NOTES ON THE METAMORPHIC ROCKS IN THE CORNER BROOK AREA (12A/13) AND REGIONAL CORRELATION OF THE FLEUR DE LYS BELT, WESTERN NEWFOUNDLAND

by

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INTRODUCTION

Geological reconnaissance was carried out in the Corner Brook map area (12A/13) during part of the 1982 field season. This work was intended to be the beginning of a two-year project involving regional correlation of the metaclastics, gneisses, and granitoids on the western side of Grand Lake with those of the Baie Verte Peninsula. Collectively, these rocks have been termed the Fleur de Lys Belt (Hibbard, in preparation). The crystalline rocks in the Grand Lake area were recently mapped by students and faculty at Memorial University (Knapp, 1980; Martineau, 1980; Kennedy, 1981; Williams *et al.*, 1982) and those of the Baie Verte Peninsula have been the subject of a Department of Mines and Energy project (Hibbard, in preparation). Although it is timely for a regional study of these rocks, it was found that the aims of the project could not be fulfilled because of the unexpected problems of (i) very poor exposure, (ii) very poor access, and (iii) lack of reliable 1:50,0000 scale mapping in the Corner Brook area. Hence, the project has been suspended. However, some interesting new observations were made on the Fleur de Lys Belt in the Corner Brook - Grand Lake area; they are described herein. In addition, a brief summary and comparison of rocks throughout the belt and recommendations for further work in the belt are presented.

GEOLOGY OF THE CORNER BROOK LAKE AREA

Kennedy (1981) divided the rocks southeast of the Trans Canada Highway into three units, including a westerly carbonate terrane, a dominantly metaclastic terrane, and an easterly cover of Carboniferous strata (Figure 1). He assigned the most easterly phyllitic rocks and recrystallized carbonates of the Lower Paleozoic carbonate terrane to the Grand Lake Brook Group and noted that they were overthrust by the metaclastic terrane. He informally subdivided the upper greenschist to lower amphibolite grade metaclastic terrane into the following three units: (i) Caribou Lake formation of mainly feldspathic psammites and metaconglomerate with subordinate greenschist and adamellite, (ii) Mount Musgrave formation of quartz semipelites, (iii) Twillick Brook formation of predominantly marble and pelitic schist. He assigned an Eocambrian to Cambrian age to these rocks based on lithic correlation with less deformed and metamorphosed rocks in western Newfoundland. Kennedy considered the metaclastic rocks to be in fault contact to the east with Carboniferous strata of the Anguille Group, although locally, at the very northeastern corner of the map area, he thought that the Anguille sandstone and shale unconformably overlapped the metaclastic rocks.

During the present study, the most significant observations centered upon a previously unrecognized sequence of rocks in the metaclastic terrane in the area of the Northern Harbour road (Figure 1), the status of some components of the Caribou Lake formation, and the nature of the faulted contact between the metaclastic terrane and the Grand Lake Brook Group.

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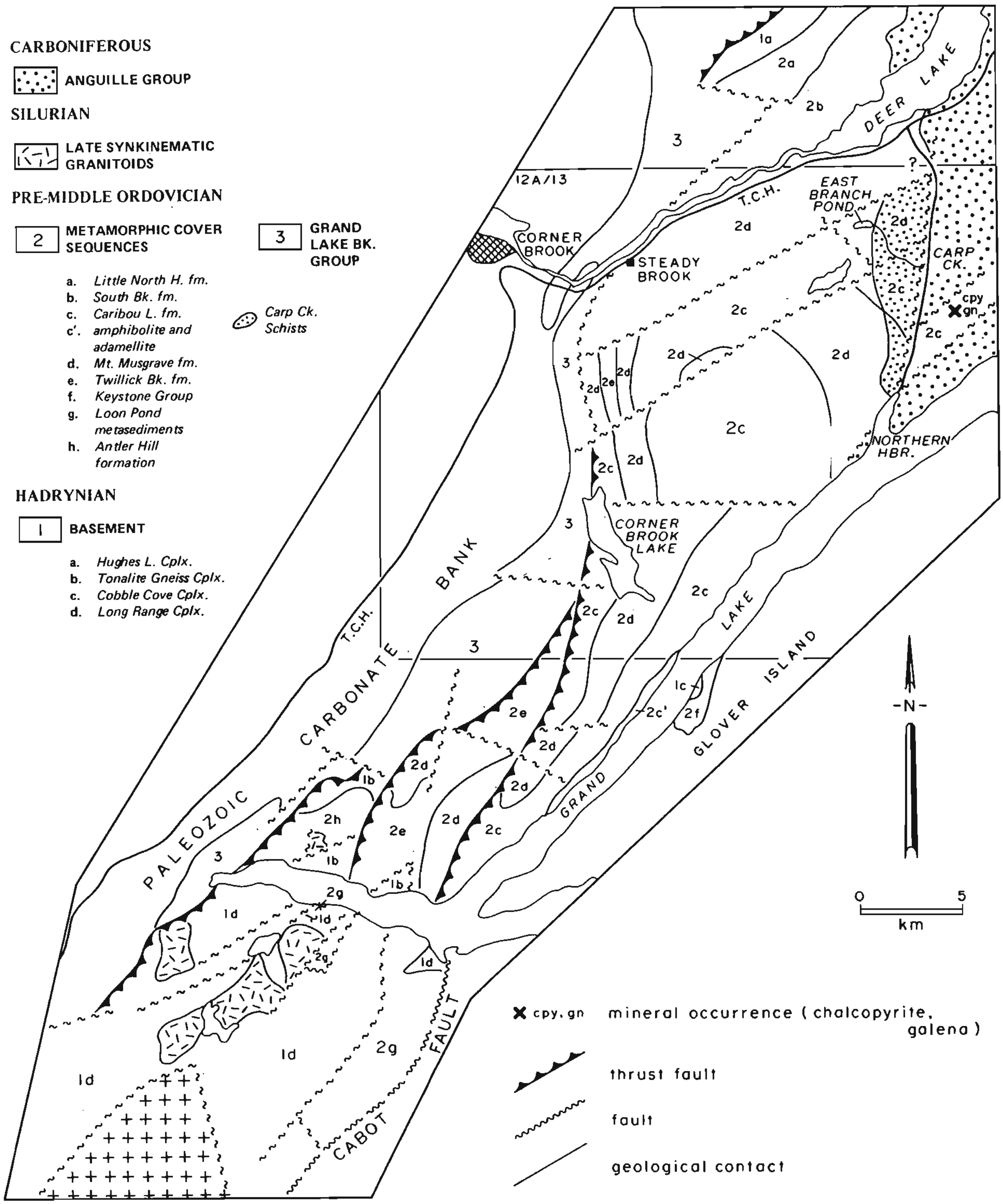

Figure 1. General geology of the area west of Grand Lake, Newfoundland. The order of the metamorphic cover sequences listed above is geographic and not intended to be stratigraphic.

Rocks immediately to the west of the Northern Harbour road were originally assigned to the Caribou Lake and Mount Musgrave formations (Kennedy, 1981). However, mapping during this study indicates that a sequence of metaclastic schists and amphibolite, distinct from either formation as described by Kennedy, strikes approximately parallel to the road, dips moderately to steeply eastward, and extends approximately 2 km inland, to the west of the road. The best exposed section of these rocks is on Carp Creek and, hence, are informally referred to here as the Carp Creek schists. The schists strike across previously erected stratigraphic boundaries (Kennedy, 1981). The full extent of these rocks is uncertain, although their known distribution is outlined on Figure 1 by the stippled area. The Carp Creek schists are dominated by gray, quartz-muscovite semipelite that is commonly garnetiferous and forms layers up to 10 cm thick. They are similar to schists of the Mount Musgrave formation; however, in contrast, they include substantial amounts of graphitic schist in layers up to 5 m thick as well as greenschist and amphibolite. The mafic rocks are best exposed on Carp Creek, where more than 100 m of plagioclase-porphyroblastic amphibolite is interlayered with the metaclastic rocks. The Carp Creek schists appear to grade structurally downward into coarser, more feldspathic semipelite and psammite that, in the area of East Branch Pond, are magnetite-rich. The stratigraphic significance of the Carp Creek schists is uncertain; however, their presence indicates that more detailed mapping of all of this northerly part of the Corner Brook area is required for a more accurate portrayal of the stratigraphy of the metaclastic terrane.

Greenschist, amphibolite, and granite east of the Northern Harbour road and immediately northeast of Northern Harbour were previously assigned to the Caribou Lake formation (Kennedy, 1981). Similar rocks outcrop southwards along strike on the western shore of Grand Lake and are spatially related to the Caribou Lake formation. In the Northern Harbour area, it appears that numerous granitic dikes and stocks intrude the mafic schists, locally crosscutting a penetrative fabric in them; however, the granite was involved in a later, intense deformation that affected all of the rocks. Since the granite appears to be unrelated to the mafic schists, it is suggested that it be excluded from the Caribou Lake formation. However, the granite is unseparable from the amphibolite at a scale of 1:50,000, hence future work on these rocks may indicate that the whole of this mafic schist-granite terrane be assigned the status of a complex. A new chalcopyrite-galena occurrence was found in the amphibolite and it appears to be spatially related to the granite (Figure 1). Chalcopyrite is disseminated through the amphibolite near the contact with the granite and also forms veins that crosscut fabric in the mafic rocks. The galena forms disseminated blebs up to 5 mm across in the amphibolite.

The faulted contact between the metaclastic terrane and the Grand Lake Brook Group was interpreted to be a thrust zone, termed the Corner Brook Lake thrust (Kennedy, 1981). Kennedy noted that the fault, which is moderately east-dipping in the Corner Brook area, steepens to the north and is a high angle fault at Steady Brook. Williams *et al.* (1982) have noted that a fault between phyllites similar to those of the Grand Lake Brook Group and gneissic basement of the metaclastic terrane north of Deer Lake (north of the 12A/13 area), is moderately overturned to the east. During the present study, this faulted contact between the carbonate and metaclastic terranes was investigated in the Corner Brook Lake area, at Steady Brook and in the area just north of Deer Lake; these exposures indicate that this contact is marked by at least three different faults rather than a single thrust zone overturned to the north.

The fault zone is poorly exposed in the Corner Brook Lake area, although where seen it is a highly disturbed, moderately east-dipping zone of friable pelitic schist. Numerous boulders containing coarse garnet- (up to 3 cm diameter), kyanite-bearing (up to 5 cm long), muscovite-quartz schist occur in the valley defining the trace of the fault just north of the lake. Although this rock type was not observed in outcrop, a highly altered and flattened muscovite schist with large patches of chlorite forming pseudomorphs of garnet is exposed in the fault zone approximately 2 km north of the lake. The spatial association of the boulders with the fault zone and the similarity between the rock type in the boulders and those deformed rocks in the fault zone suggest that the garnet-kyanite schist is associated with the Corner Brook Lake thrust in this area. This rock is particularly noteworthy in that it is the first report of kyanite from this metamorphic terrane. Its sole occurrence near such a significant tectonic break as the Corner Brook Lake thrust further supports a link between this spectacular rock and the thrust.

North of Corner Brook Lake, at Steady Brook, the contact between the Mount Musgrave formation and the Grand Lake Brook Group is a nearly vertical to steeply west-dipping fault zone. This fault zone is marked solely by contorted and highly deformed rocks of each unit juxtaposed along a narrow, fissile phyllitic zone. Polydeformed rocks of the Mount Musgrave formation that lie immediately to the east of the fault display a very intense late foliation and garnet in these rocks is largely altered to chlorite.

On the logging road leading to Old Man Pond, north of the Corner Brook map area, the basement gneisses of the metamorphic terrane structurally underlie phyllites and carbonates of the carbonate bank along a northwesterly dipping fault (Williams *et al.*, 1982). This fault zone is marked by approximately 20 m of rubbly mylonitic schists. These schists locally contain large (>2 cm) alkali feldspar porphyroblasts and, in places, these porphyroblasts have coalesced along with quartz to form postkinematic migmatitic pockets of coarse granite up to 1 m by 0.5 m in size. Unoriented biotite porphyroblasts are common in the fault schists in particular near the migmatitic zones.

It is apparent from the nature of these faulted contacts between the metaclastic and carbonate terranes that either different structural levels of the Corner Brook Lake thrust are exposed along its trace or different generations of faults are responsible for the juxtaposition of the terranes in different areas. Since rocks on each side of the fault appear to maintain consistent metamorphic grade along the strike of the contact, I prefer to view the zone as polygenetic. One other note of interest concerning this faulted contact is that structures on either side of the zone have previously been correlated (Kennedy, 1981). In view of the profound juxtaposition of rock types along this poorly exposed, complex zone, any correlation of structures across it is considered to be suspect (see Regional Correlation).

REGIONAL CORRELATION

At the start of this study, the regional geology of the Fleur de Lys Belt in the Grand Lake area was compiled from the work of Knapp (1980), Martineau (1980), Kennedy (1981) and Williams *et al.* (1982). The stratigraphy of the belt in the Grand Lake area is presented and compared with that of the Baie Verte Peninsula in Table I. This chart, along with my own observations, provide the basis for the following discussion on regional correlation both within the Fleur de Lys Belt in the Grand Lake area and throughout the belt.

The stratigraphy of the belt in the Grand Lake area is similar to that of the Fleur de Lys Belt elsewhere. It consists of three major components, including a gneissic basement, a polydeformed and polymetamorphosed cover sequence, and late phase granitoids. The basement, where exposed throughout the region, appears to be represented by mainly tonalitic gneisses, although granitic gneisses and anorthosite occur in the southern part of the area (Martineau, 1980). All of these rocks are considered to be Grenvillian in age (Knapp *et al.*, 1979; Williams *et al.*, 1982). It is interesting to note that, at the southern end of Grand Lake, calc-silicate schists are closely associated with the basement rocks; however, the interrelationship of these units is uncertain (Martineau, 1980; Kennedy, 1981). The calc-silicate schists may be equivalent to felsic metavolcanic rocks recently found in the Hughes Lake Complex (Table I) to the north (H. Williams, personal communication, 1982) and all of these may represent the basal part of the cover sequence.

The cover sequence is a somewhat homogeneous assemblage of metaclastic rocks with locally prominent units of marble, amphibolite, and greenschist. Its relationship to the basement is uncertain, but it is thought to range from Eocambrian to Lower Ordovician in age based on lithologic correlation with less deformed rocks of western Newfoundland (Martineau, 1980; Knapp, 1980; Kennedy, 1981; Williams *et al.*, 1982). Based on regional correlation, Kennedy (1981) has inferred a shorter time span for rocks on the western side of Grand Lake (Table I). However, his correlation may be too restrictive, considering the dearth of fossils in the less deformed rocks he compares with the metaclastic cover. In the Grand Lake area, the general cover sequence is interpreted to consist of basal units of quartzofeldspathic psammite and metaconglomerate with local intercalations of amphibolite. These are overlain by more pelitic schist and capped, at least in the western Grand Lake area, by marble (Kennedy, 1981). Where separated, the basal metaclastic units include the Antler Hill, Caribou Lake, and Little North Pond formations; stratigraphically higher, the more pelitic and marble-bearing units include the Mount Musgrave, Twillick Brook, and South Brook formations. At Glover Island, pelitic rocks and marble of the Keystone Group, appear to form the lower portion of the sequence (Knapp *et al.*, 1979) and thus, appear to be atypical of the stratigraphy.

The late synkinematic granitoids are confined to the southerly part of the Grand Lake area (Martineau, 1980; Kennedy, 1981). These include adamellite, granite, and syenite. A dike, assumed to originate with the Last Hill adamellite (Table I) has yielded a K/Ar biotite age of 420 $\pm$ 20 Ma (Kennedy, 1981). The more southerly granitoids, the Tulks Pond, Goose Hill and Hare Hill plutons, locally contain hastingsite (Martineau, 1980). Based on the age date and the presence of hastingsite, these plutons have been correlated with the locally peralkaline Topsails batholith in west-central Newfoundland (Kennedy, 1981).

Comparison of Fleur de Lys Belt rocks at Grand Lake with those on the Baie Verte Peninsula indicates that there are differences between respective basement terranes and late phase granitoids. The cover sequences in the two areas are grossly similar, but there are second order differences between the metaclastic cover sequences.

Basement gneisses on the Baie Verte Peninsula are represented by small patches of migmatitic gneiss and banded gneiss in the East Pond Metamorphic Suite and by screens of granitic gneiss included in the basal amphibolite unit of the White Bay Group (Table I). The granitic gneiss is identical to gneisses in the Grenville basement on the western side of White Bay and appears to be similar to gneisses in the southerly part of the Grand Lake area. The migmatites and banded gneisses of the East Pond Metamorphic Suite are different

TABLE I: SUMMARY OF STRATIGRAPHY OF THE FLEUR DE LYS BELT

	S. of Grand Lake (Martineau (1980)	Glover Island Knapp (1980)	W. of Grand Lake Kennedy (1981)	N. of Deer Lake Williams et al. (1982)	Baie Verte Peninsula Hibbard (1983)
POST- L. ORDOVICIAN	Tulks Hill, Goose Hill, Hare Hill Granites		Last Hill Adamellite		Wild Cove Pond Igneous Suite and Partridge Pt. Granite
LOWER ORDOVICIAN	? Loon Pond Metasediments	? Keystone Schist Group			Fleur de Lys Supergroup: White Bay Group; ? Rattling Brook Group ?; Birchy Complex
CAMBRIAN			Twillick Brook Fm. Mt. Musgrave Fm.	Pasadena Group: South Brook Fm.	White Bay Group; Rattling Brook Group; ? Birchy Complex
HADRYNIAN			Antler Hill Fm.; Caribou Lake Fm.	Pasadena Group: Little North Pond Fm.	White Bay Group; Old House Cove Group; Birchy Complex
HELIKIAN & OLDER(?)	Long Range Complex	Cobble Cove Complex	Tonalite Gneiss Complex	Hughes Lake Complex	Granitic Gneiss; East Pond Metamorphic Suite

from all other basement rocks in the Fleur de Lys Belt. It has been suggested that these rocks could represent a structural basement of highly deformed and migmatized Paleozoic cover rocks (Hibbard, in preparation). In addition to the gneissic basement, it is possible that some of the northeastern part of the belt in the Baie Verte area may have an ophiolitic basement represented by parts of the Birchy Complex. Although greenschists similar to those of the Birchy Complex occur in the Keystone Group on Glover Island, there is no evidence either for its intercalation with the metaclastic terrane or for its having an ophiolitic affinity.

The cover sequence is grossly similar throughout the Fleur de Lys Belt. On the Baie Verte Peninsula, it consists of a coarse, feldspathic basal unit (Old House Cove Group) which laterally interfingers with and is overlain by more pelitic units (White Bay and Rattling Brook Groups). There appear to be more amphibolite pods and layers in the basal clastic sequence of the Baie Verte area than in that of the Grand Lake area. Locally on the Baie Verte Peninsula, as in the Grand Lake area, the more pelitic units directly overlie the basement gneisses. The White Bay Group overlies granitic gneiss at the southern end of White Bay; similar relationships occur between the Keystone schists and basement on Glover Island. The White Bay Group is also compositionally very similar to the Keystone schists, although the Keystone schists are a thinner sequence than the White Bay Group. Both units have a basal amphibolite that is overlain by pelitic schists, pebbly metaconglomerates containing granite and quartz clasts, and marbles. It is noteworthy that marble occurs stratigraphically low in these sequences. Kennedy (1981) interpreted the marble sequence (Twillick Brook formation) on the western side of Grand Lake to be the stratigraphic top of the cover sequence, based solely on lithologic correlations with less deformed rocks of western Newfoundland. Considering the stratigraphic position of other marble units in the Fleur de Lys Belt and the lack of any compelling biostratigraphic evidence, it is possible that the Twillick Brook formation could encompass a much greater time range. It is conceivable that the formation may in part, be laterally equivalent to stratigraphically lower marble-bearing units in other parts of the belt such as the Keystone schists and the White Bay Group. The major difference between the metaclastic cover rocks at Grand Lake and Baie Verte is the greater proportion of graphitic schist and amphibolite and mafic schist in the more pelitic units of the Baie Verte area. This may reflect a more distal, basinal depositional environment for the Baie Verte rocks.

The late phase granitoid rocks along the belt appear to be of different age and origin; these differences appear to reflect significant differences in the tectonic setting of different parts of the Fleur de Lys Belt. On the Baie Verte Peninsula, the Wild Cove Pond Igneous Suite has yielded a K/Ar biotite age of 358 Ma (Hibbard, in preparation), which is much younger than the approximately 420 Ma age for the granitoids in the Grand Lake area. Geochemically, the Wild Cove Pond Igneous Suite is calc-alkaline and shows no tendency towards peralkalinity, as seen in the Grand Lake granitoids. Also, the granitoids at Grand Lake have been involved in late phase regional deformation, whereas the Wild Cove Pond Igneous Suite postdates any regional deformation.

The change in late phase granitoids from north to south coincides with a change in the tectonic character of the Fleur de Lys Belt. In the northern part of the belt, rocks are in generally upright, horizontal to slightly plunging major folds and juxtaposed against more westerly rock units along a major steep fault, the Cabot Fault (Figure 2). In contrast, in the Grand Lake area, the belt is characterized by moderately east-dipping thrust faults and largely appears to have been thrust westwards

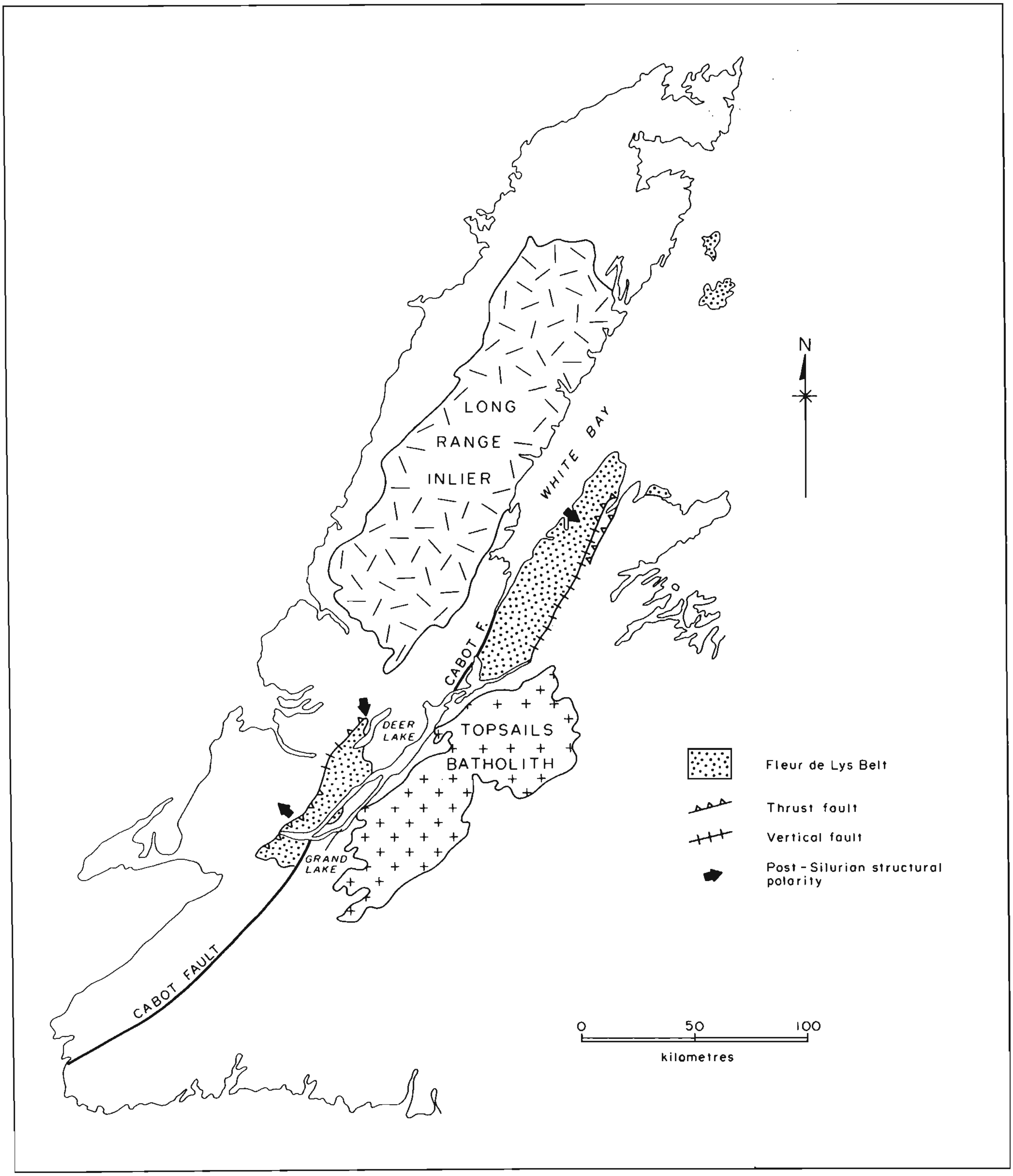

Figure 2. Tectonic setting of the Fleur de Lys Belt in Newfoundland.

over the western Newfoundland carbonate bank sequence. Based on observations noted above, I suggest that, during the Silurian, the part of the Fleur de Lys Belt now in the Grand Lake area occupied the area now underlain by the Topsails batholith (Figure 2); with the intrusion and uplift of the batholith at about 420 Ma, the metamorphic terrane was thrust westwards, partially decapitating the Topsails Granite and thus accounting for the inclusion of late phase granitoids in the Grand Lake area. This hypothetical scenario suggests an Acadian time of deformation for the Grand Lake Brook Group, situated structurally below the metaclastic thrust sheets, and accounts for the westward decrease in metamorphic grade and intensity of deformation in the carbonate terrane. It implies that Lower Ordovician volcanic rocks situated between the Topsails batholith and the Fleur de Lys Belt were also transported during the post-Silurian event. A major uncertainty in this reasoning is the amount and type of displacement along the Cabot Fault in the Grand Lake area, so a palinspastic reconstruction across this prominent zone can only be only tentative.

On the Baie Verte Peninsula, post-Silurian tectonic movement had an opposite, easterly polarity from that of the Grand Lake region. This polarity may have been induced by uplift of the Grenvillian Long Range Inlier (Figure 2). The change in polarity from west-directed to east-directed movements along the Fleur de Lys Belt appears to be located between Corner Brook Lake and the area just north of Deer Lake; this zone may mark the range of structural influence of the Long Range Inlier during post-Silurian times. It is curious, and may be critical to understanding of the tectonics of the area, that Topsails-like magmatism is absent in the belt on the Baie Verte Peninsula but is present in the southern end of the belt. Clearly, the orthotectonic Fleur de Lys Belt deserves closer scrutiny with respect to its role in post-Silurian tectonics in Newfoundland.

RECOMMENDATIONS FOR FUTURE WORK

The following recommendations are made for the type of approach to any further work in the area:

i) Comprehensive 1:50,000 scale mapping of the Fleur de Lys Belt in the Corner Brook map area (12A/13);

ii) Mapping of the Loon Pond metasedimentary rocks at the southern end of Grand Lake for better stratigraphic resolution;

iii) $^{40}Ar/^{39}Ar$ age dating of muscovite from phyllites of the Grand Lake Brook Group to test the hypothesis that the group was involved in post-Silurian tectonism;

iv) Better assessment of the stratigraphic position of the marble in the Grand Lake area (possibly by paleontological methods) and its potential for copper mineralization;

v) Radiometric age dating of the basement terrane.

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