north. Minor folds indicate that lineations are parallel to fold axes and we suspect the presence of tight-to-isoclinal major folds, overturned to the west. The folding becomes more open westward, and the regional plunge changes from north-northeast to southwest, accounting for a basinal structure adjacent to Eagle River. This basin is obvious from photolineaments and is shown on the map of Eade (1962). The isoclinal folds near Crooked Lake are interpreted as the result of west to northwest transport of the WBAC over the underlying gneisses and granitoid plutons.

The unassigned anorthosite which separates the central and western zones has been folded into a shallowly north-plunging antiform. On the northwest side of Eagle River we interpret the antiform axis as swinging north to pass through the circular alkali feldspar granite.

Southwest of the anorthosite, structures revert to a northwest trend with steep foliation dips and moderately plunging, poorly developed lineations. As in the northeast sector, map patterns indicate major Z folds. The large megacrystic granitoid pluton is interpreted to occupy a synform which, northwest of Eagle River, parallels the trend of the adjacent antiform through the anorthosite, and swings north to link up with a well-defined synform in the northwest corner of the study area.

Two post-Grenvillian northeast trending, normal faults, namely the Eagle River and Paradise River faults cross the map area (Figure 4). The faults are accompanied by zones of brecciation and low-grade alteration. The faults link up with similar structures, the Sandwich Bay map-area (Gower et al., 1983a). They define the newly recognized and informally named Sandwich Bay graben, which is probably of similar age to the Double Mer and Lake Melville grabens hosting Double Mer Formation farther northwest. One exposure of similar post-Grenvillian conglomerate was mapped by (Gower et al., 1983a) on the west side of Sandwich Bay.

METAMORPHISM

Metamorphic grade throughout the map area includes upper amphibolite to granulite facies. Garnet is a ubiquitous metamorphic mineral in the orthogneisses and granite plutons and orthopyroxene was observed in several localities in the quartzofeldspathic leucosome of associated mafic rocks. The metasedimentary gneisses are characterized by biotite + sillimanite + garnet + plagioclase - K-feldspar - quartz assemblages. Magnetite is a characteristic accessory phase and muscovite is a locally extensive retrograde mineral. In the northwest continuation of the metasedimentary belt near Paradise River (Gower et al., 1983a) kyanite, orthopyroxene and cordierite have been found in various

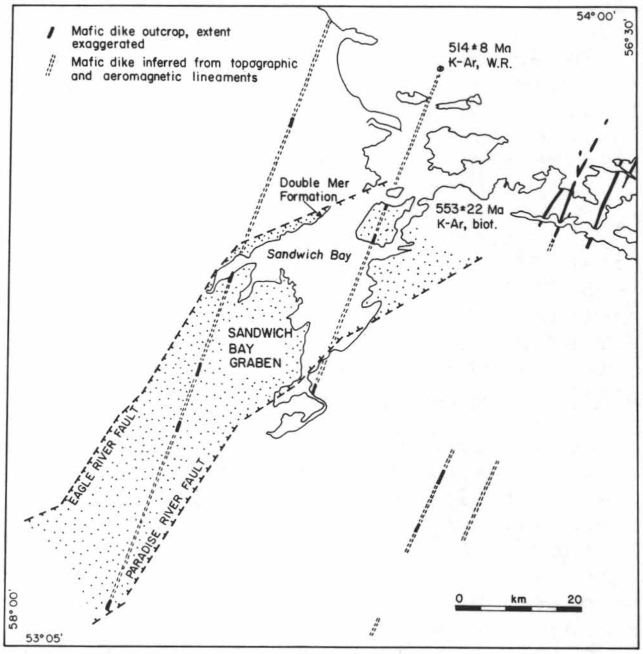

Figure 4: *Distribution of Lower Phanerozoic mafic dikes and outline of the Sandwich Bay graben.*

pelitic assemblages (Gower, unpublished data).

The anorthositic rocks partially retain primary mineralogies but they show extensive hydration to amphibole bearing assemblages and recrystallization of primary silicates. In the White Bear Arm complex primary olivine is preserved as a primary phase mantled by double hypersthene-amphibole coronas. Fine grained granulite is a widespread rock type.

A single K-Ar biotite age of 1105 Ma suggests that temperatures were elevated above 300°C (blocking temperature for biotite) until ca. 1.1 Ga.

REGIONAL STRUCTURAL SYNTHESIS OF THE LAKE MELVILLE TERRANE

Mapping in the Paradise River area, coupled with additional interpretation of previous mapping, allows a preliminary regional structural synthesis of the Lake Melville terrane to be presented here (Figure 5).

The synthesis is based on the premise that there was large-scale regional transport of the Lake Melville terrane in a northwest to north-northwest direction. Thus northeast or east-northeast trending structures are either thrust slices or overturned isoclinal folds in contrast to northwest trending structures which are essentially right-lateral strike-slip faults, with a possible thrust component. Although the east-northeast trending margin of the Lake Melville terrane has been markedly modified by post-Grenvillian normal faults related to the formation of the Double Mer graben, one thrust lobe is preserved north of the graben in the Double Mer White Hills. This lobe has well-developed, shallowly south-plunging stretching lineations. Because of lithological and metamorphic contrasts with the surrounding rocks this lobe is taken as the boundary of the Lake Melville terrane. However the thrust slice is one of a package - some thrusts cross the southern Groswater Bay terrane - and there is evidence of structural repetition within the Double Mer White Hills thrust lobe.

The Double Mer White Hills lobe is one of several thrust sheets that occur across the Grenville Province of Labrador, as well as farther west. The Cape Caribou River allochthon (Ryan et al., 1982; Wardle and Ash, 1984), north of Goose Bay (Figure 1) is comparable to the Double Mer White Hills thrust sheet in lithological make-up, structural style and metamorphic grade. Larger allochthons farther west include the Wilson Lake and Lac Joseph allochthons (Figure 1).

Southeast of Rigolet, the northern boundary of the Lake Melville terrane has a regional northwest trend, which continues to the southeast Labrador coast (Figure 1). Most foliations dip steeply southwest along this section of the boundary, except near Rigolet where, as the regional trend changes to east-northeast, foliations are less steep and south plunging lineations are obvious. We suggest that the northwest trending part of the Lake Melville terrane boundary is a major right-lateral strike-slip fault and that there are many similar faults within the southeast Lake Melville terrane.

The English River fault bounding the northeastern side of the Mealy Mountains Intrusive Suite is interpreted as major right-lateral strike-slip fault. Sense of movement is based on limited observations in the English River area. This passes through the Paradise River as a diffuse zone of ductile deformation in the region of the unassigned anorthosite. The combined effect of movement along the English River fault and movement along the northeastern boundary of the Lake Melville terrane is to slice up the intervening region into a series of blocks with internal northwest facing, frontal thrusts and flanked by strike-slip faults.

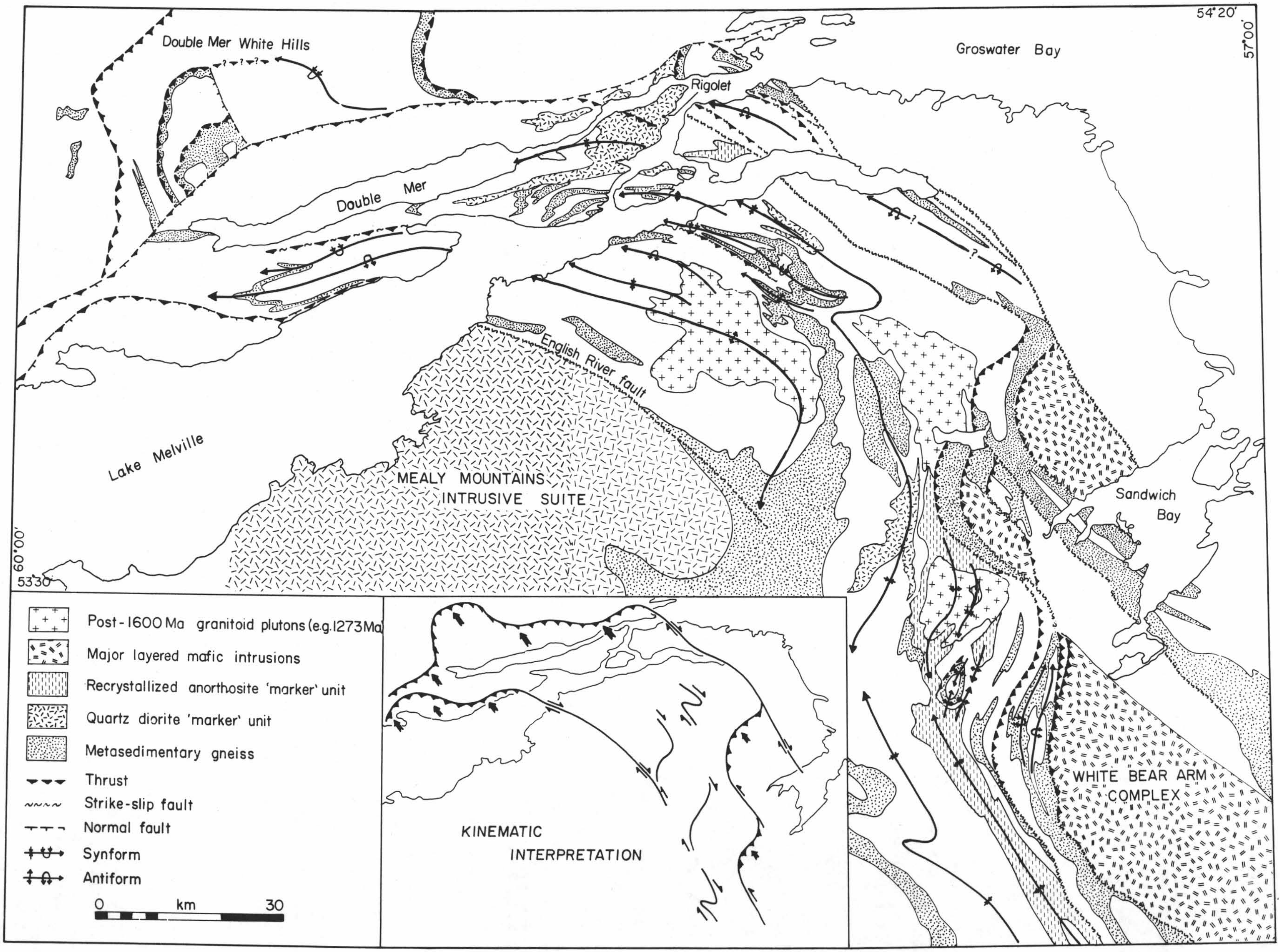

Figure 5: *Regional geological synthesis of the Lake Melville terrane.*

Structurally underlying these 'internal' thrusts the rocks have been deformed into isoclinal, overturned northwest verging folds which, away from the thrust front become more open. The folds more distant from the internal thrusts are major regional structures which are unlikely to have a direct causal link with the thrusts.

Several major folds have been interpreted to occur between Eagle River and the Mealy Mountains. An antiform northwest of Eagle River is outlined by unassigned anorthosite and the core of the fold has been intruded by alkali feldspar granite. The synform farther west has been interpreted to extend from the southern boundary of the Paradise River area to west of Rigolet, a distance of approximately 150 km. The axial trace of the synform is defined by folded quartz diorite bodies in places. The antiform west and south of the synform is actually a domal structure outlined by metasedimentary gneiss. The core of this dome has been intruded by a clinopyroxene bearing quartz syenite to granite which gives a 1273 Ma (U-Pb zircon) age (Krogh, personal communication 1984). We suspect a similar age applies to the alkali-feldspar granite intruding the antiform near Eagle River.

The effect of northwest transport of the Mealy Mountains terrane has been to tighten the northwest end of the domal structure (north of Lake Melville) into a series of tight, overturned, north verging folds and to refold the regional synform in the Paradise River region into open Z structures.

ECONOMIC MINERAL POTENTIAL

The economic mineral potential of the area was assessed during reconnaissance surveys by British Newfoundland Corporation Ltd. (BRINCO), the results of which did not encourage continued activity. However, subsequent more comprehensive aeromagnetic coverage, as well as more detailed geological mapping and results from regional lake sediment surveys suggests, to us, that the area deserves reassessment.

Metasedimentary gneiss appears to be a unit with some economic potential (see Gower and Erdmer, 1984). Sulfide rich zones (mainly pyrite, but with minor chalcopyrite) are common especially in the metasedimentary gniess belts through Crooked Lake and 8 km west of Crooked Lake. Anomalously radioactive pegmatite (counts up to 20 times background) was discovered on the west side of Crooked Lake. The metasedimentary gneiss in the Crooked Lake region also hosts an abandoned mica quarry with biotite and muscovite books 15-20 cm in diameter.

Another major feature of potential economic interest is a granite in the northwest part of the map area. This has anomalous radioactivity, in one place reaching 20 times background, and may be a host to other lithophile element mineralization.

Lake sediment geochemical anomalies (especially U in water) are closely associated with this granite.

Other economic possibilities include Ni-Co-Cr-Cu mineralization within the White Bear Arm complex and LIL element mineralization in various pegmatiates associated with some of the K-rich megacrystic granitoid plutons.

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