GEOLOGICAL ASSOCIATION OF CANADA
NEWFOUNDLAND SECTION

1970 FIELD MEETING, BAIE VERTE, SEPTEMBER 25-27

INTRODUCTION

Welcome to the first field meeting of the Newfoundland Section of the G.A.C. The next two days will be spent looking at a variety of deformed and metamorphosed rocks in an area which has been the focus of a good deal of geological interest for the past few years.

The Newfoundland Appalachians have been divided into three distinct geological provinces (Williams, 1964); namely, the western platform, the central paleozoic mobile belt and the eastern platform. The Burlington Peninsula is situated on the western side of this central paleozoic mobile belt. Here, the rocks can be divided into two distinct tectonic complexes; one, the Fleur de Lys Supergroup was deformed and metamorphosed before deposition of rocks of the later complex, which was itself deformed and metamorphosed at a later date. In effect these are two separate orogenic cycles. One ceased before deposition of the rocks of the second began in Lower Ordovician time. This second cycle ended with deformation in Upper Silurian-Devonian time.

The presence of crystalline metasediments to the northwest of less altered Lower Paleozoic deposits in this part of Newfoundland has persuaded many to draw comparisons between here and the Caledonian orogenic belt of western Europe. It would seem to be well established now that these two regions were once joined before the development of the present Atlantic Ocean.

A further development of the theory of continental drift has now emerged as Plate Tectonics. For Newfoundland, this means that the Appalachians may be the scar of an older proto-Atlantic ocean that closed in Lower Paleozoic time.

Consequently, the similarities between Burlington Peninsula and Caledonian geology, and the possibility that this whole composite orogenic belt may record the opening and closing of an earlier ocean have promoted a lively interest and a good deal of work in recent years in several parts of this area. These studies will be continuing for several years to come.

Acknowledgments

Gratitude is expressed to the staff of the Geology Department, Memorial University of Newfoundland, for assistance in preparing this report. Thanks are also due to Mr. Marten de Wit and Mr. Bill Kidd for their help in explaining the local geology during the second day of this field meeting.

GENERAL GEOLOGY

The rocks of the Burlington Peninsula can be divided into two tectonic complexes. The oldest of these consists of the Fleur de Lys Supergroup and rocks that intruded it before the development of the later complex. This later complex consists of the Baie Verte Group and Mic Mac Sequence, the Snooks Arm Group, and probably other volcanic rocks occurring west of the Snooks Arm Group at Nipper's Harbour and Burlington. Both complexes have suffered polyphase deformation but the Fleur de Lys rocks have been metamorphosed to amphibolite facies during their deformation history while the younger rocks have suffered incipient greenschist facies metamorphism.

Recent work in this area includes that by officers of the Geological Survey of Canada (Baird 1951, Neale 1959, Neale and Nash 1963, Neale and Kennedy 1967), Church (1969 and several abstracts), Kennedy (in Phillips, Kennedy and Dunlop 1969) and Dewey (1969, 1970); and by mining companies who hold concessions in the area. For detailed accounts of this work the reader is referred to these publications.

The Fleur de Lys Supergroup consists of a series of dominantly psammitic and semi-pelitic metasediments with minor conglomerate, marble and actinolite chlorite schist in its western outcrop belt. It may include remobilised older basement rocks (Fig. 1). Stratigraphy has only been worked out to date in the north of this belt where three stratigraphic sequences separated by tectonic slides are recognized. Amphibolites are common and eclogites and ultrabasic rocks also occur. East of Baie Verte the Fleur de Lys Supergroup consists of psammitic rocks of the Ming's Bight Group, basic volcanic rocks, now amphibolites, of the Pacquet Harbour Group and a series of mixed acid and basic volcanics of the Cape St. John/Grand Cove Groups (Church 1969). These are intruded by a coarse quartz feldspar porphyry. Structural work has recently shown that the Ming's Bight Group is the oldest and the Cape St. John/Grand Cove rocks the youngest of these groups and that they form an extension of the eastern stratigraphic sequence seen northwest of Baie Verte. Work now going on in the central part of the western outcrop belt will provide further information on Fleur de Lys stratigraphy.

The deformation history of these rocks in complex. The earliest features are first deformation, D_1, tectonic slides which separate the three stratigraphic sequences of the northern part of the western outcrop belt. The slides were intruded by amphibolite before the first deformation ceased. The S_1 schistosity produced by this deformation is now difficult to see except in minor F_2 fold hinges and in thin section. No major F_1 folds have been recognized but minor F_1 folds are common in places. The quartz feldspar porphyry of the eastern belt of Fleur de Lys rocks and many of the ultrabasic rocks of both belts have also developed S_1 and are pre- or syn- D_1 intrusives. The second deformation resulted in the development of the main schistosity, S_2 of the Fleur de Lys rocks, numerous minor F_2 folds and major recumbent F_2 isoclines. Some D_2 tectonic slides were formed. The major F_2 isoclines face northwards at Fleur de Lys and southwestwards east of Ming's Bight. This suggests that they were either developed on opposite limbs of an even larger F_1 fold, or that the F_2 folds form part of a nappe complex with a symmetry axis which the F_2 folds face away from.

Later deformations have produced strain-slip fabrics and kink bands. Large folds are rare, except in the Pacquet area where the hinge of an F_2 syncline is refolded by a later fold (Fig. 5). Also, along the shores of

Baie Verte the originally recumbent F_2 folds are refolded into steep attitudes after the development of two later strain-slip fabrics (Fig. 3).

Metamorphism is generally in the amphibolite facies. Garnet and plagioclase has generally grown after the first deformation and before the second. Some garnet and plagioclase growth syntectonic with D_2 has occurred. Kyanite and staurolite have generally grown after the second deformation. Micas and amphibole show a prolonged growth and recrystallisation history. The Pacquet Harbour Group of the Fleur de Lys was intruded, probably after D_2 by the Burlington Granodiorite. The presence of pebbles of this in the Baie Verte Group and of Fleur de Lys derived volcanic and metamorphic detritus in the Lower Ordovician Snooks Arm Group places the deformation and metamorphism of the Fleur de Lys rocks as pre- or very early Ordovician in age.

The less deformed Baie Verte Group and Mic Mac Sequence has yielded no fossils. The Mic Mac Sequence of mixed acid and basic volcanic rocks and ignimbrites has yielded a 393 m.y. Rb/Sr whole rock isochron and is probably Upper Silurian or Devonian in age. The Baie Verte Group of basic pillow lavas, tuffs and minor sediments is generally believed to be Ordovician on its close lithologic similarity to the fossiliferous Snooks Arm and Lush's Bight Groups. Mapping of these rocks beyond the reconnaissance stage is now under way. They show a simpler deformation history and an incipient greenschist facies metamorphism compared with the Fleur de Lys rocks.

These two tectonic complexes should be separated by a major unconformity. At present this unconformity has only been found in one place where serpentinite intrusive into the Fleur de Lys is unconformably overlain by basic flows of the Baie Verte Group. The locality is unfortunately only accessible by sea.

However, our present knowledge suggests that in this part of Newfoundland a series of sediments deposited in pre-Ordovician time was deformed and metamorphosed before deposition of the lower Ordovician and later volcanic sequences. These in turn were deformed in probable Upper Silurian-Devonian time. The Fleur de Lys rocks can probably be followed into New Brunswick and Quebec. In Newfoundland they contain economic base metal and asbestos deposits. They would seem to be just as important as the host rocks of economic deposits in Quebec and New Brunswick.

FIRST DAY

The Fleur de Lys Supergroup in the northern part of the Burlington Peninsula

DISCUSSION

Work north of Baie Verte and between Ming's Bight and Grand Cove has recently been completed, providing a detailed and fairly complex structural and metamorphic history and revealing several large recumbent F_2 folds. Although tops are rare, these F_2 isoclines face northwards in the Fleur de Lys Peninsula and southwestwards east of Ming's Bight. This suggests that either a major F_1 fold closure with an amplitude of a 15 miles separates the two areas, or that the D_2 structures of the Fleur de Lys rocks comprise a nappe complex with folds facing outwards from a central symmetry axis. East of Baie Verte the succession mapped by Fuller (1941) can be subdivided into three stratigraphic sequences, separated by D_1 tectonic slides and folded by the major F_2 folds. The most eastern of these sequences can be correlated with the succession exposed to the east of Ming's Bight. Later structures are generally of smaller scale than the D_2 structures. The ultrabasic rocks of these areas are particularly interesting as many are demonstrably pre-D_1 intrusives into the Fleur de Lys rocks and are thus not related to the Baie Verte basic volcanic sequence, but possibly to the Pacquet Harbour Group and the Birchy Schist, both basic metavolcanics of the Fleur de Lys. The day's stops will be concerned with the structural features of the Fleur de Lys rocks.

Description of Exposures and Road Log

Proceed north from Baie Verte on road to Fleur de Lys. Note Advocate Asbestos body on right hand side of the road shortly after leaving the pavement. Take right fork to Coachman's Cove. Note that schistosity in the exposures you have been passing is gently inclined -- this is the S_2 schistosity of the Fleur de Lys rocks. As you proceed eastwards to Coachman's Cove, this fabric steepens until it becomes sub-vertical in the cove itself. Proceed along shore on southward side of the cove.

STOP 1: By the government wharf; cars can be left at the road junction by the community stage. The geology will be explained with the aid of a detailed map. The main map units are shown on Fig. 2. Here quartz, garnet, magnetite, stilpnomelane bands in the Birchy Schist are folded by isoclinal F_2 folds and refolded by a later strain-slip schistosity. Returning to the community stage actinolite, sericite schists of the South Cove Schist can be seen -- they occupy the core of a northward closing F_2 fold (anticline).

STOP 2: Proceed back along the shore, past the junction with the road out of the cove to the northern shore at Flat Point. Cars can be left where the road terminates. Here the core of the syncline to the east of the anticline containing the South Cove Schist at Stop 1 can be examined. The psammites of the Flat Point Schist occupy the fold core with interbedded calcareous schists on the junction with the Birchy Schist to the east and west. Actinolite, fuchsite pods on the western side of the psammites probably represent the equivalent of pre-D_1 ultrabasic intrusions which have now been severely disrupted and folded by subsequent deformations. Two strain-slip schistosities with related folds can be seen here later than the S_2 schistosity. Numerous F_2 folds can be seen in the psammites (Fig. 3).

Proceed back out of Coachman's Cove and take the right turn at the road junction at the top of the hill for Fleur de Lys.

STOP 3: Just beyond the generating station at the entrance to Fleur de Lys village. On the south side of the road a small serpentinite body is exposed. Examination of the fabrics contained within it show that it contains the same structural history as the enclosing Fleur de Lys metasediments and amphibolites. It is a pre-D_1 intrusive. A brief walk over the hill, time permitting, will demonstrate the relationship with the overlying amphibolite. Ultrabasic bodies elsewhere in the Burlington Peninsula show similar relationships in their margins although the larger bodies are non-schistose and show relict igneous features in their centres. Most, if not all the ultrabasic bodies in the Burlington Peninsula may be early Fleur de Lys intrusives. They do not seem to be intrusions along later faults. This part of the Peninsula contains northward facing originally recumbent F_2 folds in the Fleur de Lys rocks (Fig. 3).

Proceed southwards back to Baie Verte, through the town and turn left on the La Scie road approximately 2 miles south of the centre of town. Drive eastwards, across the northern end of the Burlington Granodiorite and proceed across the Pacquet Harbour Group. Note the exposures of amphibolites of this group on the roadside and the access road to the Rambler Mine situated in these rocks. Pass the junction to Ming's Bight and turn left to Woodstock and Pacquet at the next road junction. Turn sharp left along the shore of Pacquet Harbour. Note the almost continuous exposures of the Dunamagon Granite.

STOP 4: Park beside road at entrance to Pacquet village and proceed down to shore. The Dunamagon Granite which is massive in its centre is strongly schistose in the margins here (Fig. 4). Aplitic dykes are folded by F_3 folds of the Fleur de Lys rocks. The psammites of the MIng's Bight Group show a D_1 tectonic slide, F_2 and F_3 folds. The schistosity in the granite is S_2. Thin section study may show that the granite contains S_1 as well as the S_2 schistosity. It is clearly a pre-D_2 intrusive.

STOP 5: A little further to the north the Pacquet Harbour Group, or rather its transitional facies with the Ming's Bight Group is faulted in. Here staurolite, kyanite, garnet schists can be seen. This is one of the few recorded occurrences of kyanite in rocks of the Fleur de Lys Supergroup. A few yards further north quartzites and amphibolites are superbly folded by F_2 folds.

Proceed along road into Pacquet village itself, underlain by the Ming's Bight Group and stop on the northern side of the Harbour close to the end of the road.

STOP 6: Roadside exposure of amphibolites with interbedded quartzites and psammites superbly folded by F_3 folds. One F_2 fold closure can be seen.

STOP 7: Proceed to end of road and take narrow path to shore. Amphibolites here show deformed vesicles. The long axis of the vesicles is parallel to the mineral lineation. The bulk strain was caused by the first deformation and then folded by the F_2 folds. F_2 folds of a dark quartzite, possibly originally a ferruginous chert are well shown. A little farther along the coast a concordant body of quartz feldspar porphyry is folded by F_2 folds and contains S_1 schistosity. This is interpreted as being related to the main body of porphyry seen further east which shows similar features and is also a pre-D_1 intrusive. The contacts between many porphyry sills and amphibolite in this area show evidence of D_1 tectonic sliding.

Although it is not possible to demonstrate facing in the rocks seen here grading is common in the Ming's Bight Group, showing that the major F_2 recumbent folds in this are southward facing (Fig. 5), the opposite to that west of Baie Verte.

Proceed back to La Scie road and turn left. Proceed eastwards for two miles.

STOP 8: Quartz feldspar porphyry which is intrusive into the Pacquet Harbour Group. Fabrics are not well developed in the centre of this body.

Turn around and drive westwards past the Ming's Bight junction.

STOP 9: The contact of the Pacquet Harbour Group and the Burlington Granodiorite. In the main quarry amphibolites and intensely stretched agglomerates show a gradational junction with granodiorite to the west. This is interpreted as an intrusive contact. The marginal facies of the granodiorite seems to have been hybridised by the amphibolite wall rocks.

Return to Baie Verte for dinner and refreshments.

SECOND DAY

The Fleur de Lys Supergroup south of Baie Verte and its relationship to younger rocks

DISCUSSION

Work on the Fleur de Lys and younger rocks south of Baie Verte is presently being done by graduate students of Cambridge University. This will result in a considerable increase in the information available from this area. The unconformable contact between the Mic Mac Sequence and the Burlington Granodiorite is well exposed in several places and pebbles of a rock strikingly similar to the granodiorite occur in the conglomerates of the Baie Verte Group. Both map units are thus clearly younger than the granodiorite and the Fleur de Lys rocks it intrudes. They are also structurally and metamorphically very different. It is not known if any of the deformations of these younger rocks resulted in the development of fabrics in the Fleur de Lys, but it would generally appear not to have happened. The Fleur de Lys may have behaved as a rigid basement to subsequent deformation affecting the cover rocks. No clear fault relationship between the Baie Verte and Fleur de Lys has been found and this junction may well be essentially a refolded unconformity with the ultrabasic rocks being early intrusives into the Fleur de Lys sediments. Similarly, the relationship between the Mic Mac and Baie Verte rocks is still obscure although it can reasonably be interpreted as a fault contact. Fossils from either of these younger map units would be a great help.

Description of Exposures and Road Log

Drive south from Baie Verte on the Baie Verte Highway for approximately 12 miles. The roadside exposures consist of both Baie Verte rocks, ultrabasic rocks and the Birchy Schist since the road closely follows the Baie Verte / Fleur de Lys contact.

STOP 10: Roadside exposure of quartz, carbonate, fuchsite rock -- an alteration product of serpentinite at the northern end of Flatwater Pond. The ultrabasic body here is over a mile wide.

Proceed southwards for approximately one mile, turn left on Bear Cove - Westport Road. As you drive over the hill you are on serpentinite -- red cliffs of serpentinite can be seen over the brow of the hill on the left. Past the serpentinite the road passes over a series of semi-pelitic and psammitic metasediments of the Fleur de Lys Supergroup.

STOP 11: Roadside exposure of eclogite beside road. These rocks were first recognized by Church. They consist of boudin-like bodies enclosed in quartzofeldspathic country rock. Mr. M. DeWit will probably have some further details on the geology here.

Proceed westwards along road and take right turn at junction on to Bear Cove Road.

STOP 12: Conglomerate in the Fleur de Lys rocks. The pebbles show a variety of deformation types from almost pure stretching to almost pure flattening. Some of the conglomerate may be a pseudoconglomerate produced by boudinage. Although labelled as a tilloid by Church (1969) and Harland (1969), it is probably a basal conglomerate to the Fleur de Lys sequence -- Mr. DeWit will discuss its significance in some detail.

Return to the Baie Verte road and turn southwards again. Take woods road to left just beyond southern end of Flatwater Pond and then take next turning on the left. Leave cars by bridge which is now unsafe for vehicles. Cross bridge and walk up hill.

STOP 13: Unconformable relationship between Mic Mac Sequence and Burlington Granodiorite. The granodiorite here is overlain by schistose granodiorite wash with granodiorite boulders and then conglomerates with volcanic and granodiorite boulders in it. This is the base of the Mic Mac Sequence in this area. Mr. W.S.F. Kidd will add more comments on the geology here.

Return to Baie Verte road and continue southwards, turn sharp left at next woods road. Drive back to north and turn right at junction -- drive across bridge and continue for approximately 1/2 mile.

STOP 14: Mic Mac unconformity again. Here there must have been a great deal of relief on the basal Mic Mac surface. A gulley in the granodiorite is filled with breccia, rhyolite and ignimbrite. The ignimbrites are particularly impressive. Mr. W. S. F. Kidd will add some details of the geology here.

Return to Baie Verte road and drive southwards for 1/2 mile.

STOP 15: Kidney Pond. Proceed along northern shore of pond to old dam. Basic tuffs of the Baie Verte Group face east here and indicate a syncline to the east on the S_1/ bedding intersection. These rocks are comparatively unaltered. Proceed to western shore of pond where the Birchy Schist shows a complex deformation history in comparison to the Baie Verte Group. Although both rocks are basic, their contrasting structural and metamorphic histories demonstrate that they must be of different ages. The contact between the two cuts across the strike on either side. It has been interpreted as a fault at this locality.

End of Field Trip.

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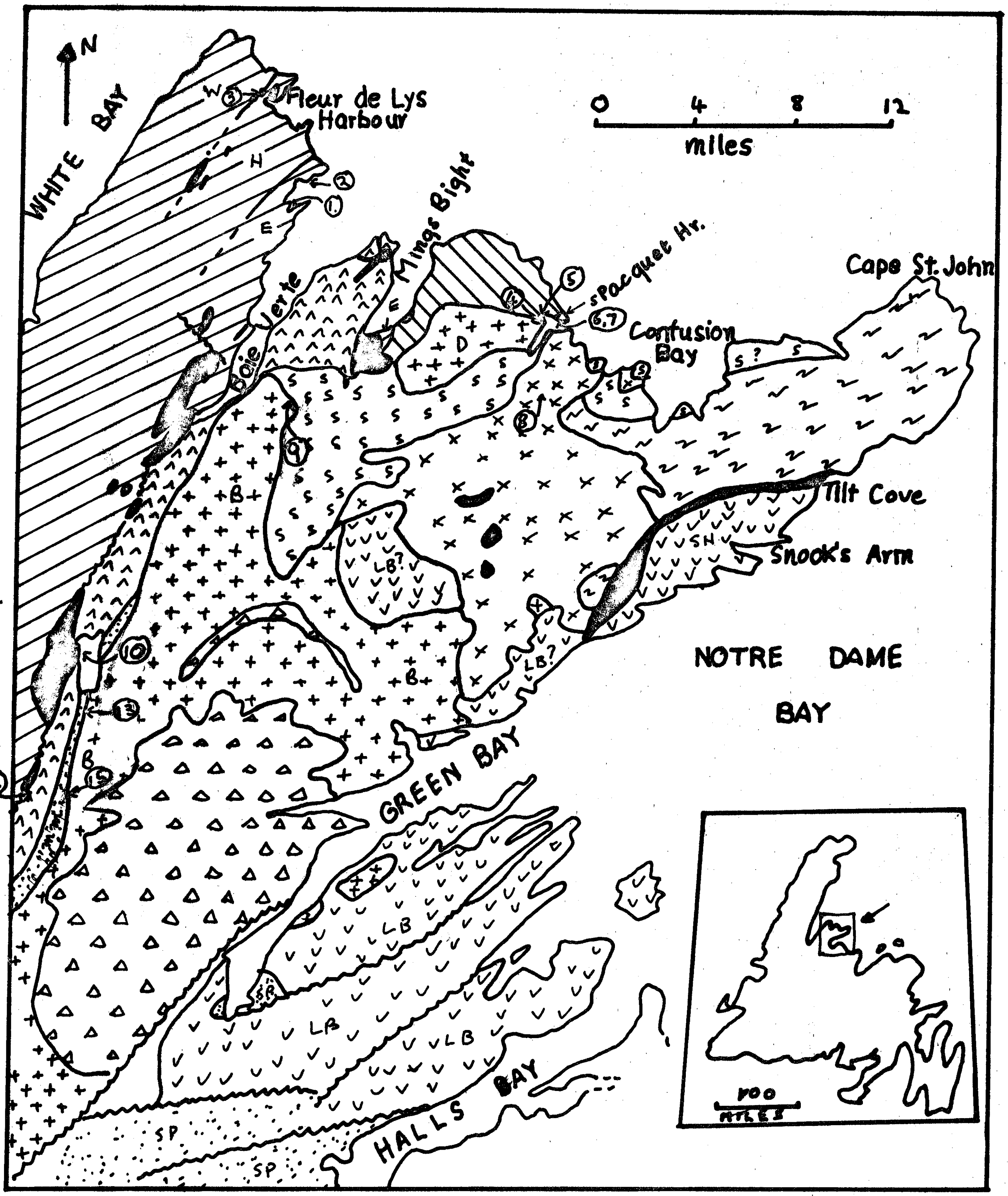

Fig. 1. Burlington Peninsula, Newfoundland. Modified after Neale and Kenney (1967), Church (1969).

LEGEND FOR FIG. 1.

SILURIAN-DEVONIAN

- SP — SPRINGDALE GROUP (SANDSTN, ACID AND BASIC VOLC)

SILURIAN?

- MM — MIC MAC SEQUENCE (CONGLOM, ACID, BASIC VOLC)
- ACID FLOW AND PYROCLASTIC ROCKS

ORDOVICIAN?

- BAIE VERTE GROUP (BASIC VOLC, MINOR SED.)

ORDOVICIAN

- GRANODIORITE INTRUSIVE INTO LUSH'S BIGHT GROUP
- SN. SNOOKS ARM GRP }
  L.B. LUSH'S BIGHT GROUP } (BASIC VOLC. SEDS)

PRE-ORDOVICIAN

FLEUR DE LYS SUPERGROUP

INTRUSIVE ROCKS

- GRANITE AND GRANODIORITE
  B. BURLINGTON GRANODIORITE (POST D_2)
  D. DUNAMAGON GRANITE (PRE D_1?)
- QUARTZ FELDSPAR PORHYRY
- ULTRABASIC ROCKS (IN PART OR ALL PRE-D_1)

METASEDIMENTARY AND METAVOLCANIC ROCKS

- CAPE ST JOHN/GRAND COVE GROUP (ACID, BASIC VOLC MINOR METASED.)
- PACQUET HARBOUR GROUP (BASIC METAVOLC)
- MINGS BIGHT GROUP (PSAMMITE) } IN PART EQUIVALENT (PSAMMITE BASIC VOLC, CALC SILICATE)
- FLEUR DE LYS ROCKS OF WESTERN BELT
  E. EASTERN SEQUENCE }
  H. HARBOUR SEQUENCE (MAINLY SEMI-PELITE)
  W. WHITE BAY SEQUENCE (MAINLY SEMIPELITE AND PSAMMITE)

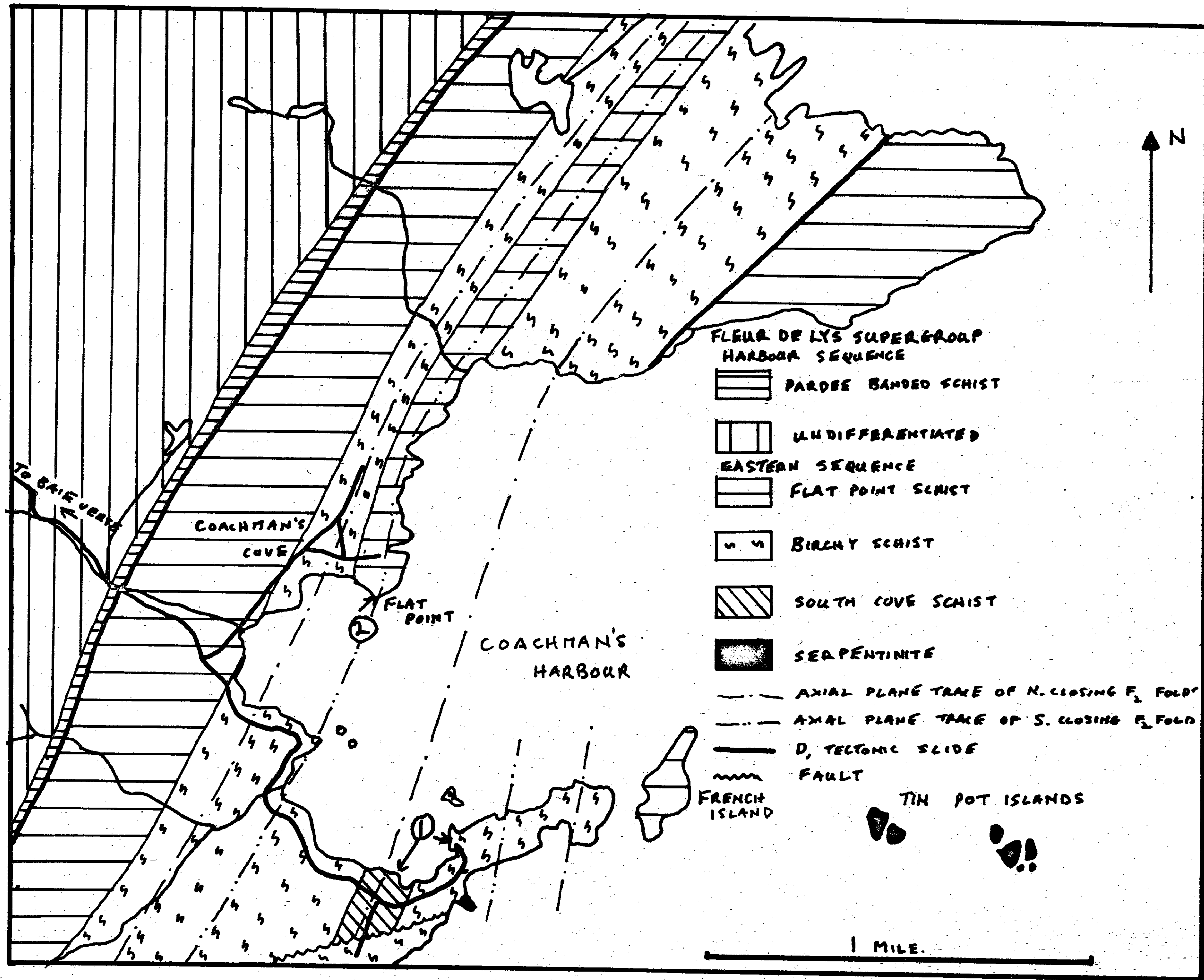

FIG. 2. GEOLOGIC MAP OF COACHMAN'S COVE.

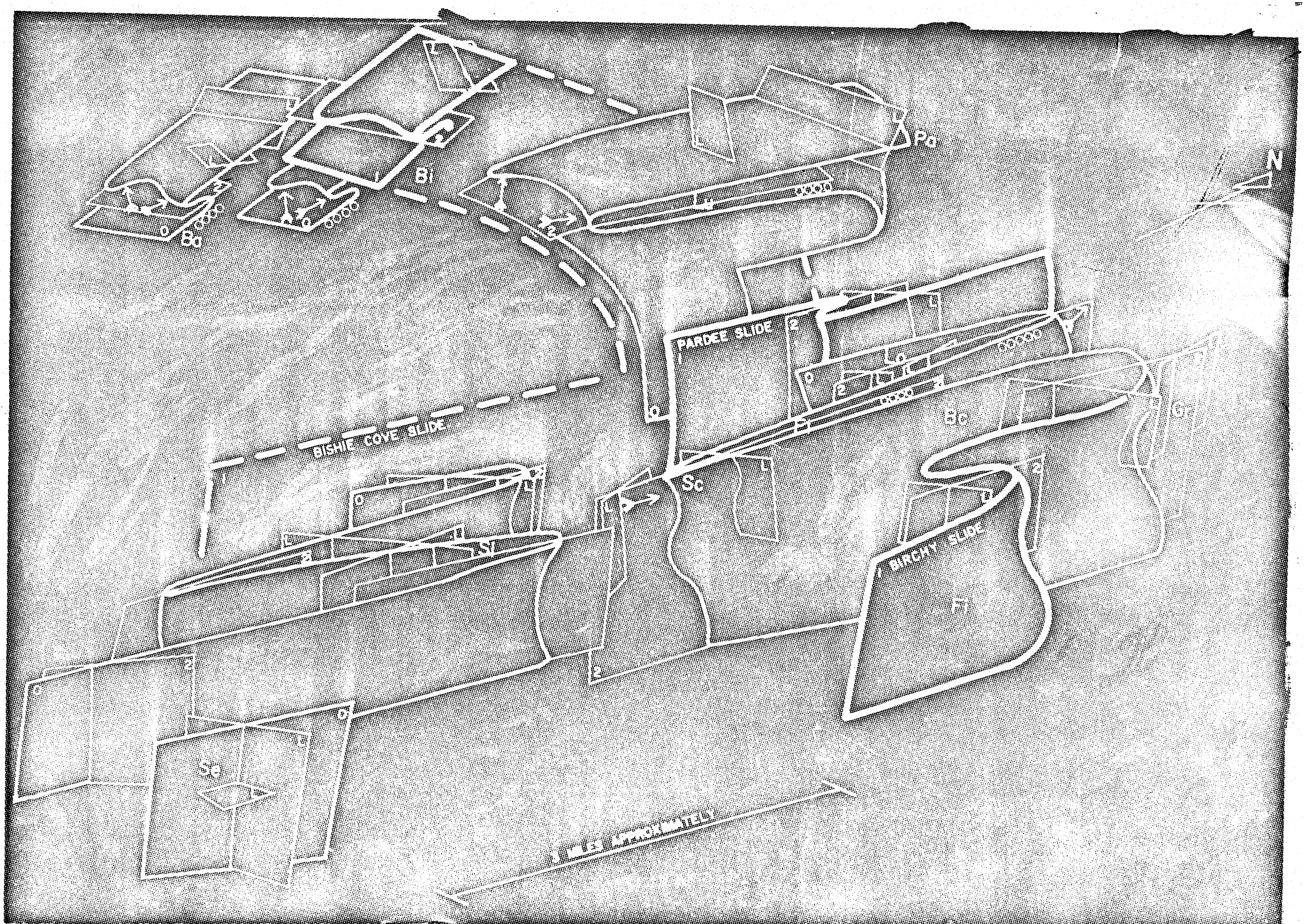

Fig. 3. Diagrammatic representation of the structures between Baie Verte and White Bay. Surfaces are labelled: 0: bedding, 1: D_1 slides, 2: S_2, L: later strain-slip fabrics.

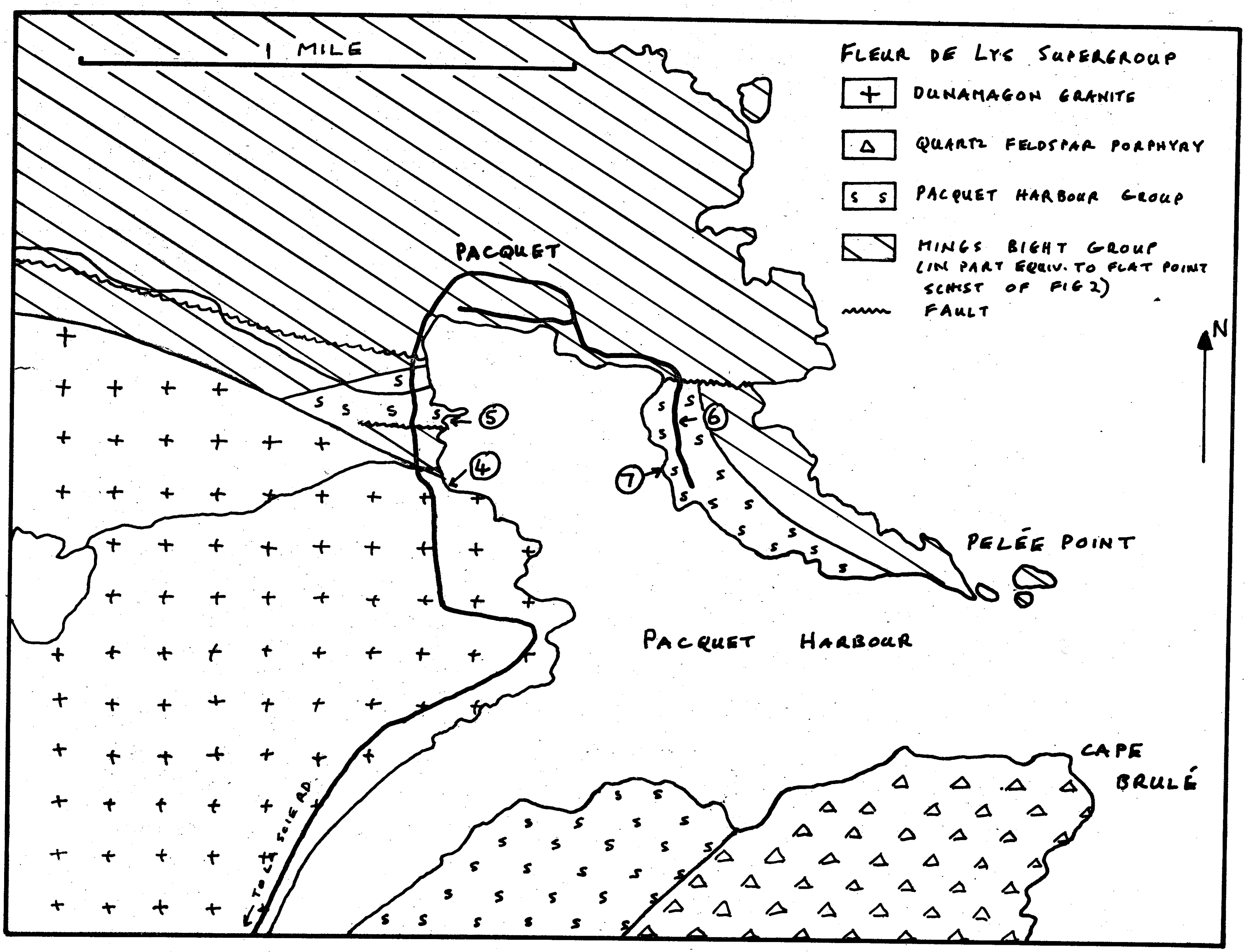

FIG 4. GEOLOGIC MAP OF PACQUET HARBOUR.

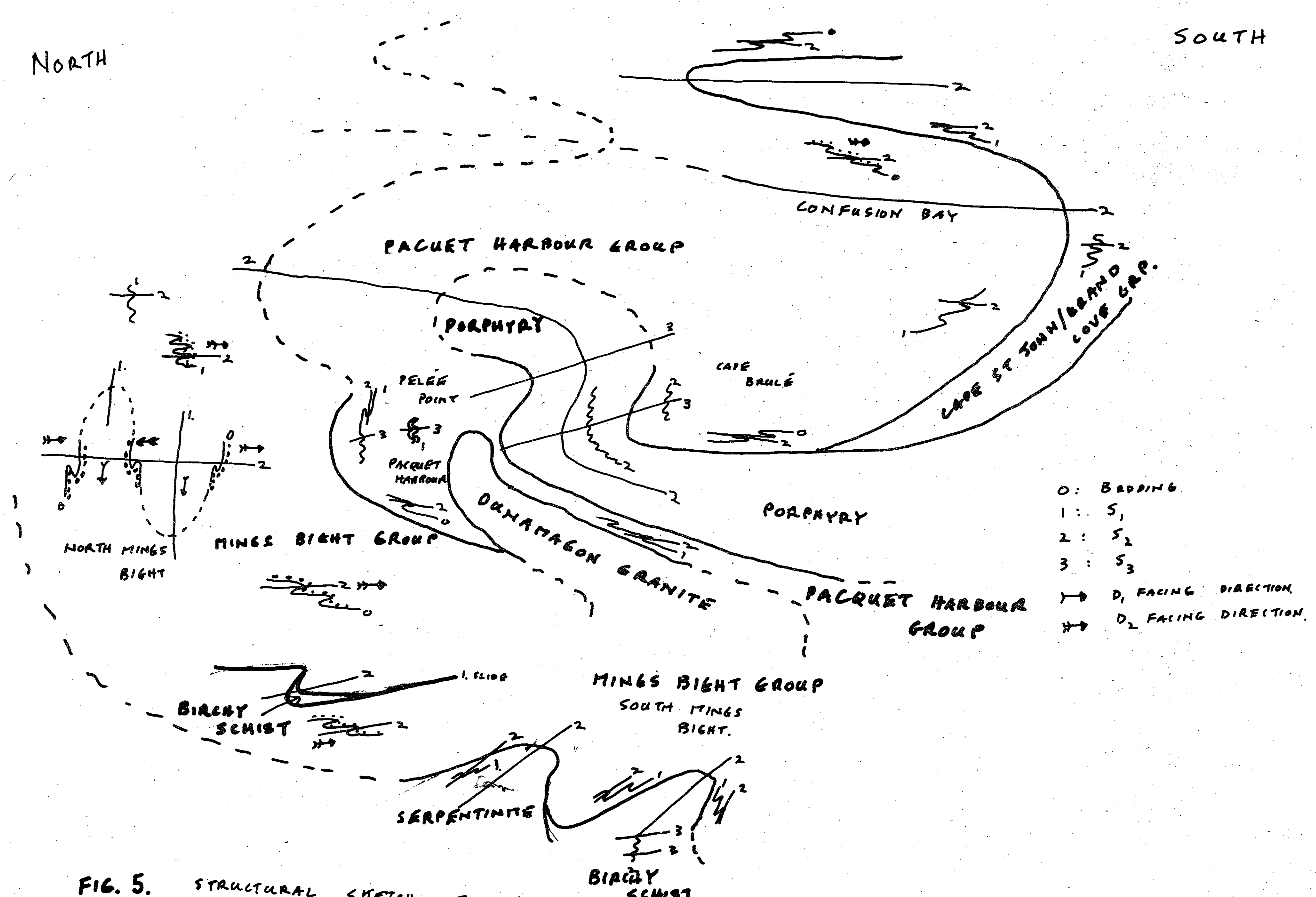

FIG. 5. STRUCTURAL SKETCH OF THE STRUCTURE EAST OF MINGS BIGHT.

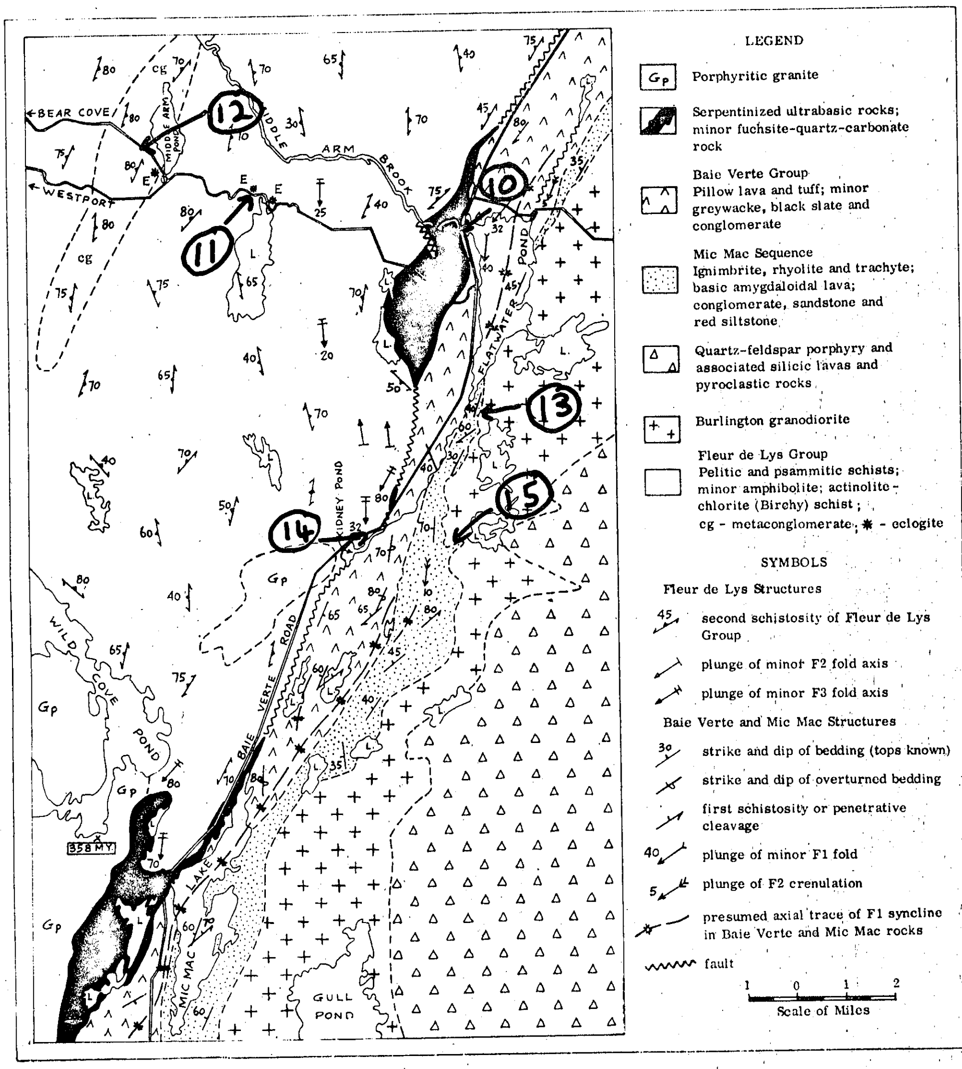

Figure [redacted]6.Geological map of the Mic Mac Lake-Flatwater Pond Region.
(FROM NEALE AND KENNEDY, 1967)