

# GEOLOGY OF PART OF THE FLEUR DE LYS MAP AREA (12I/1 E1/2), NEWFOUNDLAND

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## INTRODUCTION

Geologic mapping of parts of the Fleur de Lys map area (12 I/1, east half) west of Baie Verte was carried out during two months of the 1978 field season. In addition, some time was spent investigating the northern part of the adjacent Baie Verte map area (Hibbard, this volume) in an attempt to obtain map continuity between the two areas.

The geology west of Baie Verte has recently been of special interest as it includes well exposed sections across the western division of the Eocambrian(?) - Ordovician(?) Fleur de Lys Supergroup (Church, 1969) and contains the northern part of the contact between these polydeformed medium to high grade metamorphic rocks and the deformed ophiolites of the Baie Verte Lineament.

The area was previously mapped in full at a scale of 1:50,000 by the Geological Survey of Canada (Neale, 1959) following investigations of parts of the area by Fuller (1941), Watson (1947), and Baird (1951). Subsequently, Kennedy (1971) described in detail the geology of the northern part of the area and, in particular, emphasized the structural complexity of this part of the Baie Verte Peninsula. Bursnall (1975) mapped the area between Coachman's Harbour and the southern boundary of the map area. Prior to the present investigation no detailed mapping had been done of the White Bay section or the central inland portions of the area.

## GENERAL GEOLOGY

The following are brief descriptions of the major lithological divisions recognized during the present study. Further subdivision is possible and, therefore, the

description that follows is necessarily incomplete. All but the Advocate Complex are part of the Fleur de Lys Supergroup.

### Seal Cove group (Unit 1)

A monotonous northeasterly striking sequence of generally thick banded, buff to light cream colored, feldspathic psammites with subordinate biotitic pelite outcrops along the shore of White Bay and extends inland for a distance of 1 to 4 km. This sequence represents the northern continuation of the Seal Cove group as previously informally defined by de Wit (1972) for similar rocks in the Baie Verte map area to the south. The group probably represents the lowermost parts of the Fleur de Lys succession, overlies presumed Grenville basement, and probably is Eocambrian in age (de Wit 1972; but see Hibbard, this volume).

Psammitic layers are commonly less than 1 m in thickness but in places are greater than 3 m thick. Rock types within the group are characteristically coarse grained and distinctly feldspathic. A 20 m thick fine grained quartzite of unknown origin occurs 2 km south of Little Lobster Harbour; it is strongly foliated, containing ribbon quartz and abundant flakes of white mica, and has the lithological character of a tectonic slide although this origin cannot be confirmed from the field relations.

No occurrences of possible basement to the Fleur de Lys Supergroup were recognized nor were relict sedimentary structures that could be used to demonstrate the local younging direction of the succession. From the repetition of some distinctive rock types, minor tectonic structures, and the extrapolated configuration of the boundary of the group with the contiguous Rattling

Brook Group, it is inferred that major, approximately recumbent, folds exist within the section.

The boundary of the group with the structurally overlying Rattling Brook Group is transitional in character and, therefore, imprecisely located on the accompanying map. For the purpose of this report, it has been placed at the first appearance of predominantly pelitic and semipelitic lithologies, which are characteristic of the Rattling Brook Group succession in the eastern parts of the area. Minor graphitic schist, garnetiferous schist and calcareous pelite in the vicinity of Hard Bay and regularly banded psammites and pelites outcropping between Partridge Point and Fleur de Lys Harbour are, therefore, excluded from the Seal Cove group. It is likely that the boundary of the group will be revised when more detailed correlation is attempted between this area and the Baie Verte map area to the south (see Hibbard, this volume).

### Rattling Brook Group (Unit 5)

Watson (1947) introduced the term Rattling Brook Group to distinguish the predominantly pelitic and semipelitic sequences of the eastern and central parts of the area from mafic rocks outcropping along the shore of Baie Verte (e.g. Birchy Schist, Unit 6).

The extent of the group as defined on the accompanying map includes a major part of the White Bay sequence of Kennedy (1971), which also in part closely resembles parts of the Seal Cove group. Kennedy's Flat Point formation is also included although this was subsequently correlated with the Ming's Bight Group, which outcrops 15 km to the east (Kennedy, 1975). This possible correlation is discarded here since it depends on inferred regional stratigraphy that has not been confirmed by more recent work (Bursnall, 1975; DeGrace *et al.*, 1976). The boundaries and extent of the group as defined in the present report, however, are not entirely satisfactory and will require future revision. A number of tectonic slide zones of uncertain regional extent occur within the Rattling Brook Group, separating the succession into tectonically defined sequences. At least one of these is delineated by a discontinuous zone of ultramafic bodies (see below).

The group is characteristically more pelitic in character and lithologically more varied than the adjacent Seal Cove group. Graphitic, quartzitic, feldspathic, and calcareous schist are all present as units of variable thickness. Garnet-rich units are also present and may represent subtle compositional variations within the semipelites. Of particular significance in terms of regional correlation with adjacent areas are a sequence of interbanded pebbly psammites and pelites outcropping north of Fleur de Lys Harbour that is similar to

parts of the Horse Islands succession (Hibbard and Bursnall, this volume) and a distinctive graphitic pelite, calcareous pelite, marble, and amphibolitic schist association that extends from Fleur de Lys Harbour southwards for a distance of 10 km and which may be equivalent to a similar association within the Baie Verte map area (Hibbard, this volume).

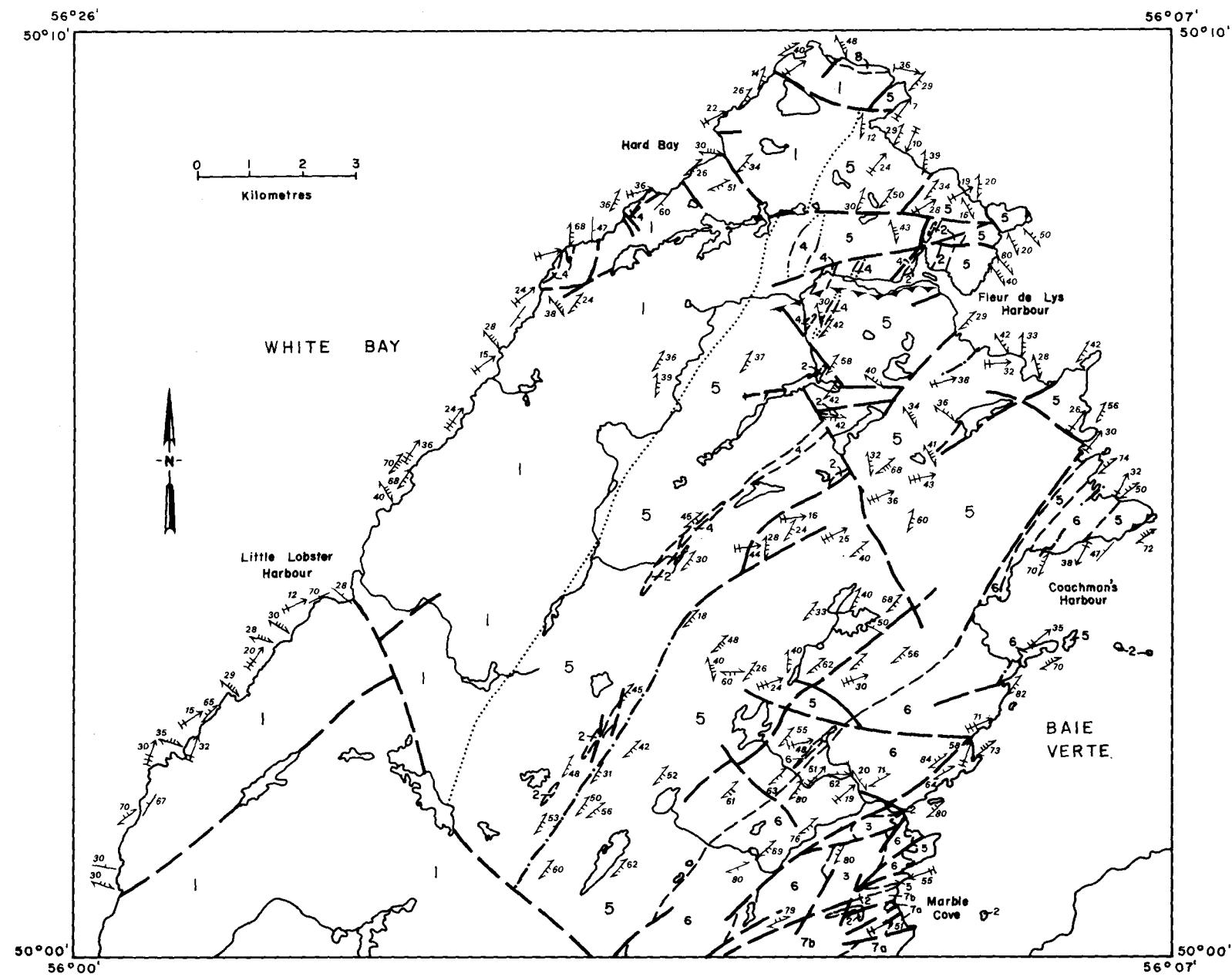
Regionally, the group exhibits a systematic variation in lithological character from west to east. The volume of pelitic content increases eastwards as does the compositional range; amphibolite content decreases eastwards (see below). The eastern sequences are distinctly more strongly foliated and tectonically disrupted than those to the west.

### Birchy Schist (Unit 6)

The Birchy Schist (Fuller, 1941) comprises a group of predominantly mafic rocks that outcrop in a north-easterly trending belt between Coachman's Harbour and Marble Cove. It is partly ophiolitic in character but its precise stratigraphic position is unknown. The contact with the Rattling Brook Group, locally, is marked by a 100 m wide zone of interbanded mafic and choritic semipelitic schists that may be of primary (depositional) origin. Elsewhere, faults or tectonic slides separate the two groups. The contact with the Advocate Complex is everywhere tectonic. The Birchy Schist as described below is equivalent to the Birchy group (Hibbard, this volume).

The Birchy Schist sequence has the most variety of rock types within the map area. A well foliated actinolite-epidote-chlorite-albite schist is the most common rock type and occurs at a number of positions within the succession. Other mappable units include thin (<3 m) zones of graphitic, semipelitic, quartzitic, spessartine garnet rich, and calcareous schist. A thin coarse grained clastic horizon that is possibly agglomeratic occurs close to the contact with the Rattling Brook Group and has been traced along strike for 10 km.

Within the central part of the outcrop area compact mafic schists occur that contain relict pre-tectonic intrusive clasts. One locality exhibits possible relict pillows. A large mainly fault bounded body of metagabbro occurs 1 km east of Marble Cove and a banded amphibolite-calc-silicate unit that locally exhibits the texture and composition of a metagabbro outcrops discontinuously from Marble Cove to Coachman's Cove. It is intruded by numerous pre-tectonic mafic dikes at a locality 1.5 km north of Marble Cove, where there is a strong superficial resemblance to rocks from the cumulate zone of the Point Rousse Ophiolite (Norman and Strong, 1975; Dewey and Bird, 1978). The origin of this unit is, however, uncertain.



## FLEUR DE LYS MAP AREA (12I/1 East), NEWFOUNDLAND

## LEGEND

## DEVONIAN (?)

8 Partridge Point Granite

## ORDOVICIAN (?) AND OLDER

5 Rattling Brook Group

7 Advocate Complex: 7a, Mafic schists; 7b, mylonitic leucocratic schists.

4 Amphibolite

3 Metagabbro

6 Birchy Schist group

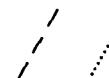
2 Ultramafic rock

## CAMBRIAN OR OLDER

1 Seal Cove group

## SYMBOLS

Geological boundary (defined, approximate).....



Compositional layering.....



Fault.....

Tectonic slide (of D<sub>1</sub> or D<sub>2</sub> age).....D<sub>1</sub> schistosity: fold hinge-line.....D<sub>2</sub> schistosity: fold hinge-line.....Post-D<sub>2</sub> cleavages: fold hinge-lines .....

A distinctive mélange horizon locally transgresses the succession and marks a major structural discontinuity within the area (Bursnall, 1975; Williams *et al.*, 1977). It predates the earliest recognized regional tectonic fabric ( $S_1$ ) but has been a locus of high strain during subsequent deformation events. Commonly lensoid fragments varying from a few centimetres to greater than 10 m in size are set in a brownish black, striped, fine grained graphitic schist. Clast lithologies include psammite, calcareous pelite, a variety of green-schists, metagabbro, actinolite-fuchsite aggregates, and serpentinite. All but the last three are referable to the inferred depositional succession of the Birchy Schist. Fault bounded serpentinite bodies and metagabbro are, however, both present elsewhere within the sequence, seemingly spatially separated from mélange-like lithologies. Whether the clasts of igneous rock were tectonically or otherwise incorporated within the mélange is at present not clear. Williams *et al.* (1977) have suggested a similar origin for the Birchy Schist mélange to the ophiolite bearing mélange zone beneath the transported allochthons on the Western Platform.

### Advocate Complex (Unit 7)

The Advocate Complex (Bursnall, 1975) comprises the ultramafic, gabbro, albite granite, and associated volcanic rock assemblage, interpreted as a dismembered ophiolite, that occurs in the vicinity of the Advocate asbestos mine 3 km south-wouthwest of Marble Cove within the Baie Verte map area (Hibbard, this volume). Within the present map area polydeformed equivalents of this succession occur and are in fault and tectonic slide contact with the Birchy Schist (Bursnall, 1975). Two formations are readily recognized in the field.

A unit of distinctive leucocratic schists (Unit 7b) that are commonly mylonitic outcrops adjacent to the contact with the Birchy Schist. In addition to a number of small elongate bodies of serpentized ultramafic rock, the unit contains lensoid zones of altered gabbro and albite granite. The unit probably represents a complexly deformed shear zone that lies structurally beneath the less deformed ophiolite at Advocate Mine. A second formation (Unit 7a) consists predominantly of mafic schists that in places exhibit pillowlike structures; additional lithologies include green to greenish gray epidotic schists, medium to fine grained lenses of metagabbro and metadiorite, thin white weathering quartzites that in places contain abundant actinolite, and medium greenish gray very fine grained mylonites. Possible metasomatized equivalents occur along the southern shore of Marble Cove in close proximity to one of the ultramafic pods of unit 7b.

### Additional igneous rocks

A number of granitic rocks occur within the area. The largest of these is the Partridge Point granite (Unit 8), which outcrops for 1.5 km along the northernmost coastal section of the Fleur de Lys peninsula. It is a nonschistose, medium grained, white to light gray, granitoid intrusion whose sharp steeply inclined contact truncates the main tectonic fabric within the host psammitic and pelitic schists. Its relationship to the later deformational events recognized within the map area is unknown. A number of large xenoliths of strongly recrystallized metasedimentary rock occur within the granite but elsewhere the host rocks are seemingly unaffected by the intrusion. Smaller aplitic and granitoid sheet intrusions exist in Hard Bay and in Seal Cove (0.5 km north of Marble Cove). A 20 cm thick felsite dike at the latter locality postdates all the recognized tectonic fabrics in that area, whereas a 1 m thick dioritic intrusion is affected by the latest movements on a tectonic slide that is probably genetically related to the tectonic boundary between the Birchy Schist and Advocate Complex.

In addition to the schistose mafic dikes within the Birchy Schist, a number of seemingly less strained northeasterly trending mafic dikes occur in the coastal section between Coachman's Harbour and Marble Cove. Some of these demonstrably cut the earliest structures but their precise age relative to the structural sequence is at present unclear.

Numerous deformed dark green to black amphibolite bodies (Unit 4) are present within the Seal Cove group and the northern and western parts of the Rattling Brook group succession. These occur as lensoid boudins or as discontinuous sheets whose generally sharp boundaries are approximately concordant to compositional layering within the host metasedimentary rocks. Most amphibolite bodies are less than 1.5 m in maximum thickness but a number of them exceed 30 m in thickness, particularly in the vicinity of Fleur de Lys Harbour and south of Hard Bay. These have relatively massive cores but structural relationships at their margins indicate that they have undergone the full regional deformation exhibited in the metasediments.

Many of the amphibolites contain garnet. The garnet is commonly rimmed by a selvedge of plagioclase or, where garnet is seemingly absent (or only present in minor amounts), the rock is distinctly feldspathic. This suggests that many amphibolites in the area were originally garnet bearing and that in many localities the garnet has subsequently broken down to plagioclase.

Although crosscutting contacts of unambiguous primary origin are rare, it is considered likely that most

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amphibolites in the map area are of primary intrusive origin.

In addition to the ultramafic rocks within the Birchy Schist and Advocate Complex, two discontinuous zones of elongate ultramafic bodies that occur as isolated bodies or enclosed within amphibolite extend southwards from Fleur de Lys Harbour within the Rattling Brook Group. The ultramafic bodies are partially or completely serpentinized, internally brecciated, and exhibit strongly schistose margins. The internal breccia fragments commonly describe a crude phacoidal cleavage that parallels the main schistosity in the margin and the enclosing metasediments. The ultramafic bodies occur within zones of high strain and, in places, blastomylonitic schists occur within the envelope rocks. A presumed tectonic slide induced quartzite occurs at the western margin of one of the large bodies in Fleur de Lys Harbour; the intrusive nature of amphibolite into this slide (Kennedy, 1971) has not been confirmed. Although graphitic schist is present in the envelope to a number of these ultramafic bodies, the structural and lithological character of the local assemblage bears no resemblance to a mélange zone of the type present within the Birchy Schist. Structural evidence suggests, however, that the origin of the zones in both groups is of approximately the same age (see below).

## STRUCTURE

The structural evolution of the area involves seven regionally important deformational episodes ( $D_1$  to  $D_7$ ) that resulted in the significant development of planar schistosity or cleavage. Since detailed correlation of structures across the area is at present incomplete, these events have been grouped into two sets whose structures, for the most part, can be readily recognized in the field. These are an early (primary) deformation phase ( $D_p$ , including  $(D_1 + D_2)$ ) and a later (secondary) deformation phase ( $D_s, D_3 - D_7$ ). In general,  $D_p$  events were accompanied by prograde metamorphism whereas  $D_s$  events were associated with diaphoresis.

$D_p$  events resulted in regionally persistent northeasterly striking schistosities that are generally axial planar to both large (in excess of 5 km amplitude) and small scale tight to isoclinal folds. The latter are gently inclined structures to the north but have been rotated during  $D_s$  into steep attitudes in the eastern part of the area. A composite  $S_1/S_2$  fabric is a common feature throughout much of the area and rarely is  $S_1$  present in rocks not containing well developed  $S_2$ .  $D_2$  is equivalent to  $D_M$  in at least the northern part of the adjacent Baie verte map area (de Wit, 1972; Hibbard, this volume).

A number of tectonic slides are of  $D_p$  age. The inclusion of ultramafic rock within the mélange zone of

the Birchy Schist, however, predates the  $D_1$  main schistosity. The linear zones of ultramafic bodies within the Rattling Brook Group are seemingly of similar age. It is apparent, therefore, that some tectonic disruption of the sequences west of Baie Verte had occurred prior to, or during, the early part of the earliest recognized regional deformation episode.

$D_s$  events resulted in the localized development of subpenetrative cleavages, minor folds, and shear zones. The latter attain their greatest expression in the eastern part of the area, where  $D_p$  structures have been considerably modified and reoriented. The boundary between the Advocate Complex and Birchy Schist is a major  $D_s$  tectonic slide that necessitates only tentative correlation of  $D_p$  structures between the two sequences.

A number of major northwesterly trending faults and northeasterly striking thrusts displace the lithological units and postdate at least the earlier part of the  $D_s$  structural sequence.

## METAMORPHISM

All the rocks within the map area, with the exception of the Partridge Point granite and some other minor intrusions, have been regionally metamorphosed to at least lower greenschist facies. Metamorphic grade, in general, increases northwards and westwards, the lower grade polydeformed rocks occurring within the Advocate Complex and the higher (almandine-amphibolite) outcrop in the vicinity of Fleur de Lys and in the White Bay coastal section. Porphyroblastic garnet is common throughout the Rattling Brook Group and staurolite is locally common in the Fleur de Lys area. Textural relationships suggest that garnet growth occurred before, during and (in the northern part of the area) after  $D_2$ .

The age of regional metamorphism is pre-Middle Silurian from recent isotopic work (Dallmeyer, 1977), and from tentative regional stratigraphic and structural correlation it may be Middle Ordovician in age (Bursnall and de Wit, 1975; Williams *et al.*, 1977).

## ECONOMIC GEOLOGY

A number of minor showings of chalcopyrite have resulted from the present work.

Two lithological associations for chalcopyrite are apparent, both within the Rattling Brook Group; namely, within and adjacent to the pelitic marble-graphitic schist-amphibolite assemblage within the central part of the group, and within calcareous chloritic semipelites adjacent to the contact with the Birchy Schist.

Minor asbestiform veining occurs in many of the

ultramafic bodies and disseminated pyrite is common throughout the Birchy Schist.

**Acknowledgements:** Thanks are due to Barry Squires and Alvin Crocker for their competent assistance in the field; James Hibbard for helpful discussion and advice, and occasional musical entertainment; and to the Department for the opportunity to continue work in the Fleur de Lys area.

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