THE STRATIGRAPHY AND SEDIMENTOLOGY OF THE CINQ ISLES FORMATION FORTUNE BAY, NEWFOUNDLAND

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By

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Abstract

The Cinq Isles Formation consists of up to 1500 feet of limestones, sandstones, shales and conglomerates, well exposed around the shores of Fortune Bay, southern Newfoundland.

The succession unconformably overlies the Simmons Brook batholith towards the southeast and Cambrian shales toward the southwest. The Formation is overlain disconformably by thick red conglomerates of the Pools Cove Formation in the northeast and it is overlain disconformably by lithologically similar thick red conglomerates that were mapped previously as the Great Bay de l'Eau Formation toward the southwest. West of Salmon River the Pools Cove Formation oversteps the Cinq Isles Formation to lie directly on the Simmons Brook granite.

The Cinq Isles Formation consists of thinly bedded unfossiliferous limestone, red and grey shales, sandstones and pebble beds. There is every gradation from laminae to discrete blebs of limestone within shale. Pebble beds, many with a carbonate groundmass, become dominant in the upper part of the sequence. Within the succession, lateral and vertical variations are common. Gneissic clasts from the metamorphic Bay d'Espoir belt and granite clasts are abundant in many of the pebble beds and in the coarse conglomerates overlying the Cinq Isles Formation. Current direction features in sandstone and pebble beds indicate incoming currents from the north and northeast. The coarseness of the clasts suggests a nearby source area. The nature of the gneissic clasts and their provenance implies Precambrian crystalline basement within the Avalon Zone toward the northeast.

The age of the Cinq Isles Formation is uncertain, however, it is regarded as being Upper Silurian or Devonian because of its close stratigraphic relationship to the possibly Devonian Pools Cove Formation and the fossiliferous Devonian Great Bay de l'Eau Formation. The Pools Cove Formation is assigned to the Devonian because it contains granite boulders lithologically similar to Devonian granites in central Newfoundland and it is cut by the Devonian Ackley batholith.

Terrestrial conditions were prevalent during Middle-Late Silurian and Devonian times throughout much of Newfoundland. The lithologies of the Cinq Isles Formation suggest a near shore carbonate environment bordering an alluvial fan chain. Periodic flooding and entrenchment of the fan surfaces brought coarse material into the carbonate basin from the north and northeast. Subsequent encroachment of the alluvial fan across the near shore carbonate environment gave rise to the coarse upper deposits of the Cinq Isles Formation and the overlying Pools Cove conglomerates.

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CHAPTER I

INTRODUCTION

Location & Distribution

The Cinq Isles Formation is exposed around shores of the central part of Fortune Bay in two main areas, Belle Bay in the east and Great Bay de l'Eau in the west (fig. 1). In the Belle Bay area exposures are seen on the east and west shores of East Bay and North Bay and on the northwest shore of Cinq Islands Bay. Exposures here are due to reverse faults that bring the Cinq Isles up against the younger Pools Cove Formation. Inland exposures are generally poor due to the thickly wooded terrain. However, small exposures are seen along the north side of the Pools Cove - Belleoram road west of Salmon River, and along Salmon River around the area locally known as 'the funnel' north of the road. A number of exposures are seen fifteen to twenty miles southwest in the Great Bay de l'Eau, Harbour Breton area.

Access

A network of gravel roads in the area has recently been connected (1972) to the Trans-Canada Highway by the Bay de'Espoir road that crosses central Newfoundland. (Figure 1). The area is also accessible by sea via Canadian National coastal boats that make regular stops at Rencontre East, Pools Cove, Belleoram, English Harbour West and Harbour Breton.

Within the study area all coastal sections are easy of access by small boats. Few of the sections can be traversed by foot due to the ruggedness of the cliffs and the lack of any sort of beaches.

FIG:1

LOCATION, ACCESS, AND TOPOGRAPHY.

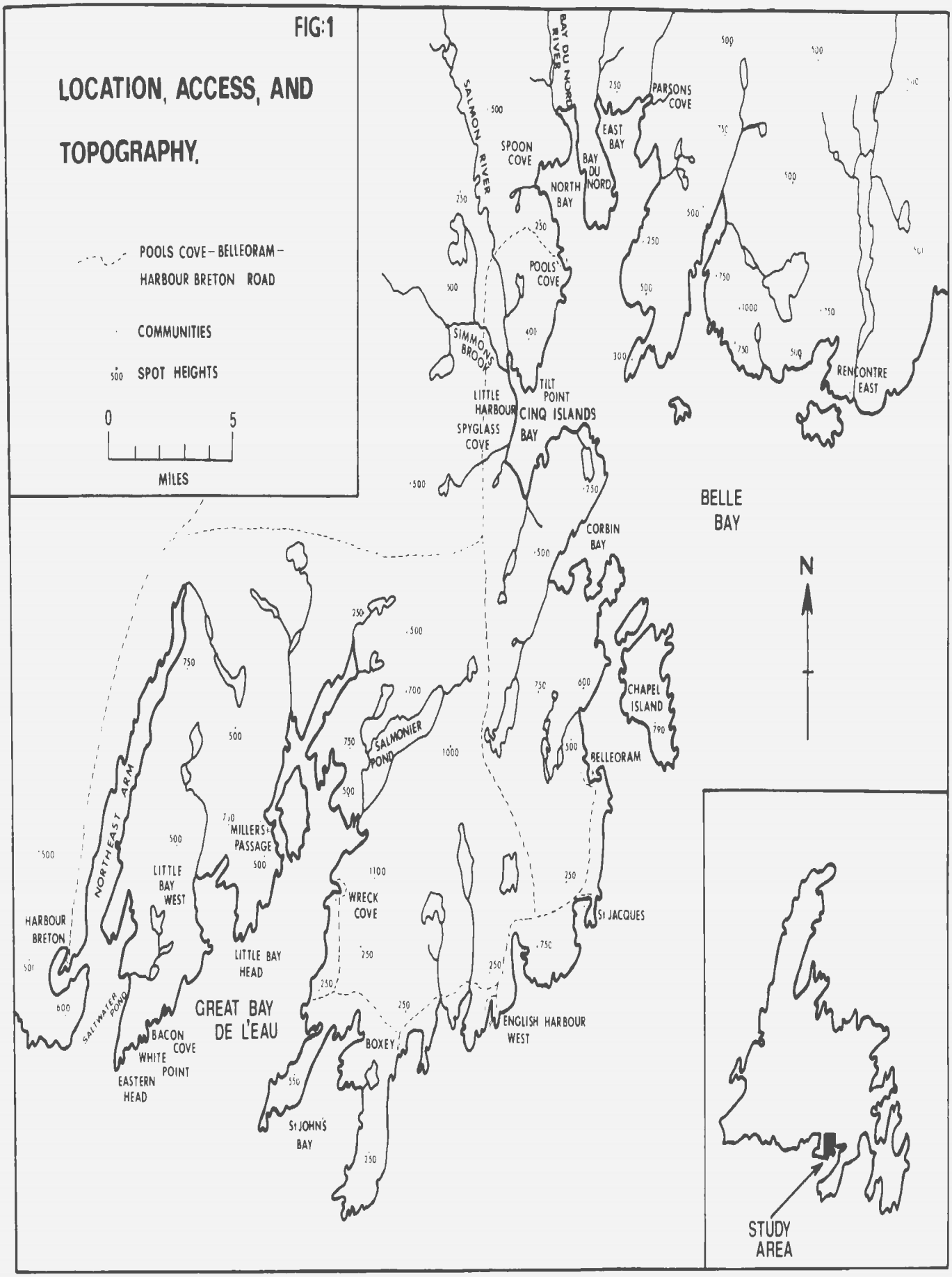
POOLS COVE – BELLEORAM – HARBOUR BRETON ROAD

COMMUNITIES

500 SPOT HEIGHTS

0 5

MILES



Physiography

The Cinq Isles Formation and other sediments are characterized by moderate to gently rolling terrain that contrasts sharply with the more rugged terrain developed upon volcanic and granitic rocks (figure 2). The Cinq Isles, Pools Cove and Great Bay de l'Eau Formations are tree-covered, with most vegetation being found in stream and river valleys and sheltered areas. Cinq Isles rocks rarely give rise to land over 500 feet. The highest hills in the area, with heights up to 1100 feet, are underlain by differentially eroded volcanics. These are seen to the north of Belle Bay and Harbour Breton. To the northeast of Belle Bay and north and north-east of Great Bay de l'Eau a barren rolling terrain is developed on the Ackley Batholith (White, 1939, 1940) (Figure 2). This is in contrast to the rough hummocky tree covered surface characterising the more sodic and heterogeneous Simmons Brook granite. This occurs as a belt from the North East Arm of Harbour Breton northeast to East Bay. West of Belleoram, the Belleoram Stock (Ermanovics et al., 1967b) has a wooded irregular topography.

Most exposures of the Cinq Isles Formation are at headlands or along the sides of northeast trending bays and sea entrants. Headlands are controlled either directly by glacial ice movement or by the modification of an earlier structural pattern. The Northeast Arm of Harbour Breton, Little Bay and North Bay are all examples of an ice carved coastline. Salmonier Pond and North Bay are other examples of an ice carved coastline. Structural control later modified by ice is seen at Great Bay de l'Eau, Cinq Islands Bay, and East Bay. These features coincide with a zone of comparatively non-resistant sandstones and shales that have been folded about northeast axes and cut by northeast trending faults.

Cinq Isles Exposures along the shore usually form small cliffs which in Belle Bay are no more than 20 feet high. In Great Bay de l'Eau the cliff exposures are somewhat higher, the highest just north of Wreck Cove is approximately 100 feet.

Local marine terraces are seen at Harbour Breton, Little Bay, Salmonier Pond, North Bay and East Bay. They are at approximately 50 feet above sea level and are composed of coarse stratified material.

The only large rivers in the area are the Salmon River draining into Cinq Islands Bay, Bay du Nord River draining into North Bay and Northwest and Northeast Brooks draining into East Bay.

Geological Setting

The Cinq Isles Formation is situated on the western margin of the Avalon Platform. The platform represents a relatively stable block with a fault contact against the westerly, more complex Central Mobile Belt of Central Newfoundland. The Avalon Platform is made up of Late Precambrian volcanics and sediments which have undergone granite intrusion and block faulting. Continuous deposition from Late Precambrian to Lower Ordovician is recorded in some troughs developed by block faulting. Uplift, faulting, local sedimentation and granite intrusion during the Acadian orogeny are some of the late events effecting the Avalon Platform.

The general geology of the Avalon Platform is reflected in the study area. A thick sequence of Late Precambrian volcanics and sediments and Lower Paleozoic sediments have been folded and faulted about northeast axes. Later granite intrusion with faulting, syn- and post-tectonic sedimentation during the Devonian are the last recorded geological events in the area.

The Cinq Isles Formation is exposed within an area bounded on the southeast by the East Bay Fault and on the northwest by the Hermitage Bay

Fault and extending southwest into Great Bay de l'Eau (Williams, 1971). Much of the area is underlain by the Simmons Brook Batholith (Figure 2) of possible Ordovician age. The batholith is composed of a variety of pink to grey, medium- to coarse-grained granite and granodiorite with locally predominant dark green mafic intrusive rocks. The mixed lithology, especially its mafic and contaminated phases, clearly distinguish it from the younger more homogeneous Ackley Batholity and the Belleoram Stock. The Simmons Brook Batholith is now recognized to be unconformably overlain by the Cinq Isles Formation and the Pools Cove Formation (Williams, 1971). Formerly these formations were thought to be intruded by the granite. The Cinq Isles - Simmons Brook unconformable contact is well displayed at Parsons Cove, east of East Bay, Belle Bay. The other contacts in Belle Bay have all been modified by faulting, although all contain a basal unit of quartz feldspar granular material from the underlying granite. To the west in Great Bay de l'Eau only one complete section is exposed. This section at Wreck Cove, unconformably overlies Cambrian argillites. Granite fragments are common in places within the Cinq Isles succession. Other Cinq Isles exposures in the area are of the upper parts of the section only.

The Cinq Isles is composed of up to 1500 feet of red to grey shale, sandstone, mixed beds of carbonate and shale and pebble beds. Lateral variations within the formation are common, and at Spoon Cove to the west of North Bay the base of the section is made up of 150 feet of dark massive sandstones that are not seen elsewhere. Several of the sections contain increased amounts of coarse sandstones and conglomerates towards the top where they are disconformably overlain by coarse deposits of the Pools Cove Formation in the northeast and the Great Bay de l'Eau Formation in the southwest. The Pools Cove Formation consists of up to 5000 feet of arkosic sandstones and red conglomerates. West of Salmon River it overlaps the Cinq

Isles Formation and rests directly upon the Simmons Brook Batholith.

The Great Bay de l'Eau Formation is exposed on the headland between Cinq Isles Bay and Corbin Bay and around the shores of Great Bay de l'Eau. The formation is made up of poorly bedded purple to red, grey and buff conglomerate. Clasts within the rock are in most cases similar to underlying rocks so that the appearance of the formation changes markedly where it overlies contrasting rock types. Recent Work by Ermanovics (1967a) on the statistical composition of two distinct plagioclase types, and by Williams (1971) suggest that the Great Bay de l'Eau Formation at Little Bay West can be correlated with the Pools Cove Formation, at least in part.

The Ackley Batholith is found to the north of Belle Bay with smaller phases northwest and northeast of Great Bay de l'Eau. The Ackley Batholith is composed of a massive, medium to coarse grained homogenous pink granite. Several isotopic dates in the order of 360 million years have been recorded placing it within the Devonian (Jenness, 1963; Wanless et al., 1965). Various intrusive phases are seen; an earlier phase, pebbles of which are included in the Pools Cove Formation and the Great Bay de l'Eau Formation, and a later phase, which cuts the Pools Cove Formation.

The youngest of the granite intrusions is the Belleoram Stock. The intrusion crops out in the vicinity of Belleoram and cuts the Great Bay de l'Eau Formation. The Belleoram stock is made up of a uniform grey to pink massive granite formally named adamellite (Ermanovics et al., 1967b). The stock characteristically contains in places small shale xenoliths from the surrounding country rock. The Belleoram Stock is Late Devonian in age emplaced at a very high level within the crust (Ermanovics, 1967b).

The Cinq Isles Formation contains clasts eroded from various older terrains within the Fortune Bay area. Some of these clasts are from the area east and southeast of the East Bay fault. Much of this terrain is underlain

by the Precambrian Long Harbour Group (Williams, 1971). The group comprises a thick succession of silicic and mafic volcanic rocks (Belle Bay Formation) overlain by grey sedimentary rocks (Andersons Cove Formation), mixed volcanic and sedimentary rocks (Mooring Cove Formation), and a thick purple to red sedimentary assemblage (Rencontre Formation). Williams (1971) has shown that the Long Harbour Group can now be correlated with the lithologically similar late Precambrian Musgravetown Group of eastern Newfoundland. A recent whole rock RG/Sr isochron age determination from the Belle Bay volcanics gives a figure of 515 ± 7 million years (Williams, 1971) further supporting the Late Precambrian age assignment for similar dates have been determined on Precambrian rock nearby (McCartney et al., 1966). Local areas are underlain by shale, siltstone and slates of the Late Precambrian or Cambrian Youngs Cove Group.

Other clasts within the Cinq Isles Formation have possibly come from the Connaigre Bay volcanics to the west of Great Bay de l'Eau. These comprise a thick sequence of massive dark green felsites and agglomerates. In the area to the northwest of the Hermitage Bay fault, schists and gneisses of the eastern margin of the Central Mobile Belt (Williams, 1964) also occur as clasts within the Cinq Isles Formation.

Previous Work

The first mention of Cinq Isles type deposits was made in an early report of the Geological Survey of Newfoundland by J. P. Howley (1887). As part of a large scale reconnaissance, Howley visited this area in Fortune Bay and described part of a section on the eastern shore of North Bay near the outport of Bay du Nord. This section was Howley's only mention of Cinq Isles lithology.

There was little subsequent work until White (1939) commenced geological investigations. This work originally concerned the molybdenite deposits north of Rencontre East and was later extended to include mapping of the Belleoram area. The results of the regional study are contained in an unpublished doctorate dissertation. Because of the scope of the work, White's study of the Cinq Isles Formation was in the Belle Bay area only.

Kemble Widmer (1950) mapped the Hermitage Bay area and studied many of the outcrops in Great Bay de l'Eau, Belle Bay and the Salmon River area. Widmer's work was quite detailed for a regional mapping project and contains the most detailed maps and descriptions of the Cinq Isles Formation up to that time. His study was carried out as a doctoral dissertation at Princeton University.

Smith and White (1954) in an unpublished report of the Geological Survey of Canada mapped the geology of the Rencontre East area. Brief mention of the Cinq Isles Formation was made, but most of the information was based on Widmer's work.

Anderson (1965) briefly mentioned Cinq Isles type lithologies in the marginal notes to accompany his one inch to four miles reconnaissance map published by the Geological Survey of Canada.

Williams (1971) mapped the Belleoram area (1M/11) at a scale of 1:50,000 for the Geological Survey of Canada. Most of his information on the Cinq Isles came from the Belle Bay and Salmon River areas. The Great Bay de l'Eau area was not included by the map boundaries although information from this area was taken into consideration in Williams' account.

Purpose and Scope of Present Study

The investigations for this study were begun in July, 1969 while the

author was working for Dr. H. Williams of Memorial University of Newfoundland on a contract for the Geological Survey of Canada to map the Belleoram map area (1M/11) on a scale of 1:50,000. During 1969, preliminary investigations and detailed measuring of sections were carried out in the Belle Bay area. The sections in Great Bay de l'Eau were measured in the summer of 1970. The Cinq Isles Formation as a whole was investigated in 1970 in all locations along with relationships to underlying and overlying rock groups.

All the Cinq Isles sections were measured by pacing and tape measure to the nearest foot. Complete descriptions of all rock units and sedimentary features were taken. Representative samples were collected and thin sections made. In addition, several large samples of favourable lithologies were collected in hopes of recovering microfossils. A large number of photographs were taken.

The study was undertaken to evaluate all previous correlations and age arguments and to further understand the mode of occurrence, geologic environment and setting of the Cinq Isles Formation within the context of Fortune Bay and Avalon Platform geology.

CHAPTER II

STRATIGRAPHY AND GENERAL GEOLOGY

General Statement

The name Cinq Isles Formation refers to an assemblage of red and grey shales, sandstones, mixed beds of carbonate and clastic units, limestones and pebble beds. The Formation is exposed around the shores of Belle Bay, Great Bay de l'Eau and part of the course of Salmon River (Figure 1).

In the Belle Bay area the Cinq Isles Formation unconformably overlies the Simmons Brook Batholith. The contact is well exposed at Parsons Cove on the eastern shore of East Bay. There, a basal conglomerate made up of red silt containing granite wash and angular granite fragments overlies the Simmons Brook Batholith. Elsewhere in the Belle Bay area the basal contact has been modified by faulting. However, all of the sections, with the exception of Spoon Cove on the eastern shore of North Bay, exhibit a basal unit containing quartz feldspar material from the underlying Simmons Brook Batholith.

To the west in Great Bay de l'Eau only one complete section is exposed (Figure 1). This is seen at Wreck Cove where the sequence rests unconformably upon dated Cambrian siltstones, shales and slates. All of the other lower contacts in this area are beneath sea level with only the upper parts of the section exposed.

Maximum thicknesses of complete Cinq Isles sections vary from 1000 to 1450 feet. Lateral and vertical variations within the sequence are common. Individual beds cannot be correlated from one section to another but large scale units can be traced within the various sequences. The most notable

example of lateral variation is seen at Spoon Cove where the base of the section is composed of 150 feet of dark grey massive sandstone. This basal unit is not present in any of the other sections. The name Spoon Cove Member is proposed for this lower section.

The Cinq Isles Formation is disconformably overlain in the Belle Bay area by the Pools Cove Formation and in the Great Bay de l'Eau area by the Great Bay de l'Eau Formation. Minor faulting in some of the sections has obscurred the actual disconformable surface. West of Salmon River the Pools Cove Formation overlaps the Cinq Isles to rest unconformably on the Simmons Brook Batholith.

Small dykes and sills probably related to the Devonian Ackley Batholith have caused slight contact metamorphism in some of the Cinq Isles sections. This is well seen at Spyglass Cove, Cinq Islands Bay. At Wreck Cove, Great Bay de l'Eau, some of the mixed beds have undergone thermal metamorphism causing solution and recrystallisation of the carbonate and hornfelsing of nearby silts. This gives a volcanic flow appearance to some of the beds. No dykes or sills are present at Wreck Cove and the metamorphism may relate to the emplacement of the Ackley Batholith.

In Belle Bay the information forms a northeast-trending southeast-dipping succession. Dips range from 45^{o}-75^{o}. The Cinq Isles at Tilt Point and Spyglass Cove in Cinq Islands Bay also forms a northeast-trending steeply southeast-dipping succession. It is faulted against the Pools Cove Formation to the northwest and against Cambrian rocks to the southeast. The succession has been brought into place by a series of reverse faults.

The Cinq Isles Formation of Great Bay de l'Eau generally strikes northeast and dips southeast, however, several structural complications are present. The Wreck Cove section contains a number of small normal faults which repeats part of the sequence. The displacement on most of the faults

is small enough to allow marker beds to be traced from one side to another. Low down in the middle of the sequence, faulting and folding cause 80 feet of beds to be overturned. The major structural complexity is the occurrence of a 150-foot wedge of Cambrian Salmonier Cove Formation slates and shales faulted into the Cinq Isles Formation. Structural effects to the Cinq Isles, however, are minimal, except for shattering and crushing within a few feet of the thrust surfaces. At Saltwater Pond, west of Harbour Breton, a thin sliver of Cinq Isles is faulted between Connaigre Bay Volcanics (Widmer, 1950) and Great Bay de l'Eau Formation. This thin wedge is somewhat crushed and broken. The other sections in Great Bay de l'Eau are structurally simple having a northeast strike and a southeast dip.

STRATIGRAPHY

Nomenclature and History of Correlation

The Cinq Isles Formation has been placed in a number of systems by previous workers. These range from Late Precambrian to Ordovician and Silurian. Recent evidence, however, in this study indicates a Devonian age. The age of the formation and its relationships to other groups according to this study and previous workers is tabulated in Table 1.

Howley in 1887 in a report to the Geological Survey of Newfoundland described part of a section on the eastern shore of North Bay near the outport of Bay du Nord. "No fossil organism could be detected in these limestones whereby to establish their true geologic horizon, but lithologically and otherwise they bear such a marked resemblance to the Primordial Silurian or more probably the lower Cambrian as displayed so largely elsewhere in Fortune Bay that I have provisionally classed them under this head." The basis for Howleys lithologic correlation of these deposits with those of a lower Cambrian age has never been discovered. The similarity is probably

with that of the Smith Point Formation, a Lower Cambrian assemblage of mixed red silts and limestones.

The first detailed observations of Cinq Isles type sediments were made by White (1939) in the Belle Bay area. He assigned the present Cinq Isles and Pools Cove Formations to the Bay du Nord Series, which he subdivided into five formations. These were in order of decreasing age, the Spoon Cove Formation, Bay d'Est Formation, Pools Cove Formation, Tilt Point Formation and the Spyglass Cove Formation.

White defined the base of the series where it is in contact with the Simmons Brook Granite (then called the Bay du Nord Granite). He thought this was an intrusive contact. The upper limit he defined by the Spyglass Fault which separated the series from downthrown dated Cambrian rocks. However, White also thought that the upper limit could be gradational into the Doten Cove Formation, an earlier name for some of the red and purple sandstones now assigned to the Rencontre Formation of the Precambrian Long Harbour Group (Williams, 1971).

The Pools Cove Formation was interpreted by White to form a central intervening unit between the southeast facing Bay d'Est Formation to the north and the southeast facing Tilt Point Formation to the south. Subsequent work has demonstrated repetition in this part of White's section (Widmer, 1950).

White placed the Bay du Nord Series within a late Precambrian to early Cambrian range. He drew on two lines of evidence to support this age data. Tentatively, he thought that the top of the Series was gradational into the Doten Cove Formation which he dated as late Precambrian - early Cambrian. His second line of evidence was the origin of the Pools Cove Formation. In describing its origin as due to block faulting and rapid erosion of a granite mass White said, "No similar block faulting of an early

Paleozoic time has been described in North America, this fact may indicate a late Precambrian age for this series." Expanding on this idea of a late Precambrian age, White linked the Bay du Nord Series with the Meguma Series of Nova Scotia and the Signal Hill Formation of the late Precambrian Cabot Group of the eastern Avalon Platform.

Widmer (1950) after mapping the Hermitage Bay area, reinterpreted White's Bay du Nord Series and renamed it the Cinq Isles Series. Widmer's mapping took into account Cinq Isles exposures at Belle Bay, Great Bay de l'Eau and Salmon River. The Cinq Isle Series of Widmer was made up of three formations which were in order of decreasing age: The Spoon Cove Formation, the Yankee Cove Formation (a composite of White's Bay d'Est and Tilt Point Formations), and the Spyglass Cove Formation. Widmer recognized that the Pool's Cove Formation did not form a central part of the Cinq Isles Series but was an overlying younger formation. For this he concluded that the Tilt Point Formation of Cinq Islands Bay was not a separate formation but rather a repetition of the Bay d'Est succession due to reverse faulting. Widmer still retained White's definition for the base of the Series, the "intrusive" Simmons Brook granite contact.

Widmer thought that the Cinq Isles Series was Middle-Lower Upper Ordovician in age. This was because the series overlies dated Cambrian sediments but does not contain many volcanic fragments from the younger (as they were thought to be then) Connaigre Volcanics and Long Harbour Group.

Smith and White (1954) and Anderson (1965) revised the name Cinq Isles Formation to Cinq Isles Group. These workers defined the base of the sequence where it was "intruded" by the Simmons Brook batholith. The top of the Cinq Isles succession was defined at the contact with the overlying Pools Cove Formation in the Belle Bay area and the Great Bay de

l'Eau area. Both of these workers retained Widmer's Ordovician age assignment.

Definition

In this present study and Williams (1971) the Cinq Isles is regarded as being of formational status. This new status is given on the practical mappability of the sequence. Because of the lateral and vertical variations present and the absence of thick dominant individual mappable beds traceable from one section to another, it is considered that no subdivisions can be made for practical mapping purposes. The only possible exception is seen in the section west of North Bay. At the base of the section up to 150 feet of grey grits and sandstones are seen. They are conformable with the rest of the sequence and the top is drawn at the first thin nodular limestone band. This lower unit is presently called the Spoon Cove Member. No similar deposits are seen at any other section.

The base of the Cinq Isles Formation is defined where it unconformably overlies the Simmons Brook Batholith to the east at Parsons Cove and Cambrian sediments to thw est at Wreck Cove. The top of the formation is drawn where it is in disconformable contact with the overlying Pools Cove Formation in Belle Bay and probable equivalent beds on the western shore of Great Bay de l'Eau, the Cinq Isles Formation is unconformably overlain by fossiliferous Late Devonian conglomerates of the Great Bay de l'Eau Formation.

Age

This study and Williams (1971) regarded the Cinq Isles Formation as being Late Silurian or Devonian in age because it was overlain by the Pools Cove Formation with at most "a minor disconformity". The Pools Cove was in turn interpreted as Devonian since it contains granite boulders that are

lithologically similar to Devonian granites in Central Newfoundland and it is cut by the Devonian Ackley Batholith. In that the Cinq Isles and Pools Cove Formations are post Cambrian and atypical of the Newfoundland Ordovician and Lower Silurian, then a Late Silurian or Devonian age seems most reasonable.

Recent assignment of certain Newfoundland granites from the Devonian to older periods (Kennedy and McGonigal, 1972) casts some doubt on the presence of Devonian granite boulders in the Pools Cove conglomerates. Thus a Devonian lower age limit for the Pools Cove Formation may be now open to reappraisal.

The Cinq Isles has yielded no fossils. However, dark grey siltstones and black shale interbeds within the overlying Great Bay de l'Eau Formation contain numerous land plant remains. These have been identified by Erling Dorf as Protolepidodendron sp. and Eospermatopteris sp., forms typical of the Upper Devonian (Widmer, 1950). Another upper age limit to the Cinq Isles is given by the Belleoram Stock, a grey to pink massive granite that intrudes the Great Bay de l'Eau Formation. The Belleoram granite has been dated isotopically at 400 and 342 million years (Wanless et al., 1965; 1967). The intrusion is most probably Late Devonian in age. An early carboniferous age for the Belleoram Stock is discounted due to the general absence of large carboniferous batholiths in Newfoundland.

The Cinq Isles Formation is unique in Newfoundland to the Fortune Bay area. It is atypical of the Newfoundland Ordovician and Lower Silurian but appears closely related to the overlying Devonian (?) Pools Cove Formation and Upper Devonian Great Bay de l'Eau Formation. On these grounds the Cinq Isles Formation is assigned to the Late Silurian or Devonian.

STRATIGRAPHIC SECTIONS

General Remarks

The Cinq Isles Formation outcrops in ten coastal sections in varying degrees of completeness around the shores of Belle Bay and Great Bay de Teau. Small outcrops are also present along part of Salmon River and west along the north side of the Pools Cove - Belleoram road and at Simmons Brook. Figure 3 summarizes the stratigraphy of the Cinq Isles Formation.

The Type Section

In this study, the type section of the Cinq Isles Formation is that section exposed on the eastern shore of East Bay (Figure 3). This particular section is chosen because both a bottom and a top are well exposed, only a few small breaks are seen in the entire succession, and it exhibits features typical of all the Cinq Isles exposures.

The type section unconformably overlies the Simmons Brook Batholith at Parsons Cove. The base of the succession is well exposed and marked by a thin basal conglomerate containing fragments derived from the underlying granite. The succession is composed of red and grey shale, mixed beds, sandstone, limestone and pebble beds. Towards the top of the sequence a series of trough cross beds are present within coarse red sandstones. The troughs indicate local incoming depositional currents from the north and northeast. The sequence becomes markedly coarse towards the top and is disconformably overlain by coarse red conglomerates that have been assigned to the Pools Cove Formation. A total thickness of 1450 feet is present.

Details of this and other sections are summarized in figure 3. A detailed columnar unit by unit description of the type section, from base to top, follows:

	Unit Thickness (Feet)	Total Thickness (Feet)
The contact between basal Cinq Isles and the Simmons Brook Batholith is relatively smooth, a few small undulations are seen but these are no more than 1-2 inches deep and 2-3 inches wide. The surface of exposure is about 4 feet in length and dips 30° to the south. The granite shows signs of weathering and is relatively crumbly in places. Overlying the granite the basal Cinq Isles is composed of coarse angular unbedded granite wash (see Plates 1A and 1B). This is made up of feldspar and quartz crystals and angular granite fragments. These are up to 2 inches in diameter but are usually 1/2 - 1 inch in diameter. All of the granite material is locally derived and shows little or no signs of transport. The granite wash is surrounded by a matrix of fine-grained red brown silt showing no bedding features. Many of the granite fragments are cracked and broken with red silt filling the fractures.	1	1
Coarse rubbly beds of granite wash and silt. Granite fragments can be up to 3 1/2 inches in length, most are 3/4 - 1 1/2 inches. Matrix is a coarse dirty red brown silt. Granite fragments make up 30% of the bed. Scattered fragments of angular fine-grained dark coloured rhyolite are present but are uncommon as are a few small surrounded quartz pebbles.	2	3
Red sandy silt bed with a few thin granite wash laminations. The granite wash material is angular to subrounded and up to 1/4 inch in length.	3	6

A. The unconformable contact at Parsons Cove. Rubbly granite wash grading into red silts and mixed beds to the right (G.S.C. 153462).

B. Basal Cinq Isle unit. Red silt and granite wash from Parsons Cove.

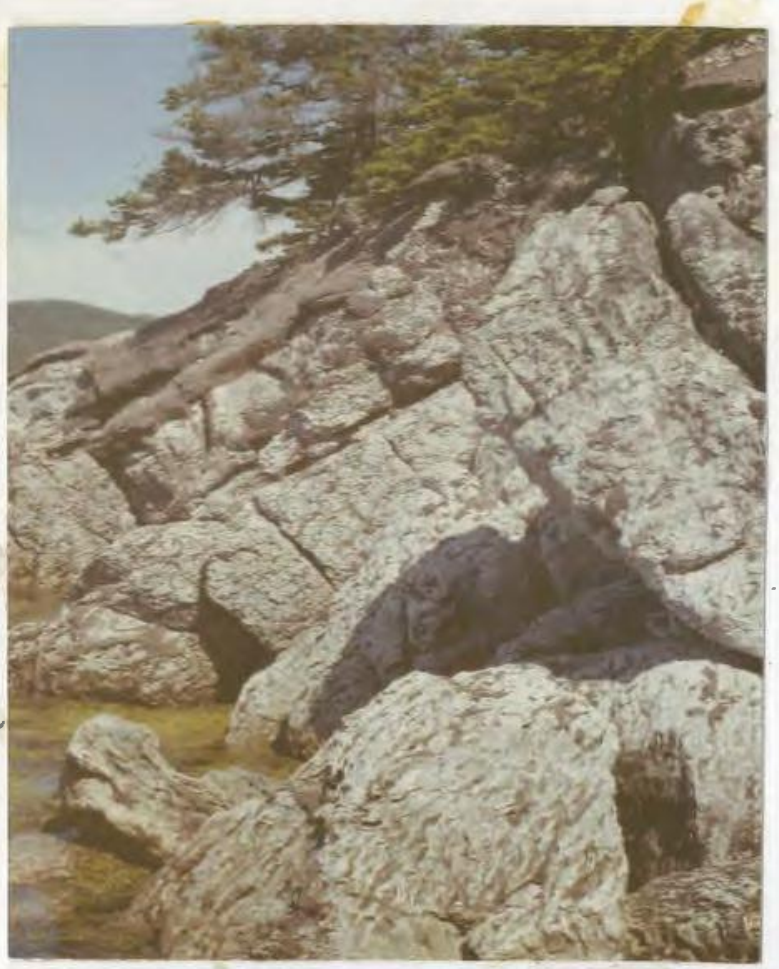
	Unit Thickness (Feet)	Total Thickness (Feet)
Mixed bed of small impure carbonate nodules within a partially laminated red silt. This is the first carbonate occurrence and marks the top of the basal Cinq Isles. Nodules make up about 15% of the bed.	3	9
Thick partially laminated red silt.	7	16
Alternating red silts and mixed beds from 2 to 4 feet in thickness with sharp and locally gradational boundaries. Some of the carbonate in the mixed beds contain up to 20% scattered red silt and quartz grains. Within the red silts a small amount of fine grain granite wash is present in the form of thin lens-like laminations.	100	116
A thick alternating series of red silts, mixed beds, reddish grey and grey sands, and a few pebble bands. Many of the sandstones are thick and massive, few are less than 6 feet in thickness. Scattered subrounded quarts pebbles are present in many of the sandstone beds. These pebbles can be up to 1 1/2 inches in diameter, most are from 1/4 - 1/2 inch. In places quartz pebble concentrations form thin lenses 2-3 inches in thickness. Cross bedding in some of the sandstones indicates incoming currents from the north and northeast.	150	266
The middle sequence of the type section shows a general fining of the sediments, red silts, mixed beds, pale grey limestones, a few grey sandstones and grits with some thin pebble beds. Many of the silts and limestone beds contain scattered quartz grains and a few small subrounded quartz pebbles. Boundaries within limits are generally sharp. Limestone beds are usually less than 6 feet thick, most are from 1-2 feet. Many of the limestones contain up to		

	Unit Thickness (Feet)	Total Thickness (Feet)
5% red silt (see Plate 2). In complete exposures many of the limestone beds are lens-like in form. One particular bed 2 feet in thickness lenses out over 10 feet into a coarse sandstone unit with a carbonate matrix.	744	1000
The upper sequence is composed of coarse red sandstones, grits and pebble beds. Only a few thin mixed beds, silts and limestones are present. Many of the sandstones are massive. Cross-bedding indicates incoming currents from the north and north-northeast. The carbonates show all gradations from pure fine-grained limestone beds to patches, masses or a coarse groundmass within sandstones and grits (see Plates 3A and 3B). Pebble beds are important in this upper section. The thickest is about 10 feet and contains subrounded quartz pebbles up to 7 inches in diameter set in a coarse red arkosic groundmass. Fragments of quartzites, basic volcanics, red shales and limestones are also present in smaller amounts. Mixed beds are poorly developed.	350	1350
Red grits and pebble beds containing a series of well developed trough cross beds indicating currents from the north and north-northeast. Troughs within red grits have smooth bounding surfaces, whereas those within a red grit with a carbonate groundmass have bounding surfaces with ridges and undulations 1-3 inches high and up to 4 inches deep.	25	1375
Red grits and quartz pebble beds. Quartz fragments are about 1/2 - 1 inch in diameter. No carbonate groundmass to the grits. A few troughs are developed with similar directions to those previously seen.	20	1395

PLATE 2

Red sandy siltstone grading into red grey impure limestone. From the middle sequence of the type section.

PLATE 3



A. Grey limestone containing patches and small lenses of red grit overlain abruptly by red grits in left background. Upper sequence of the type section.

B. Mixed bed of grey limestone and red grit overlying red grit and quartz pebble bed. Upper sequence of type section.

	Unit Thickness (Feet)	*Total Thickness (Feet)*
Red sandstones and grits, some with a carbonate groundmass, pebble beds and a few limestone bands many containing scattered sandstones and grits. The limestones contain up to 60% red grit and sandstone they are similar to the mixed beds with the coarse material taking the place of the silt (see Plate 4A). Many of the limestones are lenslike in form, often with sharp boundaries between the surrounding grits (see Plate 4B).	*30*	*1435*
Massive grey limestone bands up to 10 feet in thickness containing scattered quartz pebbles with red grit and sandstone patches, lenses and masses.	*20*	*1455*
The boundary with the overlying Pools Cove Formation is disconformable. The contact is seen where a grey limestone containing scattered quartz pebbles is overlain by thin grits and shales at the base of a thick red coarse conglomerate typical of the lower sequence of the Pools Cove Formation. The surface of contact is in the form of shallow hollows and ridges 2-3 inches deep and up to 5 inches wide (see Plate 5).		

The Section on the Western Shore of East Bay

This section exposed on the western shore of East Bay is similar to the type section and the other sections of Belle Bay with the exception of the Spoon Cove Member (Figure 3). The types of sediment and the pattern of their occurrence are the same. Lateral variations do not allow an exact bed by bed correlation from one section to another because they thin out too rapidly.

PLATE 4

A. Mixed bed of pale grey carbonate nodules and masses within red grits. Upper section of type sequence (G.S.C. 3-4-69).

B. Lens of grey limestone containing scattered quartz pebbles and red grits within red grit band. Upper sequence of type section.

PLATE 5

Disconformable contact between grey limestones and grits with quartz pebbles, and the basal red conglomerate of the Pools Cove Formation. Type Section.

The contact between the Cinq Isles Formation and the Simmons Brook Batholith is a faulted one (Plate 6). The lower part of the sequence is obscurred but a few inland exposures indicate that this succession is composed of red silts, mixed beds and a few sandstone and grit bands. The succession becomes coarser with increased sandstones and grits. Some of the coarser beds contain cross-bedded units indicating local incoming currents from the north and northeast. A fine grained succession and an increased coarser succession follows. The top of the sequence is made up of sandstones, grits, pebble beds, limestones with minor silts and mixed beds. Some of the pebble beds contain rounded quartz pebbles up to 3 inches in diameter. The boundary between the Cinq Isles Formation and the overlying Pools Cove Formation is a disconformity. This disconformable contact has been slightly modified by a small minor fault. The whole section consists of 1240 feet of beds.

	Unit Thickness (Feet)	*Total Thickness (Feet)*
Lower section composed of red silts, mixed beds and a few sandstones and grit bands.	*150*	*150*
The first shore exposures are similar to the lower section. Sandstones and grits are minor in amount. Few of the beds extend 6 feet in thickness.	*50*	*200*
A coarser sequence composed of red and grey sandstones and grits, red silts, a few mixed beds and thin limestones. Many of the sandstones and grits are massive, few exceed 5 feet in thickness. Cross-bedding indicates incoming currents from the north and north-northeast		

PLATE 6

Topographic expression of the fault contact between the Cinq Isles Formation and the Simmons Brook Granite to the right. West of East Bay. (G.S.C. 153455).

	Unit Thickness (Feet)	Total Thickness (Feet)
(see Plate 7A). A few of the sandstones contain subrounded quartz pebbles up to 3/4 inch in diameter.		
A few thin pebble bands are present. These are composed of subrounded quartz pebbles set in a gritty matrix.	320	320
Alternating series of mixed beds, silts, thin limestones with a few thin grits and sandstones. Many of the boundaries are sharp (see Plate 7B). A few of the limestone beds are over 2 feet in thickness.	280	600
Red and grey grits and sandstones, red silts and mixed beds. Cross bedding in the sandstones indicates towering currents from the north-northeast and northeast.	100	700
Red silts, mixed beds, thin limestones with minor amounts of red and grey grit. Some of the limestones contain scattered amounts of red grit and sandstone.	330	1130
The upper sequence is composed of grey and red grits, sandstones, red silts, mixed beds and limestones. Some of the limestones are up to 12 feet in thickness and contain scattered grits and subrounded quartz pebbles.	110	1240
The upper bed is a thick red grit with a carbonate groundmass. Subrounded quartz pebbles within the bed are up to 3 inches in diameter. The contact with the overlying Poole Sandstone Formation is disconformable, the disconformable surface has been modified by a small normal fault.	10	1250

PLATE 7

A. Cross-bedded grey grits overlying quartz pebble conglomerate. From about the 250 foot level, west of East Bay. (G.S.C. 3-12-69).

B. A sharp boundary between mixed beds and red silts. From about the 650 foot level west of East Bay. (G.S.C. 5-4-69).

The Eastern Shore of North Bay - The Bay du Nord Section

The Bay du Nord section of the Cinq Isles Formation exposed on the eastern shore of North Bay is typical of the type section and the other Cinq Isles sections of Belle Bay with the exception of the Spoon Cove Member (Figure 3).

The section is in fault contact with the underlying Simmons Brook Batholith. The surface of contact is hidden by rock fall and vegetation but its topographic expression is well displayed (Plate 8). The lower sequence of beds is similar to that of the type section. This is overlain by a dominantly coarse clastic succession, cross bedding within this succession indicates currents coming from the north-northwest, north and northeast. This is overlain by a finer sequence which is in turn overlain by a dominantly coarser clastic succession.

The contact between the Cinq Isles Formation and the Pools Cove Formation is disconformable. However, minor faulting has obscurred the actual boundary. A total of 850 feet of sediment is present within the section.

	Unit Thickness (Feet)	*Total Thickness (Feet)*
The Lower section is composed of red silts and shales, some with scattered red sandstones and grits, mixed beds, red sandstones and grits, many with small sub-rounded quartz pebbles up to 1/2 inch in diameter. In the lower part of this sequence a few thin laminae of granite wash material are present within red silts. Few of the beds in this succession are over 10 feet in thickness.	*270*	*270*

PLATE 8

Topographic expression of the fault contact between Simmons Brook Granite to the left and the Cinq Isles Formation at the deserted community of Bay du Nord, east of North Bay. (G.S.C. 153464).

	Unit Thickness (Feet)	Total Thickness (Feet)
Coarse quartz conglomerate composed of subrounded quartz pebbles up to 3 inches in diameter, and lesser amounts of red mudstone, quartzite and basic volcanic fragments set in a grey grit matrix.	15	285
Grey grits and sandstones, pebble beds, thin silts and mixed beds. Some of the sandstones and grits are lens-like in form. Pebble beds are composed mainly of subrounded quartz pebbles, red mudstone, volcanic and quartzite fragments are also present (see Plate 9). Some of the sandstones contain cross beds indicating incoming currents from the north and northeast.	265	550
Alternating series of red and grey sandstones and grits, red silts, mixed beds and thin limestones.	200	750
A coarser sequence composed of red and grey sandstones and grits, thin pebble bands, thin limestones, many with scattered quartz fragments, and a few red silts and mixed beds, most of which have a coarser admixture. Cross bedding in some of the sandstones indicates north and northeasterly incoming currents.	50	800
The upper part of the section is composed of relatively thick massive grey limestones containing higher in the sequence scattered amounts of red grits and subrounded quartz pebbles. The increase in the clastic content leads to a preponderance of sandstone over limestone.	30	830
The upper bed is a massive red grey grit composed of 50% angular grit particles, 30% carbonate and 20% subrounded quartz pebbles up to 2 inches in diameter.	20	850

PLATE 9

Conglomerate containing mainly red shale fragments set in an arkosic groundmass. From about the 500 foot level, east of North Bay.

The Section on the Western Shore of North Bay

The lower part of the section exposed on the western shore of North Bay is lithologically different from all other lower Cinq Isles successions. At Spoon Cove where the lower part of the sequence is present, the contact with the underlying Simmons Brook Batholith is not exposed. However, the granite surface is thought to be only a few feet away from the first beds seen. The lower part of the section is composed of 150 feet of medium to dark grey sandstones, dark grey mudstones and a few grey silts. There is a complete lack of any form of carbonate. This absence of any carbonate is in contrast to the other Belle Bay sections where limestone is seen within a few feet of the contact. This is the most marked example of lateral variation within any section of the Cinq Isles Formation. The name Spoon Cove Member is proposed for this clastic lower succession of the western shore of North Bay.

Overlying these dark sandstones is a sequence typical of the lower part of the type section. The sequence is almost wholly made up of red silts and mixed beds. Few of the beds are over 6 feet in thickness. The carbonate of the mixed beds varies in form from nodules to masses to interconnecting networks to laminae. As in the other sections, nodules are the most common form. These fine-grained sediments grade into a slightly coarser sequence. Towards the base is a massive conglomerate, containing quartz pebbles up to 5 inches in diameter set in a red arkosic groundmass. This slightly coarser sequence is made up of increased amounts of grits and sandstones. A few of these coarser units contain cross bedding indicating incoming currents from the northeast.

This sequence is overlain by an even coarser succession of beds. Grits, sandstones and pebble beds are the most important units. One particular pebble bed is about 10 feet in thickness. A grit band within the succession contains a torn up, subrounded limestone block 17 inches in diameter. This is the largest limestone clast seen within the Cinq Isles of any section.

This coarse sequence grades into a series of beds containing more red silts and shales and fewer grits, sandstones, and pebble beds. Limestone bands are relatively abundant in this succession, many contain scattered quartz fragments up to 1/2 inch in diameter.

The upper part of the section is made up of coarse grits, sandstones, conglomerates, red silts and a few impure limestone bands. Many of the grits and conglomerates contain a carbonate matrix. The uppermost bed is a coarse red arkosic sandstone with a carbonate groundmass and a few limestone fragments.

The contact with the overlying Pools Cove Formation is disconformable, the details of which have been obliterated by minor faulting.

Total thickness of the section is 1315 feet.

	Unit Thickness (Feet)	*Total Thickness (Feet)*
Massive dark grey sandstones. Fine-grained granite wash fragments are scattered throughout the rock in the lower few feet. A few small subrounded quartz pebbles are present.	*20*	*20*
Massive dark grey sandstones	*30*	*50*

Dark grey sandstones, bedding planes 1-2 feet apart. Thin laminations of fine sandstone and grey silt in places.	*50*	*100*
Dark grey and brown silts and sandstones. Moderately well bedded.	*30*	*130*
Red shales and silts.	*20*	*150*
Mixed bed of carbonate nodules within red silt. This first occurrence of carbonate marks the top of the Spoon Cove Member. The nodules are impure, round to ovoid set in a matrix of fine-grained red silt laminated in part.	*4*	*154*
Well bedded grey sandstone.	*8*	*162*
Alternating series of red silts and mixed beds. Well bedded, most of the units are less than 5 feet in thickness. Silts vary in colour from red to grey. The carbonate within the mixed beds varies in purity from fine-grained light grey limestone to a carbonate reddish grey in colour containing up to about 20% red silt and fine sandstone.	*176*	*338*
Thick conglomerate composed of quartz, granite, red shale fragments set in a coarse arkosic groundmass. The quartz pebbles predominate and are angular to subrounded, some as much as 5 inches in diameter (see Plate 10A).	*15*	*353*
Grey grit containing subrounded quartz pebbles up to 1/2 inch in diameter.	*5*	*358*
Thick sequence of red silts, mixed beds, reddish grey sandstones and a few limestone bands. Many of the sandstones contain a carbonate groundmass. Boundaries are in most cases quite sharp (see Plate 10B).	*202*	*560*
Coarser sequence of red and grey sandstones and grits, pebble beds and thin silts. Quartz pebbles within some of the conglomerates are as much as 6 inches in diameter. Within a thick red arkosic bed a large subround limestone boulder, 17 inches in diameter, is present. This has been torn		

PLATE 10

A. Thick quartz pebble conglomerate overlying thick lower series of red silts and mixed beds. From about the 340 foot level of the section on western shore of North Bay. (G.S.C. 15476).

B. An abrupt boundary between red sandstone to the left and grey grits with angular quartz fragments to the right. From about the 500 foot level of the section on the western shore of North Bay (G.S.C. G-2-69).

	Unit Thickness (Feet)	Total Thickness (Feet)
up from an underlying bed and redeposited within the coarse clastic material (see Plate 11). This is the largest example of a redeposited limestone block within the Cinq Isles Formation.	*290*	*850*
Red silts, mixed beds, thin limestones with a few red and grey sandstones. Usually well-bedded, few units exceed 6 feet in thickness.	*210*	*1060*
The Upper sequence is composed of coarse grits and sandstones, quartz conglomerates, red silts and a few impure limestone bands. Quartz pebbles within the conglomerates are angular to subround, many with a diameter of up to 2 inches, most are about 3/4 - 1 1/2 inches (see Plates 12A and 12B). Many of the grits and conglomerates contain a carbonate groundmass (see Plates 13A and 13B).	*245*	*1305*
The upper bed is a coarse red arkose with a carbonate groundmass and a few limestone fragments and subrounded quartz pebbles up to 1 1/2 inches in diameter.	*10*	*1315*

Cinq Isles exposures along the Salmon River

Along the course of the Salmon River north of the Pools Cove - Belleoram road, a few hundred feet of Cinq Isles sediments are exposed. The exposures are poor due to stream flood deposits covering them.

The underlying Simmons Brook Granite is separated from the basal Cinq Isles by a small fault. There is probably little displacement at this point, similar to the fault contact at Spoon Cove, a mile or so northeast. The basal unit is composed of red silts containing thin laminae and lenses of coarse quartz feldspar material

PLATE 11

Rounded limestone boulder within coarse red arkose. From about the 700 foot level of the section on the western shore of North Bay.(G.S.C. 153485).

PLATE 12

A. Quartz pebble conglomerate overlying coarse grit band. Upper sequence of the section on the western shore of North Bay.

B. A coarse sandstone with a carbonate matrix and scattered quartz pebbles. Upper sequence of the section on the western shore of North Bay.

PLATE 13

A. Quartz pebble beds and coarse sandstones with a carbonate groundmass from the upper sequence of the section on the western shore of North Bay. (G.S.C. 154387).

B. Coarse grit with a carbonate matrix and scattered quartz pebbles showing cross-bedding, which indicates incoming currents from the northeast. From the upper sequence of the section on the western shore of North Bay. (G.S.C. 153490).

from the underlying Simmons Brook Batholith. This material comprises about 40% of the basal unit. Within the material angular granite fragments up to 3 inches in length are seen along with coarse unsorted angular pink feldspar crystals. The basal unit is about 10 feet in thickness but 2 or 3 small faults repeat the sequence giving an apparent thickness of 30 feet. The thick, dark-coloured basal sandstones seen at Spoon Cove are not present at this locality. The lowermost beds of the section grade into thinly bedded red silts, mixed beds and a few red sandstones. The succession is faulted against the basal unit of the Pools Cove Formation toward the south.

The Cinq Isles Formation west of Salmon River and at Simmons Brook

The Cinq Isles sediments become markedly reduced in thickness west of Salmon River. Only a few feet of the basal unit are represented. Farther west only local pockets of Cinq Isles sediments occur between the Simmons Brook Granite and the Pools Cove Formation. Non-deposition over a probable 'high' area and partial erosion probably combine to explain this diminished succession.

One half mile west of the Salmon River on the north side of the Pools Cove-Belleoram Road, the Cinq Isles Formation is represented by 6 feet of red silts and quartz feldspar material (see Plate 14). This material is in the form of irregular beds, patches and lenses within the red silt. This basal unit is seen as fallen and dislodged blocks from the fault scarp formed by the fault contact with the underlying Simmons Brook granite. South of the road coarse red conglomerates of the Pools Cove Formation are exposed.

PLATE 14

The basal unit of the Cinq Isles Formation, granite wash and red silt. North of the Pools Cove - Belleoram Road, west of Salmon River.

A quarter of a mile southwest of Salmon River at Simmons Brook steeply southeast-dipping Pools Cove conglomerates overlie the Simmons Brook granite. The conglomerates are locally separated from the granite by pockets up to 3 feet thick of red silt and shale containing coarse, unsorted quartz feldspar material and granite fragments. At the base of the pockets a coarse granite arkose is seen which is almost indistinguishable from the underlying granite. Abundant shale and siltstone fragments within the Pools Cove conglomerates indicate that the Cinq Isles Formation was once more extensive in this area before being eroded prior to the deposition of the conglomerates.

The Cinq Isles Formation at Cinq Islands Bay

The Cinq Isles Formation is exposed in three coastal sections in Cinq Islands Bay, namely Spyglass Cove, Little Harbour and Tilt Point. The thickest exposure is at Spyglass Cove where about 720 feet of beds are exposed. The presence of the Cinq Isles is due to a moderately southeast-dipping fault, bringing the sediment upward and northwestward to structurally overlie the younger conglomerates of the Pools Cove Formation. This fault parallels the East Bay Fault and has the same sense of relative vertical movement.

The Cinq Isles sediments of Spyglass Cove in the western part of Cinq Islands Bay are similar to the lower succession of the Wreck Cove sequence. However, the Cinq Isles at Little Harbour and Tilt Point bear more resemblance to the Belle Bay exposures.

The Spyglass Cove Section

The Cinq Isles Formation at Spyglass Cove forms a northeast-

trending southeast-dipping succession faulted against the Pools Cove Formation to the northwest and Cambrian rocks to the southeast. The section is made up mainly of grey sandstones, grits, pebble beds, micaceous siltstones and shales and a few thin mixed beds and limestones. Many of the finer sediments are hornfelsic and dark in colour due to granite dyke intrusions.

The lower part of the sequence is composed mainly of quartzite bands, many of which are quite pure in composition. These quartzites are up to 6 feet thick and are massive. A few thin red and grey silts and some mixed beds are also present. Much of the carbonate within the mixed beds has been leached out due to the metamorphic effects of the dyke intrusions. Nodules of the mixed beds are now composed of epidote and recrystallized quartz and plagioclase feldspar. These metamorphic effects are also well seen in the Wreck Cove section.

The lower sequence is overlain by a coarse thick conglomerate containing subrounded quartz, volcanic and siltstone fragments up to 4 inches in diameter set in a dirty red coarse arkosic groundmass. This conglomerate, about 50 feet thick, is the thickest seen in all of the Cinq Isles exposures.

The conglomerate is overlain by a series of grey grits, sandstones, and silts; a few thin mixed beds and limestones are also present. These sediments grade into a thick succession of meta silts and shales, dirty quartzites, pebble beds, and a few metamorphosed limestones and mixed beds. All of the finer sediments are hornfelsic and splintery in character.

The top of the sequence is composed of meta silts and shales which are faulted against Cambrian sediments.

	Unit Thickness (Feet)	Total Thickness (Feet)
The lower part of the section is composed of quartzites, recrystallised limestones, silts, and a few mixed beds. Most of the quartzites are quite pure in composition and massive. The carbonate of the mixed beds has been leached and replaced by epidote, recrystallised quartz and plagioclase feldspar. All the finer-grained beds are hornfelsic and splintery.	50	50
Similar units with the addition of scattered subrounded quartz pebbles up to 3/4 inch in diameter.	20	70
Predominantly grey sandstones and grits with a few red silts and mixed beds. Metamorphic effects are present in the finer sediments.	68	138
Thick, poorly sorted, coarse conglomerate consisting of angular to subrounded quartz, dark volcanic and mudstone fragments set in a coarse dirty arkosic groundmass. Many of the pebbles are as much as 5 inches in diameter. Within the conglomerate, shaley lenses up to one foot in thickness are present.	45	183
Coarser conglomerate with pebbles up to 9 inches in diameter.	5	188
Thick alternating sequence of grey sandstones, limestones and thin mixed beds. This sequence is intruded by a 10 foot thick quartz feldspar dyke. Some digestion of the sediments has taken place on either side of the porphyry walls. Many of the finer-grained sediments are hornfelsic.	106	294
Thick series of sandstones, grits, red silts and mixed beds. Metamorphic effects are minimal. Cross bedding in some of the grits indicates incoming depositional currents from the north and northeast.	146	440

	Unit Thickness (Feet)	Total Thickness (Feet)
Massive meta silts and shales with a few dirty quartzites and sandstones.	*40*	*480*
Massive meta silts, shales and sandstones with a few mixed beds and limestones. All of the carbonate shows metamorphic effects. This section is cut by a 40 foot thick quartz feldspar dyke.	*121*	*601*
Grits, sandstones, pebble beds with a few thin silts and mixed beds. Pebbles within the conglomerates are dominantly quartz with a few dark coloured volcanics and red silts. Scattered quartz pebbles up to 3/4 inch in diameter are present within many of the sandstones and grits.	*24*	*625*
The top of the section is composed of thick massive meta silts, shales and quartzites. Three quartz feldspar dykes and at least two dolerite dykes cut the sequence. Towards the contact with the Cambrian the beds are broken and crushed.	*95*	*120*

The Little Harbour Section

The Cinq Isles Formation at Little Harbour is the smallest exposure of the Cinq Isles Formation in Cinq Islands Bay. The outcrop is in the form of a small island no more than 150 feet in length joined to the mainland by a sand bar which is covered at high tide. About 85 feet of beds are exposed at Little Harbour.

The succession is composed of two thick massive conglomerates separated by a sequence of finer-grained grey sandstones, silts and mixed beds. These sediments show little similarity to those at Spyglass Cove, being more closely related to the Cinq Isles of Belle Bay.

	Unit Thickness (Feet)	*Total Thickness (Feet)*
Coarse conglomerate composed of angular to subrounded quartz, fine grain volcanic and mudstone pebbles set in a coarse arkosic matrix. Some of the pebbles are up to 4 inches in diameter. A few lenses of predominantly coarse arkose are present within the bed.	*25*	*25*
Alternating red silts, mixed beds, fine sandstones and thin limestones.	*40*	*65*
Coarse conglomerate similar to the lower bed, clasts within the unit are coarse and up to 6 inches in diameter.	*20*	*85*

The Tilt Point Section

The Cinq Isles at Tilt Point has been brought upward and northwestward by fault movement to lie against the younger Pools Cove Formation.

Above the fault plane the lower part of the section is composed of sandstones, silts, mixed beds and limestones, many with scattered quartz fragments. Most of the beds are less than 6 feet in thickness.

These beds pass into a coarse thick poorly sorted conglomerate composed of quartz, volcanic and red mudstone fragments set in a coarse arkosic groundmass.

The upper sequence of the section above the conglomerate is made up of grits, sandstones -- many with scattered quartz pebbles, pebble bands, silts, thin limestones and mixed beds. Within some of the grits vague cross bedding is present indicating incoming depositional currents from the northeast. The top of the section is bounded by the ocean.

	Unit Thickness (Feet)	Total Thickness (Feet)
The lower part of the sequence is composed of an alternating series of grey sandstones, mixed beds, limestones and silts. Many of the sandstones contain a matrix of carbonate between the quartz grains. Carbonate within the mixed beds is mainly nodular (see Plate 15). Scattered quartz pebbles are common within some of the sandstones, they are usually less than 1/2 inch in diameter.	130	130
Coarse, poorly sorted conglomerate composed of quartz, dark volcanic siltstone and phyllite pebbles set in a coarse arkosic groundmass. Some quartz pebbles are as much as 6 inches in diameter, most are less than 2 inches.	70	200
Massive grits and sandstones with thin quartz pebble bed lenses. Subrounded quartz pebbles up to 3/4 inch in diameter are scattered throughout the coarser grits and sandstones. Some of the grits contain a carbonate groundmass.	67	267
Grey grits and sandstones with scattered quartz pebbles. Some of the finer sandstones contain nodules of carbonate up to 1 inch in diameter comprising up to 25% of the rock in places. Carbonate as a groundmass is present in a few of the sandstones and grits.	33	300
Mixed beds, red silts and a few thin sandstones.	20	320
The upper section is composed predominantly of red silts and mixed beds, a few thin sandstones are present. Cross bedding within some of the sandstones indicates incoming currents from the north and northeast.	40	360
Mixed beds, red silts, thin grey limestones and sandstones. Few of the beds are over 3 feet in thickness.	22	382

PLATE 15

Mixed bed of grey carbonate nodules within red silt. From the lower sequence of the Tilt Point section.

The Wreck Cove Section

The Wreck Cove section is the only complete section of the Cinq Isles Formation exposed in the Great Bay de l'Eau area.

The base of the succession, exposed at Salmonier Cove unconformably overlies dated Cambrian silts and mudstones. The contact surface is relatively smooth with only a few small undulations present. The basal unit of the Cinq Isles Formation is devoid of any carbonate material. This unit is composed of hornfelsic siltstones, sandstones and pebble beds, some of which are coarse. The first indication of carbonate is seen 60 feet above the contact. The limestone is in the form of small nodules within a mixed bed. This unit as well as other fine-grained beds in much of the lower section shows the effect of slight metamorphism. The metamorphism is probably due to the emplacement of the Ackley Batholith and related intrusions, however, no dykes are seen within the Wreck Cove section. Most or all of the carbonate in this first mixed bed has been leached out. The nodules are now epidote rich and green in colour. The rest of the material in the nodule is composed of recrystallised quartz and plagioclase feldspar. The silts of the mixed beds are dark and hornfelsic in character.

The lower part of the sequence is made up of red silts, mixed beds, thin limestones and a few sandstones. Less variety of form is seen in these units than those present in the Cinq Isles of the Belle Bay area. Current directions in cross beds within the sandstones indicate east-northeast incoming currents.

Above this sequence sandstones and grits become more important.

The metamorphic effects seen lower in the succession are less common.

Further up the sequence a wedge of dated Cambrian argillites is thrust into the Cinq Isles Formation. The thrusted rocks are part of the Upper Cambrian Salmonier Cove Formation. They are about 150 feet thick and contains trilobites and brachiopods. This section of the Cinq Isles is the most structurally complex of the Great Bay de l'Eau area. Elsewhere within the sequence normal faults disrupt the strata, at one point about 80 feet of beds are overturned due to faulting and folding.

Above the thrusted Cambrian rocks the sequence is made up of sandstones, grits, mixed beds and limestone bands. Metamorphic effects are uncommon at this level. Some of the limestones are quite thick. One particular band is 20 feet in thickness; the thickest single limestone unit of any Cinq Isles section.

In the upper sequence sandstones and gritty sandstones and grits become increasingly important. They range from relatively clean quartzites and arkoses to dirty quartz feldspar clastics containing varying amounts of volcanic fragments and clay material. Lateral variation of the beds in this upper section is common. Metamorphic effects within the finer sediments are in places abundant.

The unconformable contact with the overlying Great Bay de l'Eau Formation is well exposed on the headland just south of the community of Wreck Cove. The upper part of the Cinq Isles Formation is gently folded into a broad shallow open fold. The base of the Great Bay de l'Eau Formation is composed of a thick conglomerate made up of limestone

boulders up to 2 feet in thickness set in a coarse, buff coloured arkosic groundmass.

	Unit Thickness (Feet)	*Total Thickness (Feet)*
Coarse grained dark grey sandstone unconformably overlying grey Cambrian mudstones and silts. Within this basal unit subrounded quartz pebbles and angular fragments of the Cambrian sediments are present.	*1*	*1*
Coarse dirty buff coloured grit containing subrounded quartz pebbles, Cambrian silt and mudstone fragments with a few quartzite and rhyolite fragments.	*8*	*8*
Coarse pebble bed composed of quartz pebbles, angular Cambrian silts and mudstones, quartzites, and a few rhyolite fragments set in a dark grey grit matrix. Some of the quartz fragments are as much as 8 inches in diameter, most are less than 2 1/2 inches. The bed is hard and compacted and stands out from the surrounding sediments.	*15*	*24*
Pebble bed similar to the underlying unit but with a decreased clast size.	*5*	*29*
Coarse grey grit with a few thin pebble band lenses.	*5*	*34*
Coarse pebble bed with subrounded quartz pebbles up to 5 inches in diameter.	*4*	*38*
Dark grey massive sandstone.	*10*	*48*
Red siltstone, hornfelsic and splintery with a few thin sandy laminations.	*12*	*60*
Mixed bed of small ovoid nodules within a dark red brown hornfelsic silt. The nodules occur in thin bands 2-3 inches thick every foot or so throughout the bed. Nodules show the effects of metamorphism. They are composed of recrystallised quartz and plagioclase feldspar with epidote (see Plate 16).	*5*	*65*

PLATE 16

Metamorphosed mixed bed. Recrystallised leached nodules within dark hornfelsic splintary siltstone. From about the 100 foot level of the Wreck Cove section.

	Unit Thickness (Feet)	Total Thickness (Feet)
Thick succession of alternating mixed beds, red silts, thin limestones with a few sandstones and grits. Few of the units exceed 10 feet in thickness, all boundaries are sharp. Cross bedding within some of the coarser beds indicate incoming currents from the northeast and east-northeast. All of the beds show signs of metamorphism.	143	208
Alternating red silts, mixed beds and thin limestones. Some of the beds show metamorphic effects, others don't.	42	250
A coarsening of the sequence with the dominant beds being sandstones and grits. These vary from clean quartzites to arkoses to dirty coarse grits composed of quartz, volcanic fragments, and feldspars. Some of the units contain subrounded quartz pebbles usually less than 1/2 inch in diameter. Thin red silts and mixed beds, some showing slight metamorphism effects are also present.	220	470
A wedge of Upper Cambrian argillites bounded by two faults striking 100°E, the northern fault dipping 70°W and the southerly one dipping 45°SW. The wedge is composed of about 150 feet of the Salmonier Cove Formation, blue grey slates, silts, and shales. Towards the south the sediments are darker in colour, thinly bedded and fissile. They are dated on the presence of a number of Trilobites belonging to the genus Peltura and brachiopods of the Lingulella and Obolus types. Above the wedge the Cinq Isles sediments have suffered only minor breaking and contortion.		
Thin impure limestone with slight metamorphic effects. Partially broken due to the thrust faults.	2	472
Massive dark grey silty sandstone with a slight carbonate matrix.	6	478

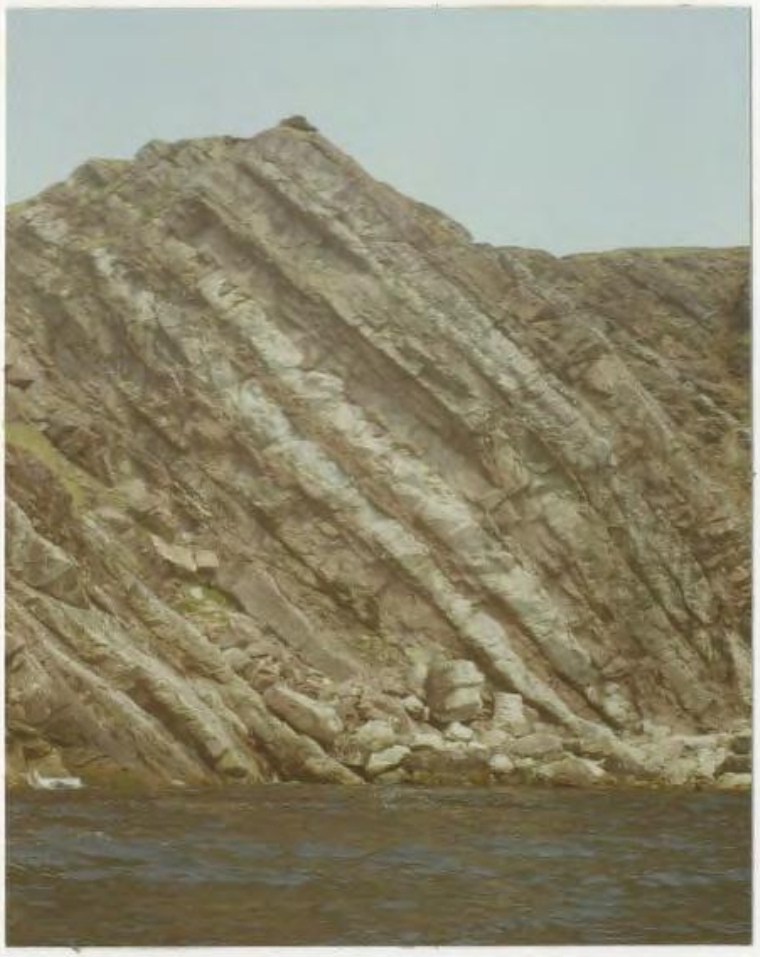
	Unit Thickness (Feet)	*Total Thickness (Feet)*
Alternating series of red silts, mixed beds, sandstones and grits. Few of the beds are over 8 feet in thickness. Boundaries are locally gradational, most are sharp.	*220*	*698*
Thick massive pale to medium grey limestone. Thin laminae of red silt are present in the upper part. This is the thickest single limestone unit in all of the Cinq Isles exposures.	*20*	*718*
Thick sequence of grey sandstones, red silts, mixed beds and limestones. Within a few of the sandstones small subrounded quartz pebbles are present.	*235*	*953*
The Upper sequence is composed of massive grey sandstones, many with subrounded quartz pebbles up to 2 1/2 inches in diameter, red silts, mixed beds and limestones (Plate 17). Metamorphic effects are abundant in places.	*260*	*1213*

The contact with the overlying Great Bay de l'Eau Formation is unconformable. It is well exposed on the headland just south of Wreck Cove (Plate 18). The upper part of the Cinq Isles sequence has been gently folded into a broad shallow open fold, these beds at the contact dip 15° to the southwest. The younger Great Bay de l'Eau Formation dips 35° southwest at the contact. The lower part of the formation is composed of thick conglomerates of limestone boulders up to 2 feet in thickness, red shale fragments and quartz pebbles set in a coarse buff coloured arkosic groundmass. These thick conglomerates are succeeded by massive buff arkoses comprising the bulk of the Great Bay de l'Eau Formation.

The Cinq Isles exposures on the western side of Great Bay de l'Eau

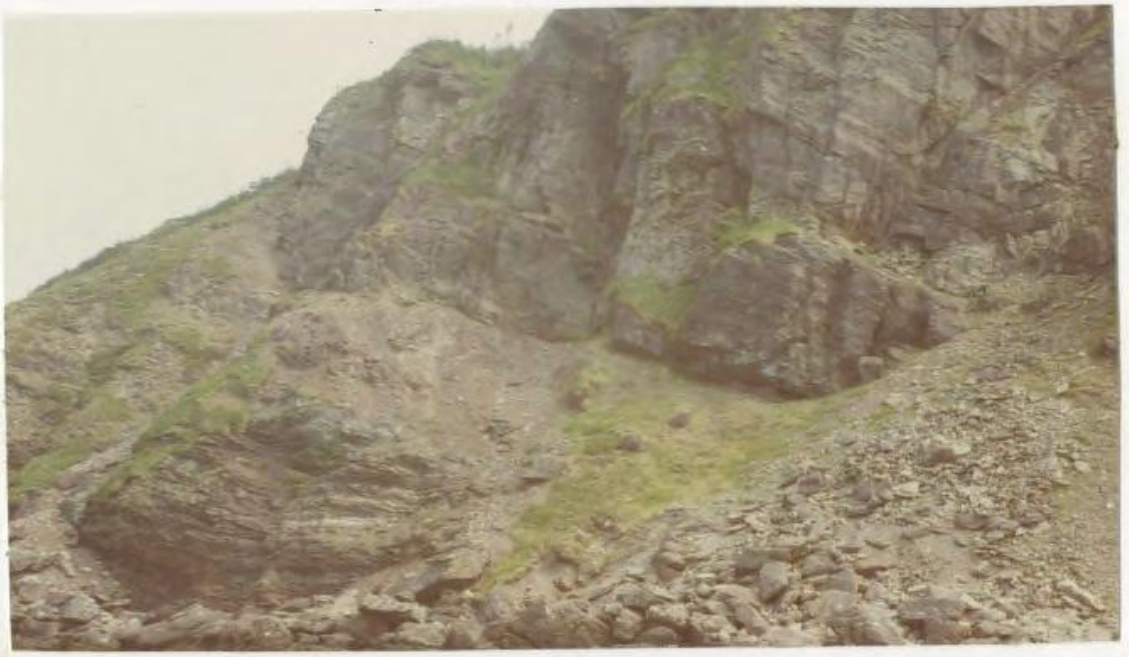
On the western side of Great Bay de l'Eau there are two small Cinq Isles exposures. In each case they are shore line exposures

PLATE 17



Thick sequence of limestones, sandstones and silts from the upper sequence of the Wreck Cove section.

PLATE 18



The unconformable contact between the Cinq Isles Formation and the overlying Great Bay de l'Eau Formation just south of Wreck Cove. The Cinq Isles Formation is gently folded into a broad shallow open fold.

outcropping from sea level to the junction with the Great Bay de l'Eau conglomerate. The successions are composed predominantly of red shales, mixed beds and limestone bands which are somewhat more similar to those seen in Belle Bay than at Wreck Cove. Unlike Wreck Cove there are no signs at all of any metamorphic effects of the limestone and shale in these outcrops. The thickest exposure is from Bacon Point to Michael Day Cove where 341 feet of beds are seen. A hundred yards southwest the upper 150 feet of this section is repeated along strike due to topography at White Point. The second exposure is 3 miles northeast at Little Bay Head at the entrance to Little Bay where 100 feet of Cinq Isles sediments are present.

The Section from Bacon Point to Michael Day Cove

The base of the section along this coastline is bounded by the sea. The lower part of the sequence is made up of red siltstones, mixed beds, limestone bands and a few fine-grained reddish grey sandstones. Few of the beds are over 6 feet in thickness, especially the limestones which are usually less than 3 feet. Overlying these beds is a thick layer of poorly bedded impure somewhat nodular limestone. Within this bed thin lenses and laminations of red silts and sandstones are present as well as scattered clastic particles. Further up the sequence other thick limestones are seen.

The upper sequence of this section is made up of an intraformational breccia and mixed beds of carbonate within silt, and carbonate within red sandstone. The contact with the overlying Great Bay de l'Eau Formation is a strike slip fault which cuts through a

once disconformable erosional surface. On either side of the fault the beds are crushed and broken for a few feet. The upper 150 feet of the Cinq Isles and its contact with the Great Bay de l'Eau Formation is repeated a few hundred yards southwest along strike due to the topography at White Point.

	Unit Thickness (Feet)	*Total Thickness (Feet)*
Red siltstones, mixed beds, limestone bands and a few thin fine-grained reddish grey sandstones. Few of the beds are over 6 feet thick. A few scattered rounded quartz pebbles up to 1/2 inch in diameter are present in the sandstones.	*200*	*200*
Thick poorly bedded impure medium grey limestones, nodular in part. Thin lens-like laminations of red silts, sandstones and grits are well defined. Scattered red silt and sandstone particles comprise as much as 15% of the unit in places.	*20*	*220*
Medium grey fine-grained massive featureless limestone. A few nodular horizons are present. The bed weathers to a sharp hackly surface.	*25*	*245*
Rubbly nodular limestone set in scaley red shale matrix, the crushed limestone nodules are due to a small strike slip fault within the unit.	*15*	*260*
Complex thinly laminated bed of red silts, fine sandstones and limestone (see Plate 19). The laminations up to 3/4 inch in thickness appear in wave like forms with a distance of 4 inches from crest to crest. Many of the red silt and sandstone laminations are broken, the spaces between are filled with grey micrite.	*10*	*270*

PLATE 19

Thinly laminated grey micrite, red silt and fine silty sand in wave like forms. The unit is overlain by a thick massive grey impure limestone. From the 270 foot level of the Bacon Point to Michael Day Cove section, Great Bay de l'Eau.

	Unit Thickness (Feet)	Total Thickness (Feet)
Grey, fine-grained limestone with few scattered silt and sand particles.	5	275
Grey fine-grained limestone with thin red silt laminations.	10	285
Thick intraformational limestone breccia. Composed of angular limestone blocks up to 18 inches in diameter that have been torn up then redeposited very nearly in place with very little reworking or transportation. Between the clasts is a coarse red grey angular quartz feldspar sandstone.	25	310
Mixed bed of nodules up to 6 inches in diameter set in a coarse red sandstone which comprises 5-10% of the rock in the lower part increasing to 20% higher in the unit.	10	320
Impure limestone bands interlayered with red silt and fine sandstone.	5	325
Limestone conglomerate made up of dark grey, red grey subround to round limestone pebbles 1-2 inches in diameter set in a medium grey limestone matrix. The lower part of the bed contains about 40% red slate within the matrix. This is absent to rare in the upper part of the bed.	12	337
Fault crushed fine-grained reddish grey limestone.	4	341

Above this bed the contact with the overlying Great Bay de l'Eau conglomerate is present (Plate 20). The contact is in the form of a strike slip fault which cuts through a once disconformable surface. On either side of the fault the beds are crushed and broken for a few feet. The Great Bay de l'Eau conglomerate immediately above the contact is made up of a coarse red sandstone containing

PLATE 20

The upper part of the Cinq Isles Formation (left) in contact with the Great Bay de l'Eau Formation of the Bacon Point to Michael Day Cove section at White Point. Brunette and Sagona Islands in the background.

reworked angular Cinq Isles shale fragments and impure limestone. Present within the sandstone are some small carbonate nodules. Above this basal unit the Great Bay de l'Eau conglomerate continues as thick massive units of red arkosic sandstone with a few limestones and shale fragments. Pebble incursions are seen in places. The pebbles are up to 5 inches in diameter. Imbrication of many of the pebbles indicates a depositional current from the northwest.

Little Bay Head

The exposure at Little Bay Head comprises about 100 feet of red silts and shales, mixed beds, micritic limestones, pebble grit beds and sandstones.

	Unit Thickness (Feet)	*Total Thickness (Feet)*
Massive grey and red grey sandstones and grits composed of angular to subrounded quartz and plagioclase feldspar fragments with a few subrounded volcanic particles. Pebble lenses are present within these coarse sandstones and grits. The pebbles are subrounded and are predominantly quartz with a few granites and angular red shale and limestone fragments.	*30*	*30*
Thick massive limestones containing a few thin red sandstone and silt beds up to 2 inches thick. The limestone is relatively pure and fine-grained, in places a red sandstone matrix comprising up to 15% of the rock is present. The limestones are nodular in part.	*40*	*70*
Alternating series of mixed beds, thin sands and limestones. The limestones are nodular. Few of the beds are over 3 feet in thickness.	*30*	*100*

The contact with the overlying Great Bay de l'Eau conglomerate is in the form of a disconformity. In places the actual surface has been obscured by a small strike slip fault. The contact is very similar to that seen on the east side of East Bay, Belle Bay between the Cinq Isles and the Pools Cove Formation.

The Great Bay de l'Eau conglomerate above the contact is made up of a thin basal layer of red shale followed by thick arkosic units. Within the lowest units a few thin bands of small impure limestone nodules are present. Pebble bands up to 2 feet thick are seen in some of the arkoses. The pebbles are angular to subround and up to 4 inches in diameter. The majority of the pebbles are granites with a few dark volcanics and some torn up shale and limestone fragments.

The Cinq Isles at Saltwater Pond

A small outcrop of Cinq Isles Formation is seen near Saltwater Pond just south of Jersey Harbour, one mile due east of Harbour Breton. The exposure is in the form of a thin sliver of crushed Cinq Isles faulted between Connaigre Volcanics to the north and Great Bay de l'Eau conglomerate to the south. The thin wedge of sediment is no more than 80 feet in thickness. The beds strike northeast and dip 75° northwest, the bounding faults have similar attitudes.

The exposure is made up of thin bedded red grey shales, impure limestones, some up to 5 feet in thickness, and a few mixed beds. Many of the nodules in the mixed beds have a squeezed out

PLATE 21

The Little Bay Head section of grey limestones, mixed beds, red shales and sandstones of the Cinq Isles Formation overlain on the right by red conglomerates and arkoses of the Great Bay de l'Eau Formation.

appearance due to the movement of the faults. None of the carbonate of the mixed beds is pure. They are all somewhat reddish grey in colour with up to 10% containing red silt and fine sandstone particles.

The sliver of Cinq Isles Formation is probably from high up in the succession and has been faulted into what is the lithologically typical lower part of the Great Bay de l'Eau sequence.

CHAPTER III

SEDIMENTOLOGY

Introduction

The Cinq Isles formation is made up of red and grey argillites, grey limestones, mixed beds, red and grey sandstones and grits and quartz pebble conglomerates. Most characteristic of the Formation are the limestones and mixed beds of nodules and interconnecting masses of micritic limestone within silts and sandstones. These mixed beds are commonly associated with red and grey silts and shales and form thick alternating sequences in most sections.

Limestone beds may reach 20 feet in thickness but as a rule are less than 4 feet in thickness. Most are featureless, but in a few places the limestone has a concretionary appearance. Limestone also occurs as a matrix in some sandstones and quartz conglomerates.

Sandstone units range from clear quartzites and arkoses to a dark coloured rock containing clastic material made up of quartz, volcanic rock, feldspar and siltstone fragments.

The conglomerates, although relatively minor in abundance constitute a wide variety of characteristic rock types. Some are red or grey sandstones with scattered white quartz pebbles, others have pebbles of quartz, granite, gneiss, volcanic rock, red silt and sandstone in an arkosic red sandstone matrix.

Current direction indicators within some of the sandstones, grits and pebble beds indicate incoming currents from a northerly and northeasterly direction. These current direction features include

tabular cross bedding, trough cross bedding and pebble imbrications. The Cinq Isles Formation and the overlying conglomerates contain a variety of clasts derived from older terrains in the Fortune Bay area. These clasts include Simmons Brook granite, Precambrian Long Harbour Group volcanics and sediments, Upper Cambrian argillites and gneisses and schists from the Garrison Hills metamorphic terrain of the Central Mobile Belt. The occurrence of these metamorphic clasts indicates either a possible sedimentary link between the Central Mobile Belt and the Avalon Platform or derivation from a metamorphic basement underlying the Avalon Platform.

Fine-Grained Clastics

Red and grey silts and shales make up about 30% of the Cinq Isles Formation. The most common fine clastic is a red, even-grained shale consisting of haematite stained quartz grains with numerous small flakes of clastic muscovite. Fine-grained clastics are found throughout the succession but because of the increased coarseness of the sediments in the upper parts they tend to be more common in the middle and lower parts of the section.

The amount of muscovite in the red shales varies from about 5% to as much as 15% in some beds. The mica flakes are absent to uncommon in the silts. Grey silts and shales make up about 1/3 of the total fine-grained clastic content, the amount of clastic muscovite in them is similar to that of the red shales.

These units are rarely found in beds over four feet thick. They are usually from 6 ins. - 2 feet in thickness. Many silts and

shales are commonly present as thin beds and laminae within other sediment types.

Silts and shales are fairly evenly distributed in the lower and upper parts of the succession with the exception of the Spoon Cove Member outcropping at Spoon Cove on the western side of North Bay. At this location few fine-grained sediments are seen within the several hundred feet of sandstone present. Within the upper parts of the succession fine-grained clastics are less common because of the increased amounts of coarser sediment.

At the base of the Cinq Isles Formation at Parsons Cove on the eastern side of East Bay and to the north of the Pools Cove-Belleoram road west of Simmons Brook up to about 25% red silt is mixed with the coarse angular quartz feldspar material derived from the Simmons Brook granite. Further west on the Pools Cove-Belleoram road the Pools Cove Formation is locally separated from the Simmons Brook granite by about three feet of red shale and siltstone that has unsorted angular pink feldspar fragments and a few Simmons Brook granite pebbles. The red shale, atypical of the Pools Cove Formation is interpreted to represent local pockets of Cinq Isles Formation preserved at the base of the sedimentary succession.

Silts and shales are usually associated with mixed beds. Thick beds alternating series of mixed beds and fine-grained clastics are commonly seen in many of the sections. Boundaries between the two units tend to be quite sharp (Plate 23).

Silts and shales are the softest rocks of the Cinq Isles Formation. Most have been eroded a few inches below the level of other

nearby units. Where parts of the section have been eroded back and covered by beach material, this is thought to be due to the high amount of fine-grained clastic material present. In the lower and middle parts of the Wreck Cove section and the Spyglass Cove section dyke intrusions related to the Ackley Batholith have locally metamorphosed the silts and shales into a hard splintery hornfelsic rock which resists erosion.

Mixed Beds

The mixed beds of carbonate material within silt, shale and locally sandstone and grit give the Cinq Isles Formation its uniqueness. Mixed beds in all their various forms make up about 20% of the succession. The dominant form of the carbonate is nodular. However, all gradations are seen from nodules to lumps and masses to interfingering networks to individual laminae. The carbonate is usually micritic and pale to medium grey in colour. Few of the mixed beds are over 5 feet in thickness, most tend to be from 2-3 feet.

Some of the Cinq Isles sequences contain significantly lower amounts of mixed beds than others. The Spyglass Cove section and the lower part of the Wreck Cove section contain only about 10-15% mixed beds. Mixed beds are absent in the Spoon Cove member west of North Bay, Belle Bay. Other sections, such as the upper part of the type section, where coarse beds are dominant, show little or no diminution in the amount of mixed beds. The carbonate in these successions occurs as a groundmass or lumps and masses with red arkosic sandstones and grits.

Nodules range from 1/4 to 3 inches in diameter (Plates 22A & B). The amount of carbonate nodules in a mixed bed ranges from 5-50%. Any increase in amount and/or size results in a coalescence of the carbonate to form large lumps and masses (Plate 23A). The coalescence can also take the form of a vague interconnecting network of carbonate within the surrounding sediment (Plate 23B). The form of the carbonate within the coarser sediments is somewhat different from that within silts and fine sandstones. Mixed beds of carbonate within coarse sandstones and grits are more commonly present in the upper sequences. This is particularly true of the exposures around Belle Bay. These coarser sediments are red arkosic sandstones and grits, many of which contain sub-rounded quartz pebbles up to one inch or so in diameter. The carbonate within these beds ranges from a groundmass comprising about 10% of the rock to interconnecting lumps and masses making up to 70-80% of the bed (Plates 24A and B). In these coarser deposits carbonate nodules and laminae are rare to absent.

The carbonate of the mixed beds is pale to medium grey in colour and very fine grained in texture. Much of the carbonate is featureless except for a few small nodules which have a vague oolitic like structure. Microscopic examination of the material shows an almost featureless uniformly crystalline micrite. A few small lenses and patches of sparite are present in the micrites of the fine sediments. The carbonate of the coarser sediments commonly contains more sparite. Some of the crystals are moderately coarse, up to 1 mm in diameter. The sparite in these coarser beds occurs as irregular

PLATE 22

A. Mixed bed of carbonate blebs within red silt. Specimen from the lower part of the type section.

B. Mixed bed of carbonate blebs and small nodules within fine red sandstone. Specimen from the middle part of the section east of North Bay.

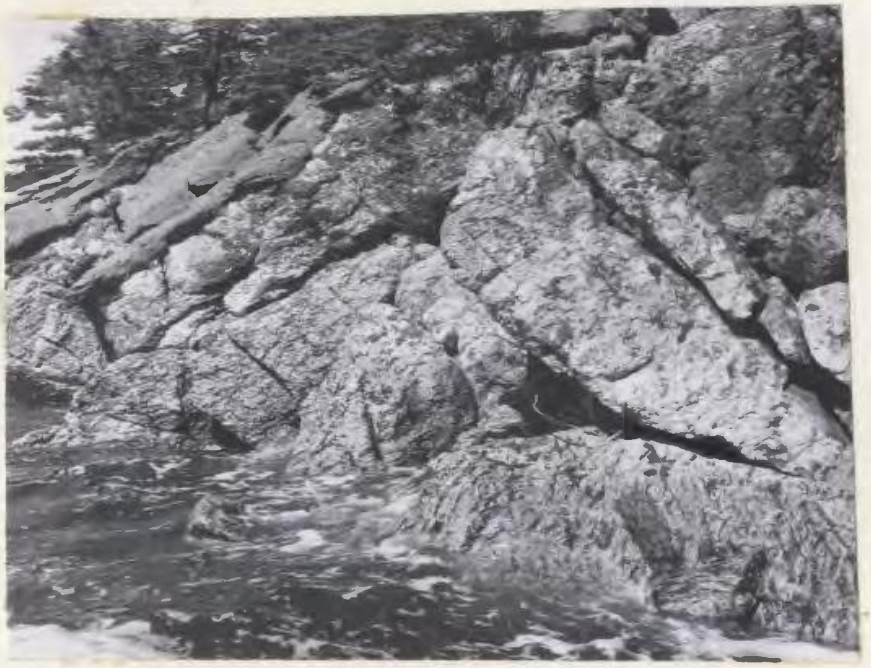
PLATE 23

A. Mixed bed of carbonate nodules and masses within red silt. The mixed bed is bound by two silt units. From the middle part of the section east of East Bay. (G.S.C. 153483).

B. Mixed bed of nodules and interconnecting carbonate network within red silt. From the middle part of the section east of East Bay (G.S.C. 153456).

PLATE 24

A. Mixed bed of interconnecting carbonate masses within coarse red arkosic grits with quartz pebbles. From the upper part of the type section. (G.S.C. 153448).



B. Mixed bed dominantly composed of interconnecting carbonate masses within red arkosic sandstone. Overlain by red arkosic grits with quartz pebbles. From the upper part of the type section. (G.S.C. 153454).

lumps and lens like bodies within the fine-grained carbonate.

The carbonate of the fine sediment rarely contains an admixture of the fine sediment. Under the microscope small cracks are seen within the carbonate around the margin which introduce some silt into the material (Plate 25). The carbonate of the coarser sandstones and grits contains as much as 10-15% of the surrounding sediment.

The boundaries between the carbonate and the enclosing sediment are usually quite sharp (Plate 26). Within the finer sediments mixed beds are usually overlain and underlain by shales and silts rather than limestones. Gradational boundaries are more common within the coarser sediments. Where a gradation occurs it is commonly over less than one foot. Mixed beds are rarely over 5 feet in thickness. Lens like bed forms are very uncommon.

Many of these mixed beds are similar to lithologies described by Freshney (1961) from the Lower Cambrian Cementstone Group of the Midland Valley of Scotland. According to Freshney, analysis of a series of insoluble residue and Ca/Mg ratios from an underlying shale through a nodular cementstone and up into an overlying shale indicates that the nodular cementstones may have been formed by differential vertical segregation within unconsolidated carbonate muds.

Freshney found that the typically sharp contact between the carbonate and the enclosing sediment corresponds with a sudden rise of the Ca/Mg ratio from the silt or shale into the carbonate nodule and a sudden drop in the insoluble residue content. The sharp basal contact is interpreted by Freshney as a former impermeable layer to downward migrating solutions. The solutions presumably leach the carbonate from the overlying calcareous muds while the muds are unconsolidated. The downward migrating solutions then deposit carbonate above the impermeable layer in the form of nodules

PLATE 25

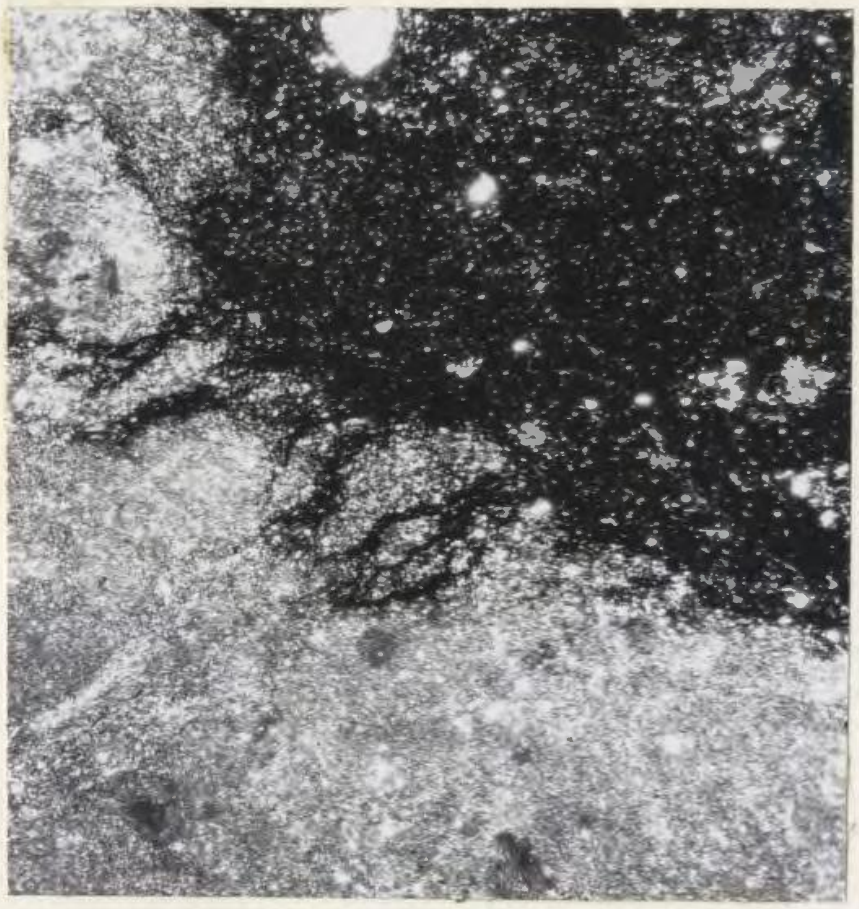
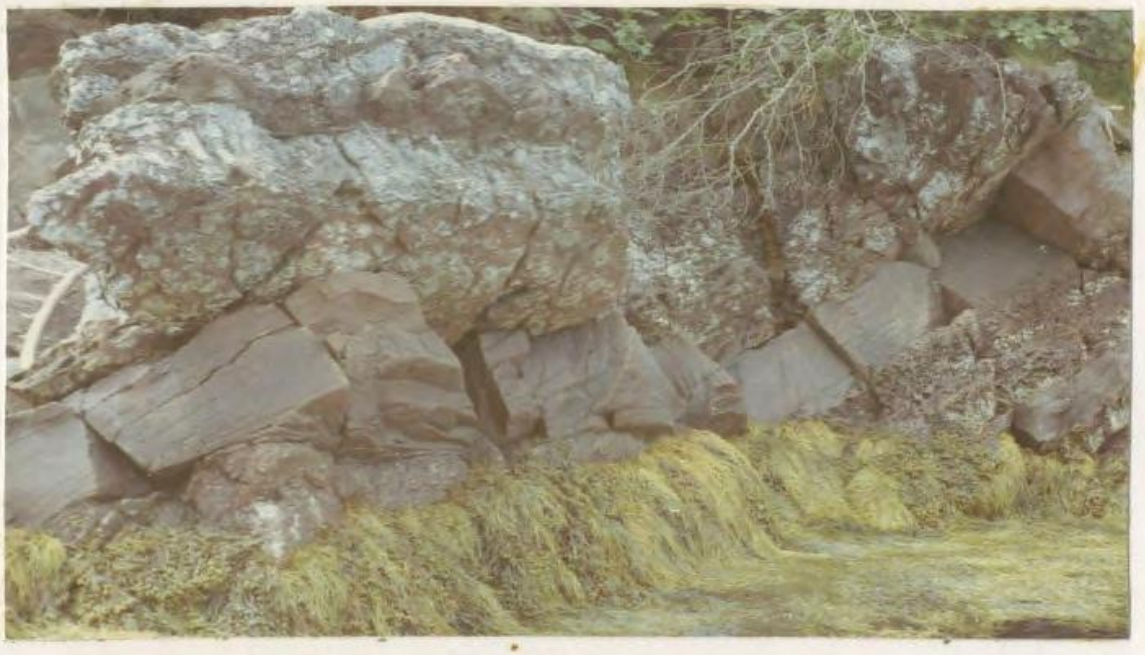


Photo-micro of a contact between a fine grained carbonate nodule towards the bottom of the picture and red silt towards the top. Note cracking at the edge of the nodule and the introduction of red silt. The specimen is from a carbonate nodule, red silt mixed bed from the Little Harbour section. Plain polarised light x 20.

PLATE 26



Fine red sandstone unit overlain and underlain by mixed beds. Note the sharp contacts. From the middle part of the section west of North Bay.

or a nodular layer. A similar origin is proposed for the mixed bed lithologies of the Cinq Isles Formation.

Some of the mixed beds of the Wreck Cove and Spyglass Cove sections have been slightly metamorphosed by dyke intrusions, possibly related to the Ackley Batholith. Much of the carbonate of the mixed beds has been leached out. The nodules there are slightly green in colour due to a fine-grained epidote content of as much as 10%. The rest of the nodule is made up of about equal parts of coarse-grained quartz and plagioclase feldspar. The nodules of these metamorphosed mixed beds are harder than the fresh variety and stand out on a weathered surface. The silts and shales of these metamorphosed mixed beds are dark reddish brown in colour and hornfelsic in character. These metamorphosed mixed beds were erroneously identified as amygdaloidal volcanics by Hutchinson (1962).

Limestones

Limestones account for about 15% of the Cinq Isles Formation. They range from a fine grained micritic limestone light to dark grey in colour to coarse crystalline sparry limestones containing scattered quartz grains and pebbles. In the coarser parts of the upper sections limestone forms a groundmass for some sandstones and pebble beds. Most limestone beds are less than 4 feet in thickness.

The most common type of limestone is a light to medium grey micrite, massively bedded and featureless weathering to a hard jagged surface. These micrites contain varying amounts of silt and mud material either scattered or as thin laminae or lenses (Plate 27). As the proportion of this contained material increases so the colour of the rock darkens causing some micrites to be very dark grey in colour. These limestones

PLATE 27

Reddish grey micritic limestone containing scattered red silt. Note the rough weathered surface. From the middle part of the section east of East Bay.

are in most places 6 inches - 2 feet in thickness. In the upper part of the Wreck Cove section one limestone bed is 20 feet in thickness, this is the thickest single limestone bed of all Cinq Isles Formation exposures. Limestones are commonly associated with silts, shales, sandstones and to a lesser extent mixed beds. The boundaries are commonly gradational, over an inch or so, from one rock to another (Plate 2). Boundaries in places can be sharp. Locally in some of the upper sections the upper boundary of a limestone overlain by coarse sandstones presents an irregular torn up surface. (Plate 17, upper surface of limestone units).

Some limestones, especially those in the middle and upper parts of the sections contain angular to rounded fragments of limestone, commonly fine grained, cemented together by carbonate material of a similar or slightly coarse nature. These units vary from a scattering of limestone fragments to as much as 80% contained limestone fragments. Many of these fragments can be up to 1 1/2 inches in diameter; commonly they range from 1/4-3/4 inch in diameter. A limestone bed from the middle part of the section on the east shore of East Bay consists of about 60% of limestone balls and folded fragments about 1/4-1/2 inch in diameter set in a fine-grained medium grey lime mud matrix. These fragments are interpreted to be thin, soft limestone laminae torn up and rolled into ball shaped or folded masses by a turbulent current. These fragments were later redeposited and set within fine carbonate muds during quieter conditions. Some of these storms or turbulent currents were quite strong; an example of a particularly strong disturbance is seen on the western shore of North Bay at about the 700 foot level where a single rounded micrite boulder, 17 inches in diameter, is contained within a coarse red arkose (Plate 11).

In the upper parts of the sequences particularly in the Belle Bay

area many of the limestones are coarse in texture. These sparry limestones are pale in colour and are always associated with scattered quartz grains and quartz pebbles. As the amount of clastic material increases the carbonate becomes a matrix to either coarse sandstones or quartz conglomerates (Plates 12B, 13A + B).

An unusual limestone unit from the 270 foot level of the Bacon Point to Michael Day Cove presents a "semi-algal" appearance on first observation (Plate 19). The bed, about 18 inches thick is made up of laminae of micritic limestone, red silt and silty sand. A number of wave like forms within the bed are seen to be slump folds, the argillaceous layers have fractured, with micrite filling the fractures. This unusual bed is unique within the Cinq Isles Formation.

Sandstones

Sandstones make up about 25% of the Cinq Isles Formation. They range from clean quartzites and arkoses to coarse dark coloured sediments composed of quartz, volcanic rock, feldspar, siltstone and mud fragments. Locally some sandstones in the upper parts of the sections are composed of rounded quartz grains with as much as 40% carbonate material as a matrix. The colour of the sandstones varies from dark grey to red, reddish yellow, buff and occasionally white.

Very coarse sandstone (Folk, 1968) recorded as grit in field notes become more prevalent in the upper sections with the exception of those outcrops on the western side of Great Bay de l'Eau where they are of minor importance.

The most common sandstone type is brick red in colour, even grained, even bedded, fine to coarse in texture consisting of haematite stained quartz grains, some muscovite fragments, and occasional feldspar fragments.

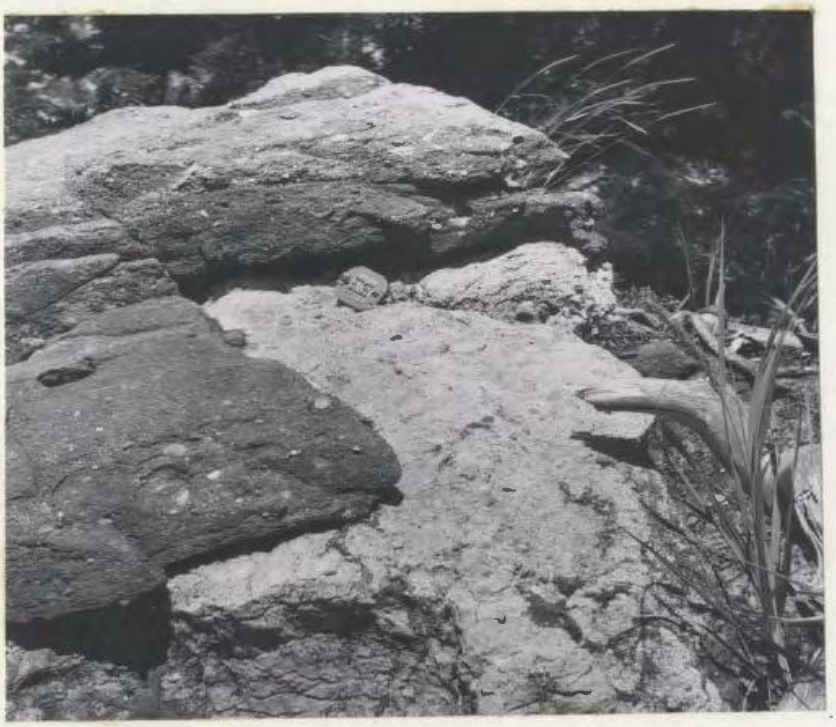
The quartz grains are subrounded to moderately rounded, the feldspars are usually angular to subrounded. Many of these beds are quite thick and massive. The Belle Bay and Wreck Cove sections contain thick sandstone sequences, many of the beds being 4-6 feet in thickness. The boundaries are usually quite sharp. Some of the sandstones contain scattered white quartz pebbles, a few are as much as 1 1/2 inches in diameter, the great majority though are usually less than 1/2 inch.

Reddish-yellow arkosic sandstones are present locally in most sections. They are relatively uncommon in the Spyglass Cove and Wreck Cove sequences. These units are often coarse and poorly sorted. They occur as lenses, thin beds and as units occasionally up to several feet in thickness. They are massive bedded sandstones containing round clear quartz grains, coarse angular pink feldspar and fine white feldspar grains. Some of these sandstones have a calcareous cement.

Most of the very coarse sandstones composed of fragments of quartz, volcanic rock, feldspar and siltstone. They are commonly poorly sorted. The fragments are set in a reddish grey to dark grey fine grain material. In most of these units all size grades from the finest to the coarsest fragments, up to 1/2 inch in length are present. Many of the very coarse sandstones contain scattered quartz pebbles (Plate 28). These beds can be up to 6 feet in thickness, most are from 1-3 feet in thickness.

The Spoon Cove Member on the western shore of North Bay is dominantly composed of several hundred feet of massively bedded medium to dark grey and purple sandstones. The rock is made up of dark fine-grained volcanic, quartz, siltstone and some feldspar fragments angular to subrounded and moderately well sorted. Throughout the member there are laminae and thin beds of fine dark silts and coarse sandstones. The rock as a whole is hard and brittle. This thick basal sandstone is not present in any other

PLATE 28



Coarse reddish grey grit with scattered quartz pebbles abruptly overlying a medium grey micritic limestone. From the upper part of the section east of East Bay. (G.S.C. 153451).

section of the Cinq Isles Formation.

Quartzites are uncommon in the Cinq Isles Formation with the exception of the lower part of the Spyglass Cove section and parts of the Wreck Cove section. In the Spyglass Cove sequence there are a number of clean quartzites as much as 5 feet in thickness. The majority are from 1-3 feet, massive and composed of up to 90% moderately sorted and rounded white quartz grains. Silica cement between the grains gives these beds a high resistance to erosion. The colour varies from buff to pale grey.

The Conglomerates

The conglomerates of the Cinq Isles Formation are confined mainly to the middle and upper parts of the succession; they make up about 10% of the total formation. They constitute a wide variety of characteristic rock types. Some are composed of varying amounts of rounded quartz pebbles set in a red or grey sandstone matrix. Others are composed of pebbles of quartz, granite gneisses, dark fine-grained volcanics, red sandstones and quartzites in a red arkosic sandstone or grit matrix. A few others consist of mainly white quartz pebbles in a matrix of fine white quartz and carbonate material. Most of the conglomerates are poorly bedded with few directional features present. They are, in most places, overlain and underlain by sandstones only locally are they bound by other sediments. The thickest unit is seen at Spyglass Cove and Tilt Point where a 70-foot coarse polymictic conglomerate outcrops. Few of the conglomerates are over 15 feet in thickness.

The most abundant conglomerate type is one made up of scattered quartz pebbles within a sandstone or grit matrix (Plate 29). Unlike the other conglomerate types these are less restricted in their occurrence.

PLATE 29

Conglomerate with scattered quartz pebbles, set in a course grit matrix. From the 1150 ft. level of the section on the western shore of North Bay. (G.S.C. 153488).

The quartz pebbles range in size from 1/4 inch to 6 inches in diameter. The large sizes are not common however, the average size being about 1/2 to 1 inch. The quartz itself is of the white crystalline plutonic vein quartz type. The clasts are subrounded to rounded, few are angular. They occur within a matrix of red or grey sandstones and grits. The amount of clasts can vary considerably. Some beds contain widely scattered pebbles, while in others the pebbles account for as much as 80% of the rock. The widely scattered pebbles are usually moderately well sorted with only a few size grades being represented. They average 3/4 inch in diameter. Beds with a high pebble content are only poor to moderately sorted. This more common conglomerate type ranges from 1-5 feet in thickness.

The other main conglomerate type is composed of a varied selection of clasts within an arkosic or quartz and rock fragment groundmass. The clasts present include quartz, granite, rhyolite, dark fine-grained mafic volcanics, quartzite, red sandstone and silt.

Quartz is the dominant clast comprising as much as 60% of the pebble content. Quartzites, rhyolites and mafic volcanics are important, especially in those conglomerates occurring in the lower and middle parts of the sections. Granite clasts make up about 5-10% of the pebble content as do fragments of fine sediments, red sandstone and shale. The granite and fine sediment clast content does not vary appreciably throughout the succession. The various clasts are moderately coarse, quartz pebbles up to 5 inches in diameter are not uncommon in some beds. The other clast types are smaller, few being over three inches in diameter. The average size for the quartz fragments is about 1 1/2 inches. For the other clasts it is about 1/2 - 1 inch. The quartz pebbles are moderately rounded, the granites and quartzites subrounded to moderately rounded, the volcanics and fine sediments are angular to sub-rounded, most being angular. The fine sediments are often

tabular in shape having been broken parallel to the bedding planes.

The matrix of these conglomerates varies from a red arkose to a reddish grey material composed dominantly of quartz, small rock fragments and mud. The arkosic matrix in many units can be quite coarse. The thick conglomerate exposed at Tilt Point and Spyglass Cove contain a groundmass composed of coarse angular quartz and feldspar fragments, many of which are up to 1/4 inch in diameter. The arkosic groundmass of many of the conglomerates is poorly indurated and crumbles easily. The groundmass composed of quartz, rock fragments and mud can be equally as coarse as the arkose in some localities. This material is harder than the arkose. The arkosic groundmass tends to be the dominant groundmass of this conglomerate type higher in the sequence.

From a distance, many of the conglomerates are red in colour due to a thin red iron oxide covering on much of the material. Upon closer inspection, the conglomerates with a high arkosic groundmass are reddish buff coloured, while those with a quartz rock fragment groundmass are a dirty reddish grey colour.

The above data indicate a great similarity between the conglomerate facies and piedmont alluvial deposits (Blissenback, 1954; McKee, 1957; Bull, 1963; Melton, 1965). The stratigraphic and paleogeographic position, poor sorting, lack of primary structures and poor rounding of locally derived clasts strongly suggest that these conglomerates are alluvial fan deposits derived from nearby source areas and deposited by intermittent streams.

The basal conglomerate and the conglomerates of the lower part of the Wreck Cove section are somewhat different from the other conglomerates of the Cinq Isles Fm. These units contain a significantly higher amount

of argillite clasts and groundmass material with some subrounded scattered quartz pebbles within a dirty reddish grey sandstone and grit matrix. The argillites are derived from the underlying Lower and Middle Cambrian Youngs Cove Group upon which the Cinq Isles Fm. at Wreck Cove lies unconformably. The Youngs Cove Group is made up of purple grey shales, slates and mudstones. Fragments from these beds are seen in conglomerates up to about 100 feet from the base of the succession. The clasts are angular to subrounded, few are over three inches in diameter. The average size is about 3/4 inch. The groundmass of the conglomerates contain as much as 30% small rock fragments and clay material derived from the underlying Cambrian succession. Many of the sandstones and grits in the lower part of the section contain a matrix rich in clay, also derived from this same Cambrian source.

Directional Features

Directional features, indicating incoming currents from the north and northeast, are well displayed in a number of coarse sedimentary units in the Cinq Isles Formation (Figure 4). These current directional features include tabular cross bedding (McKee and Weir, 1953) and trough cross bedding (McKee and Weir, 1953) and pebble imbrication. Directional features are present in all sections of the Cinq Isles Formation but are uncommon in those sections on the western shore of Great Bay de l'Eau due to the relative absence of coarse sediments.

Tabular crossbeds are the commonest directional features of the Cinq Isles Formation. They are found in sandstones, grits and local conglomerates. The cross bedding is brought out in most places by differences in grain size or colour, or both. They occur in single units or in a series up to 5 or 6 in number in a single bed, commonly separated by a thin layer of sediment. This intervening sediment is often finer-grained than that composing the

FIG:4

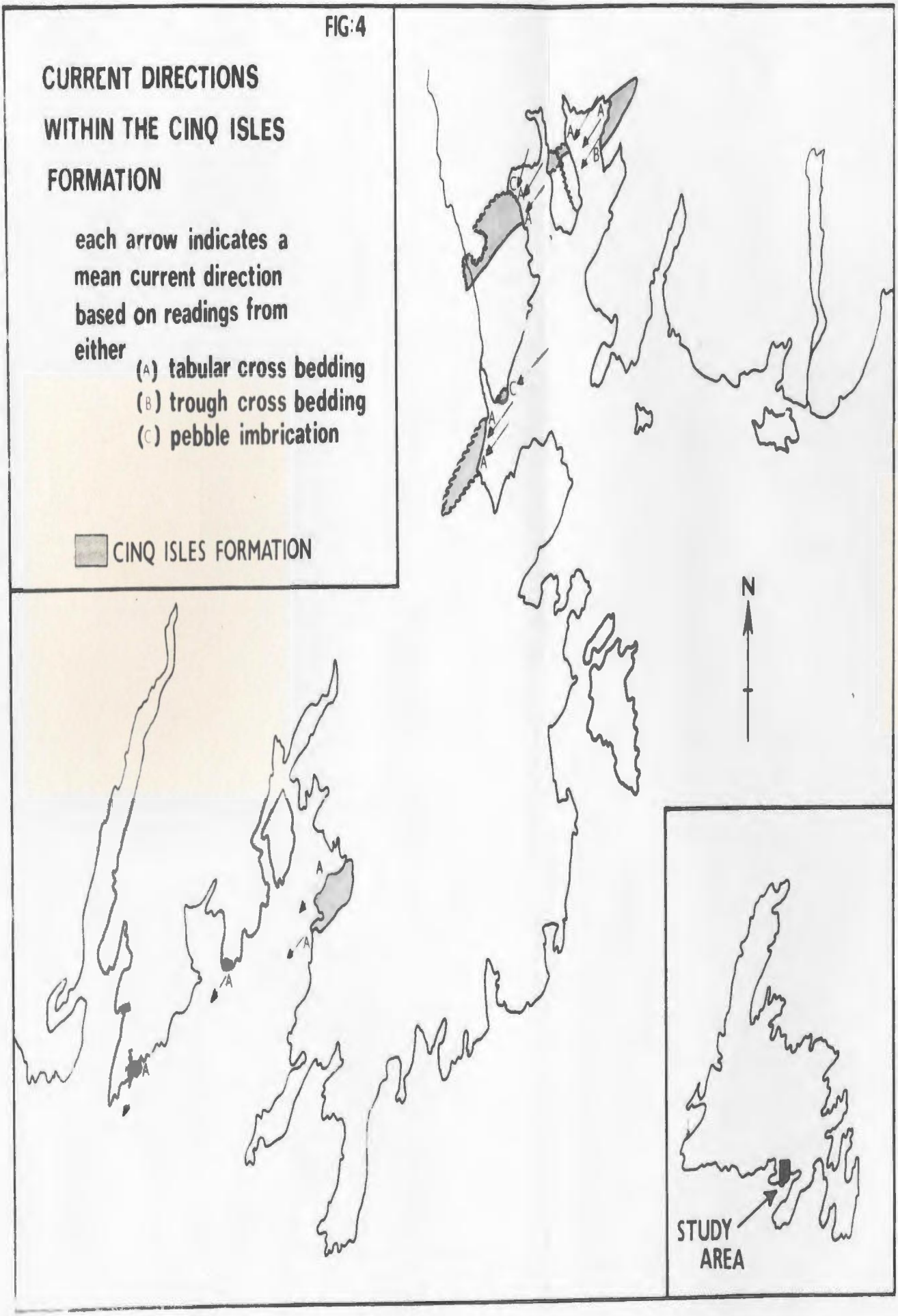
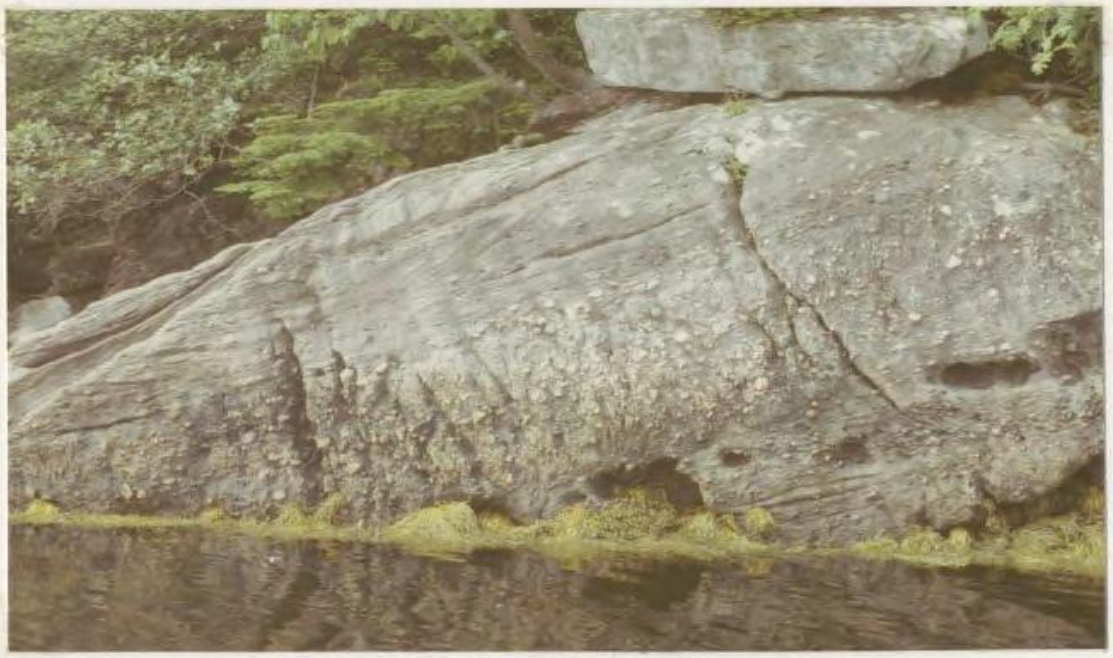

CURRENT DIRECTIONS
WITHIN THE CINQ ISLES
FORMATION
each arrow indicates a
mean current direction
based on readings from
either
(A) tabular cross bedding
(B) trough cross bedding
(C) pebble imbrication
CINQ ISLES FORMATION
N
STUDY
AREA

Plate 30



Tabular cross bedded unit composed of grey grits and scattered quartz pebbles. From the 250 foot level west of East Bay.

Plate 31

Trough cross bedded unit in coarse reddish-grey sandstone with scattered quartz pebbles, bounded by quartz pebble conglomerate. From the upper part of the type section on the eastern shore of East Bay.

crossbed. Individual crossbeds range from 6 inches to 2 feet in thickness. A series of readings from 32 tabular crossbeds exposed in three dimensions indicates incoming currents from a northeasterly direction.

Trough crossbeds are restricted in occurrence to coarse red and grey sandstones and grits of the upper parts of the sections. These coarse sediments contain abundant quartz pebbles and fragments, and locally a carbonate matrix. They are moderately common in the type section to the east of East Bay, rare to absent in the other Cinq Isles Formation sections of Belle Bay, and absent in the sections in Great Bay de l'Eau. Most trough crossbeds are from 3 to 5 feet in width and are commonly shallow, few being over 10 inches in depth. Individual laminae within a unit are from 1/2 inch to 1 1/2 inches in thickness. Trough crossbeds are commonly bounded by coarse poorly sorted quartz pebble conglomerates (Plate 31). Thirty-five directional readings along the long axis of three dimensional trough crossbeds were recorded. The mean average indicates incoming currents from a northeasterly direction with a range from the north northeast to the east northeast.

Pebble imbrications are rare in the Cinq Isles Formation. From the middle part of the section on the western shore of North Bay three examples were recorded in grey grits, at Tilt Point two examples were recorded in red sandstones from the upper part of the section. The occurrences consisted in all cases of several layers of overlapping, somewhat tabular shaped shale, dark volcanic rock and quartz fragments. These fragments varied from 1/2 inch to 2 inches in length. Pebble imbrications on the western shore of North Bay indicate current directions from the north northeast, those at Tilt Point indicate currents from the northeast.

Externally Derived Clasts

The Cinq Isles Formation and the overlying conglomerates contain clasts eroded from various older terrains in the Fortune Bay area. These clasts include granite fragments similar to the underlying Simmons Brook Batholith, abundant vein quartz fragments, volcanic rock fragments and some sediments from the late Precambrian Long Harbour Group, dark grey Upper Cambrian argillites and foliated granites, gneisses and schists typical of the Garrison Hills metamorphic terrain of the Central Mobile Belt.

Clasts derived from the Simmons Brook Batholith include pink to grey medium to coarse-grained granite and granodiorite. Most of the batholith and the clasts are altered, as indicated by the transformation of mafic minerals to chlorite, epidote and zoisite. Quartz pebbles and fragments are the most abundant clasts within the Cinq Isles Formation. The quartz is of the vein quartz variety (Folk, 1968) and is probably derived from the Simmons Brook Batholith. The Pools Cove and Great Bay de l'Eau Formations in addition contain coarse grained porphyritic biotite granite and medium grained pink alaskitic granite typical of the Devonian Ackley granite and other Devonian granites north of the area.

Dark grey argillite clasts from the underlying Upper Cambrian Salmonier Cove Formation at Wreck Cove are locally abundant in the basal section of the Cinq Isles Formation. These clasts are absent from other Cinq Isles successions.

A wide variety of silicic to mafic volcanics and some fine grained sediments from the late Precambrian Long Harbour Group exposed to the east and northeast are present throughout much of the Cinq Isles succession, and are common in the overlying conglomerates. Many of the finer-grained

sediments derived from this source are hornfelsic in character.

A variety of foliated granite, granite gneiss and mica schist clasts typical of the Garrison Hills metamorphic terrain to the north and northwest of the Hermitage Bay Fault are present in the conglomerates of the Cinq Isles Formation and are abundant in the overlying conglomerates. Similar rocks have been traced northeastward across Newfoundland to the Wesleyville map area on the north coast of the island (Jenness, 1963; Williams, 1968) and westward to Grey River on the south coast (Williams, 1972). Everywhere along their southeastern margin these metamorphic rocks are bounded by faults. This is a fundamental break which in Newfoundland separates the Avalon Platform from the Central Mobile Belt (Williams, 1969). The occurrence of these clasts indicates either a possible sedimentary link between the Avalon Platform or because of the common occurrence of north-easterly current directions, derivation from the metamorphic basement underlying the Avalon Platform.

CHAPTER IV

SYNTHESIS AND CONCLUSIONS

The Cinq Isles Formation contains a number of significant sedimentological and stratigraphical features that are important in an interpretation of its depositional environment, its relationships with the overlying conglomerates and the orogenic development of Fortune Bay and the Northern Appalachians.

These features include:-

(A) Mixed red bed - carbonate lithologies.

(B) Lateral and vertical variations.

(C) A variety of externally derived clasts.

(D) Incoming current directions from a dominantly northeasterly direction.

(E) Torn up limestone boulders, and a number of other erosional features.

(F) The unconformable relationship with the underlying Simmons Brook granite and Cambrian argillites.

(G) The intimate relationships with the overlying conglomerates of the Pools Cove and Great Bay de l'Eau Formations.

(H) The intrusive relationships of the Devonian Ackley Batholith with the Cinq Isles Fm. and the overlying conglomerates.

The Cinq Isles Formation is interpreted to represent a post orogenic near shore carbonate environment bordering an alluvial fan chain lying to the north and northeast. Block uplift and granite intrusion during an early phase of the Devonian Acadian orogeny led to an extensive alluvial fan development in the Fortune Bay area.

The basal unit of the formation represents a relatively quiet marine transgression onto a low, flat lying Simmons Brook granite surface to the northeast, and onto moderately dipping Upper Cambrian argillites to the southwest. Fragments from these underlying rock types are contained in the basal deposits of the formation at these localities. At Spoon Cove on the northern shore of North Bay, lateral variation in sediment distribution and probably small local barriers account for the accumulation of the basal unit, the Spoon Cove Member. Streams draining an uplifted block of Precambrian Long Harbour Group volcanics and sediments were the probable source of supply for this local development.

Conditions during much of lower and Middle Cinq Isles time were often relatively quiet. Deposition of red silts, shales and fine sandstones, washed into the lagoon from the fan surface, alternated with biochemically formed or chemically precipitated grey micritic limestones. Slight changes in environmental conditions, such as the solubility of the water, water depth, turbulence, amount of rainfall in the catchment area and concentration of suspended sediment in the lagoon would effect the type of deposition. Differential vertical segregation within the carbonate muds accounts for the development of the mixed bed lithologies. Abundant mixed beds, thin alternating units, lateral variations and lens like bodies indicate the frequency of fluctuating conditions.

Increased rainfall, erosion, and periodic flooding of the fan surface caused the lagoon to be inundated at times with coarse alluvial material giving rise to the sandstones, grits and conglomerates of the lower and middle parts of the succession. With the approach of the encroaching fan these coarser units become dominant in the upper parts of the sections, with the exception of those sequences on the western shore of Great Bay de l'Eau.

The variety of different clasts within the conglomerates indicates that the fan was supplied with material from a number of geologically different terrains. These varied clasts include Precambrian Long Harbour Group sediments and volcanics, Simmons Brook granite and Garrison Hill type foliated granites, gneisses and schists. These various source areas were probably in the form of a series of horst blocks bordering the fan chain.

Probable uplift of the fault blocks in Late Middle and Upper Cinq Isles times leading to further erosion and fan development caused a marked increase in the amount of coarse sediment and conglomerates entering the lagoon, especially in the Belle Bay area.

Increased trubulence in the lagoon and the action of migrating and changing channels is indicated by the occurrence of a number of features. These include the rapidly thinning and lensing out of beds, torn up limestone boulders and reworked limestone units, erosional and irregular upper surfaces of many units overlain by coarse sandstones, and the abundant trough crossbeds in the upper part of the sections to the east at Belle Bay.

The type section on the eastern shore of East Bay contains abundant erosional features and some of the coarsest deposits of the Cinq Isles Formation. The sequences on the western shore of Great Bay de l'Eau contain relatively few coarse sediments and few erosional features. This indicates that they were deposited in quieter conditions further to the southwest of the fan chain than those successions in Belle Bay.

At the end of Cinq Isles time in the Belle Bay area and on the western shore of Great Bay de l'Eau little or no orogenic disturbance of the lagoon took place before the final encroachment of the alluvial fan. The coarse conglomerates of the Pools Cove Formation rest, at most with a

minor disconformity, on the underlying Cinq Isles Formation. West of Salmon River the Pools Cove Formation rests unconformably on the Simmons Brook granite with the Cinq Isles Formation represented by only a few small pockets of red silt and granite wash. Red sandstone fragments in the Pools Cove conglomerates suggest that the Cinq Isles Formation was previously more extensive in this area. Restricted deposition over a probable 'high' and partial erosion along the unconformable boundary combine to explain this markedly diminished sequence. The unconformable contact between the Great Bay de l'Eau Formation and Cinq Isles Formation at Wreck Cove indicates slight uplift and folding before being overlain by coarse arkosic conglomerates of the encroaching fan.

The Pools Cove and Great Bay de l'Eau Formations contain abundant fragments of Ackley Batholith granite and, in the case of Pools Cove Formation, is cut by a later intrusive phase of Ackley Batholith. This relationship indicates that these coarse conglomerates overlying the Cinq Isles Formation are synorogenic sediments deposited during intrusive episodes of the Ackley Batholith related to the Devonian Acadian orogeny.

Lithologies similar to the Cinq Isles Formation have been described from only a limited number of localities. The deposits showing the most similarities are those of the Visean and Tournasian Carboniferous cementstone facies of the Midland Valley of Scotland and their extension into Northern Ireland (Freshney, 1961). The non-marine cementstone facies of Eastern Canada found in the Fundy Basin (Belt, 1967), unlike their British counterparts, do not contain many of the characteristic features of the Cinq Isles Formation. Cementstone type facies are also found in the Triassic rift valley of Connecticut and Massachusetts (Emerson, 1898). The cementstone facies of the British Isles and the Cinq Isles Formation of Fortune Bay were both deposited in marginal marine to restricted marine

environments bounded by uplifted fault blocks.

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AGE	WHITE 1939	WIDMER 1950	SMITH AND WI 1954
DEVONIAN	GREAT BAY DE L'EAU FM	GREAT BAY DE L'EAU FM	GREAT BAY DE L'
	ACKLEY BATHOLITH	ACKLEY BATHOLITH	ACKLEY BATHOL
	BAY DU NORD GRANITE	BAY DU NORD GRANITE	BAY DU NORD GRA
SILURIAN	1 of		
	RENCONTRE FM	RENCONTRE FM	RENCONTRE
ORDOVICIAN	LONG HARBOUR SERIES: MOORING COVE FM; ANDERSONS COVE FM; BELLE BAY FM	MOORING COVE FM; ANDERSONS COVE FM; BELLE BAY FM; POOLS COVE FM; CINQ TELLES SERIES: TILT POINT FM, YANKEE COVE FM, SPOON COVE FM	GROUP; BELLE BAY FM; POOLS COVE FM; CINQ TELLES GROUP: TILT POINT, YANKEE COV, SPOON COVE

INTERPRETATIONS OF THE CINQ ISLES FORMATION AND NEARBY GROU

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		ACKLEY BATHOLITH		GREAT BAY D
E L'EAU FM	GREAT BAY DE L'EAU FM	TERRENCEVILLE FM	GREAT BAY DE L'EAU FM TERRENCEVILLE FM	TERRENCEVI
THOLITH	ACKLEY BATHOLITH		UNSEPARATED ACKLEY BATHOLITH	UNSEPARAT GRANITES
GRANITE	BAY DU NORD GRANITE		BAY DU NORD GRANITE	POOLS COV
		[redacted]		SEDIMENTS THE CINQ
FM	RENCONTRE	RENCONTRE FM	RENCONTRE FM	RENCONTRE ANDERSONS BELLE BAY
COVE FM	GROUP	ANDERSONS COVE FM	ANDERSONS COVE FM	
FM	BELLE BAY FM	BELLE BAY FM	BELLE BAY FM	
E FM	POOLS COVE FM		POOLS COVE FM	
NT FM	CINQ ISLES GROUP: TILT POINT FM		CINQ ISLES GROUP	
COVE FM	CINQ ISLES GROUP: YANKEE COVE FM			
OVE FM	CINQ ISLES GROUP: SPOON COVE FM			
VE FM	SALMONIER COVE FM		LOWER - UPPER CAMBRIAN DATED SEDIMENTS	LOWER - U CAMBRIA DATED SE
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E FM	YOUNGS COVE FM			

ISLES FORMATION AND NEARBY GROUPS, FORTUNE BAY

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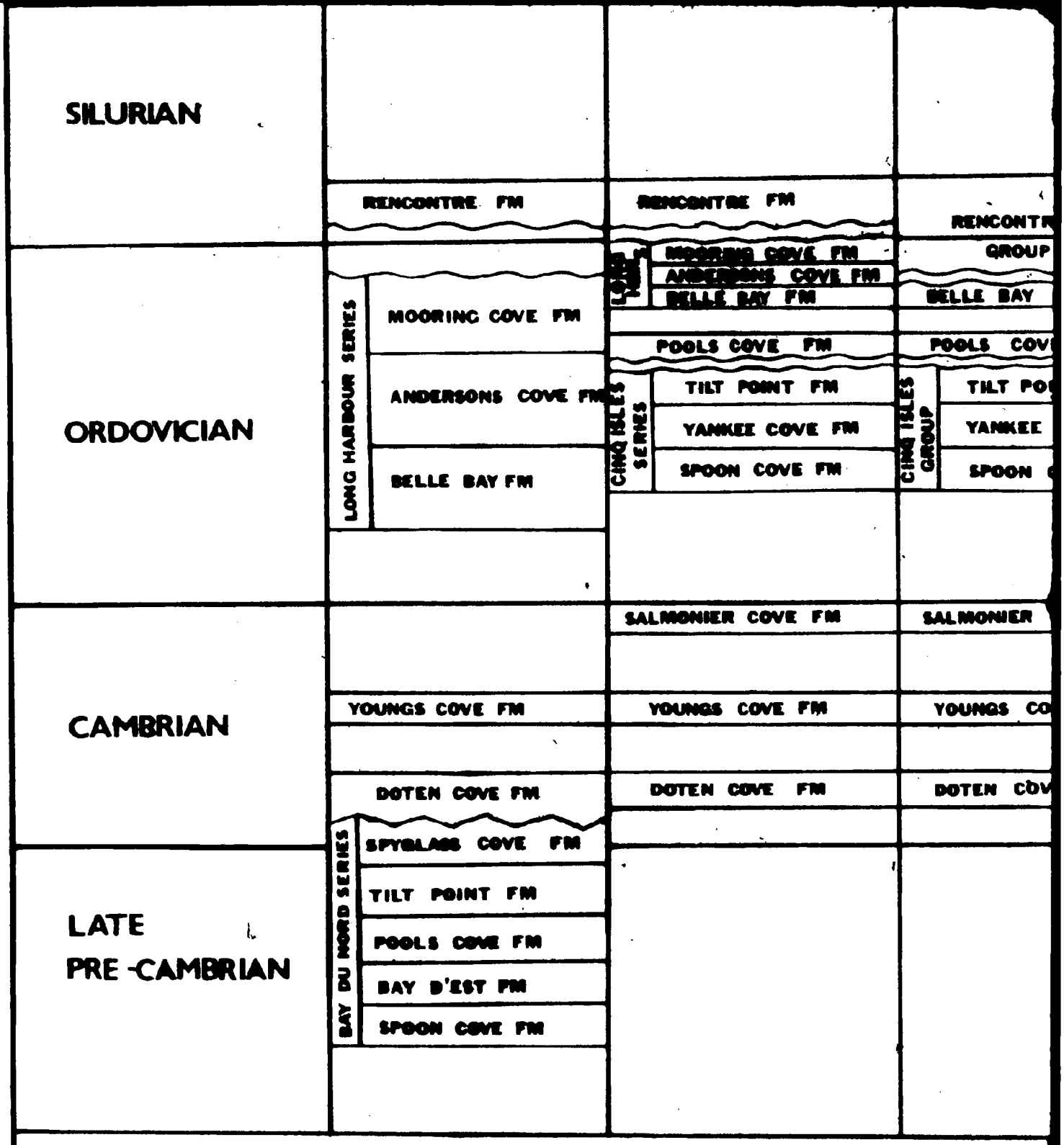
Y BATHOLITH			GREAT BAY DE L'EAU FM
	GREAT BAY DE L'EAU FM	GREAT BAY DE L'EAU FM	ACKLEY BATHOLITH
NCEVILLE FM	TERRENCEVILLE FM	TERRENCEVILLE FM	POOLS COVE FM
		UNSEPARATED GRANITES	CINQ ISLES FM
	UNSEPARATED ACKLEY BATHOLITH BAY DU NORD GRANITE	POOLS COVE FM	WRECK COVE / SIMMONS BROOK / BELLE BAY
		SEDIMENTS OF THE CINQ ISLES FM	YOUNGS COVE GROUP AT / CINQ ISLES FM UNCONFORMABLE ON / CINQ ISLES FM UNCONFORMABLE ON BATHOLITH IN
ONTRE FM	RENCONTRE FM	RENCONTRE FM	
		ANDERSONS COVE FM	
RSONS COVE FM	ANDERSONS COVE FM	BELLE BAY FM	
E BAY FM	BELLE BAY FM		SIMMONS BROOK BATHOLITH
	POOLS COVE FM		
	CINQ ISLES GROUP		
MILE HILL FM	LOWER - UPPER CAMBRIAN DATED SEDIMENTS	LOWER - UPPER CAMBRIAN DATED SEDIMENTS	YOUNGS COVE GROUP

3 of 1


SILURIAN
RENCONTRE FM
RENCONTRE FM
RENCONTR
ORDOVICIAN
LONG HARBOUR SERIES
MOORING COVE FM
ANDERSONS COVE FM
BELLE BAY FM
MOORING COVE FM
ANDERSONS COVE FM
BELLE BAY FM
GROUP
BELLE BAY
POOLS COVE FM
POOLS COVE FM
POOLS COV
CINQ ISLES SERIES
TILT POINT FM
YANKEE COVE FM
SPOON COVE FM
CINQ ISLES GROUP
TILT PO
YANKEE
SPOON
SALMONIER COVE FM
SALMONIER
CAMBRIAN
YOUNGS COVE FM
YOUNGS COVE FM
YOUNGS CO
DOTEN COVE FM
DOTEN COVE FM
DOTEN COV
BAY DU NORD SERIES
SPYGLASS COVE FM
TILT POINT FM
POOLS COVE FM
BAY D'EST FM
SPOON COVE FM
LATE
PRE-CAMBRIAN
note: 1) THE BAY DU NORD SERIES (WHITE 1988) IS THE EARLIER NAME FOR THE CINQ ISLES FM.
2) THE BAY DU NORD GRANITE (WHITE 1988 ETC) IS THE EARLIER NAME FOR THE SHINGLE HEDGE BATHOLITH.
3) TH
AB
BA
TH
4 of

				SEDIM THE C
TBE FM	RENCONTRE	RENCONTRE FM	RENCONTRE FM	
RING COVE FM ERSONS COVE FM LE BAY FM	GROUP BELLE BAY FM	ANDERSONS COVE FM BELLE BAY FM	ANDERSONS COVE FM BELLE BAY FM	
S COVE FM	POOLS COVE FM		POOLS COVE FM	
LT POINT FM	CINQ ISLES GROUP: TILT POINT FM		CINQ ISLES GROUP	
NKEE COVE FM	CINQ ISLES GROUP: YANKEE COVE FM		CINQ ISLES GROUP	
OON COVE FM	CINQ ISLES GROUP: SPOON COVE FM		CINQ ISLES GROUP	
ER COVE FM	SALMONIER COVE FM			
		NINE MILE HILL FM	LOWER - UPPER CAMBRIAN CATED SEDIMENTS	LOW CA DAT
S COVE FM	YOUNGS COVE FM			
N COVE FM	DOTEN COVE FM			

5 of 1

2) THE BAY DU NORD GRANITE (WHITE 1969 ETC) IS THE EARLIER NAME FOR THE SIMMONS BROOK BATHOLITH.

3) THE CINQ ISLES FM IS ABSENT IN BRADLEY'S (1962) MAP AREA TO THE EAST OF THE PRESENT STUDY AREA.

UNCONFORMITY.

FAULT.

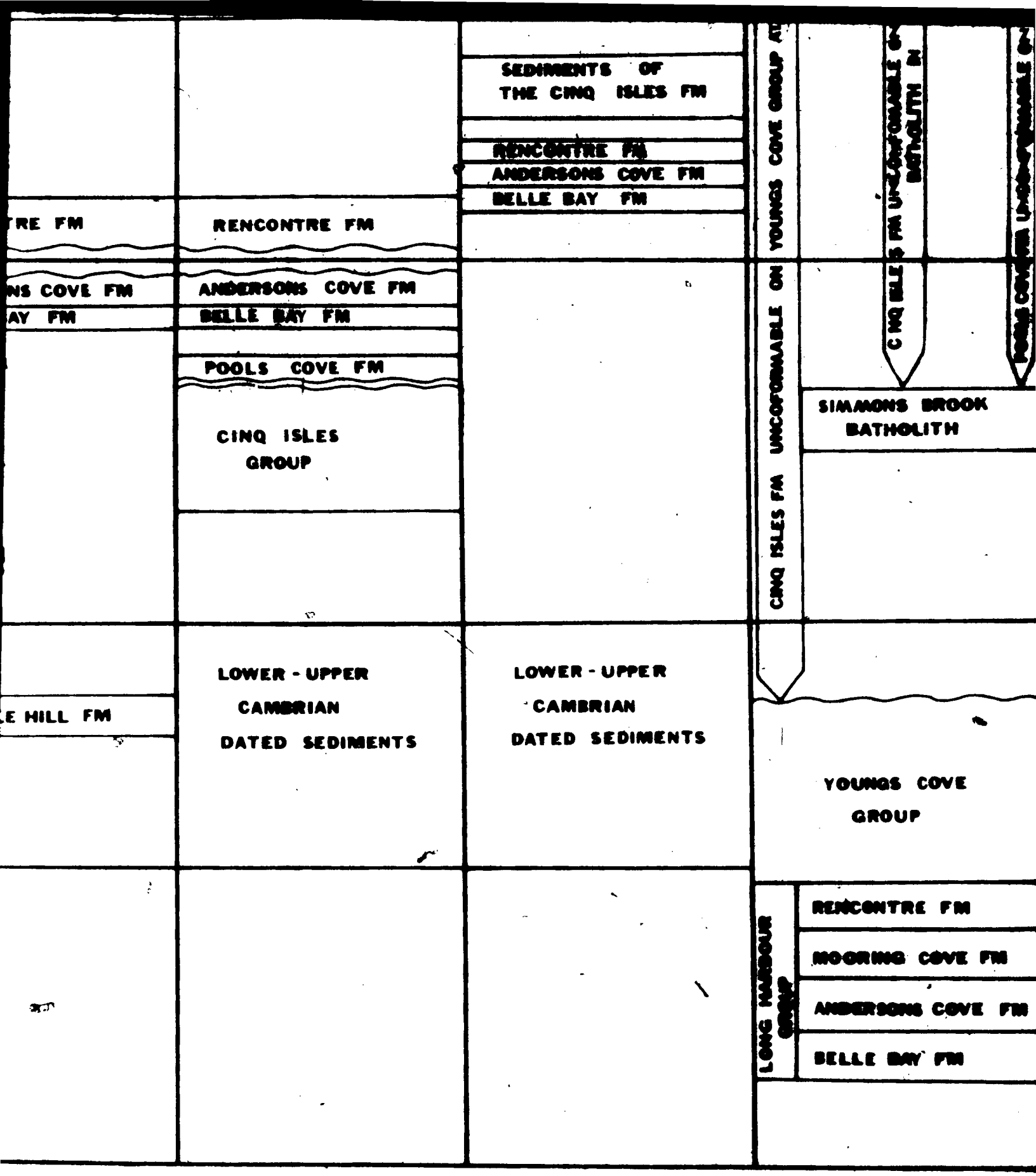
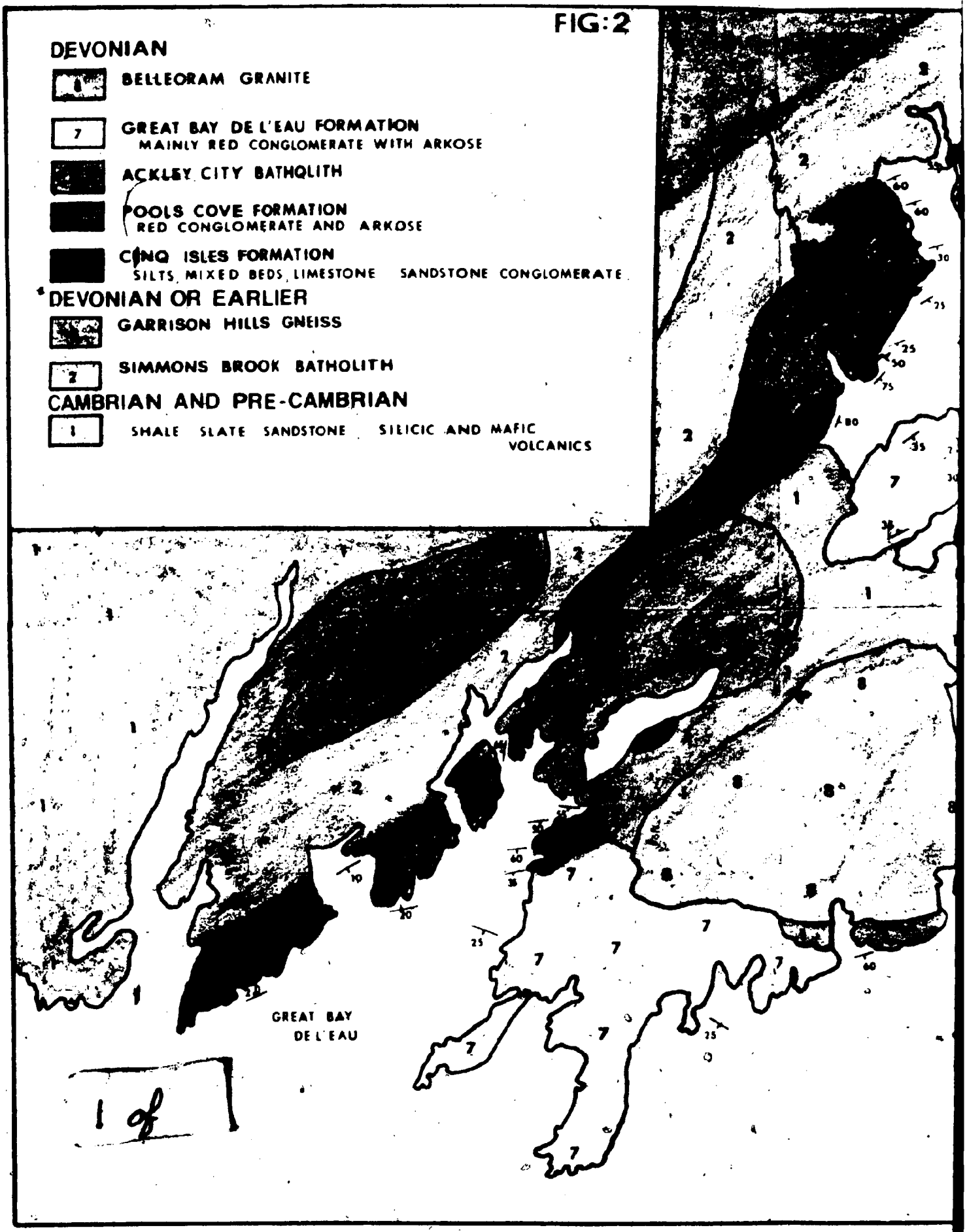
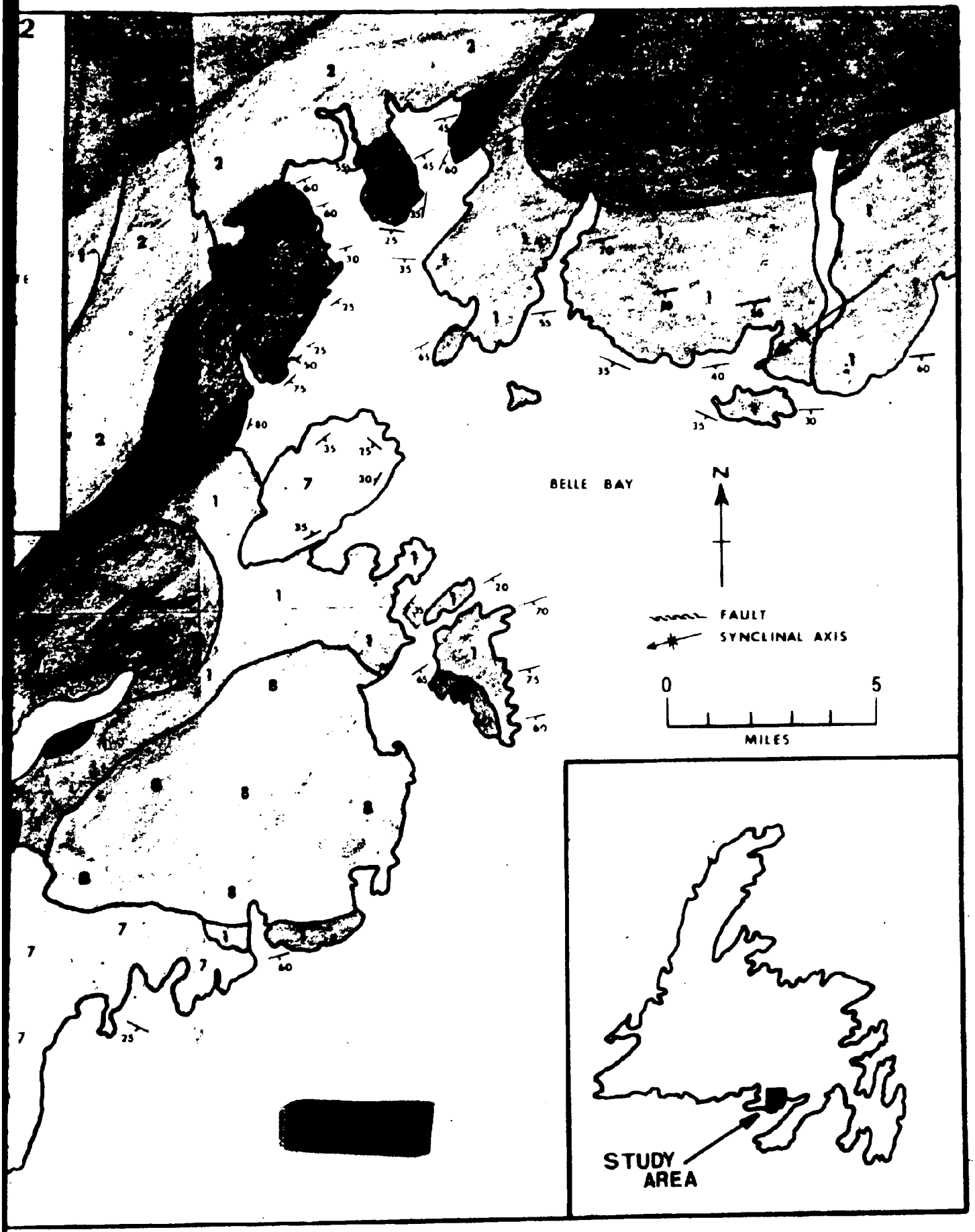

SEDIMENTS OF THE CINQ ISLES FM
RENCONTRE FM
ANDERSONS COVE FM
BELLE BAY FM
TRE FM
RENCONTRE FM
NS COVE FM
ANDERSONS COVE FM
AY FM
BELLE BAY FM
POOLS COVE FM
CINQ ISLES GROUP
CINQ ISLES FM UNCONFORMABLE ON YOUNGS COVE GROUP
CINQ ISLES FM UNCONFORMABLE ON BATHOLITH
SIMMONS BROOK BATHOLITH
E HILL FM
LOWER - UPPER CAMBRIAN DATED SEDIMENTS
LOWER - UPPER CAMBRIAN DATED SEDIMENTS
YOUNGS COVE GROUP
LONG HARBOUR GROUP
RENCONTRE FM
MOORING COVE FM
ANDERSONS COVE FM
BELLE BAY FM
UNCONFORMITY.
FAULT.

FIG:2


DEVONIAN
8 BELLEORAM GRANITE
7 GREAT BAY DE L'EAU FORMATION
MAINLY RED CONGLOMERATE WITH ARKOSE
ACKLEY CITY BATHOLITH
POOLS COVE FORMATION
RED CONGLOMERATE AND ARKOSE
CINQ ISLES FORMATION
SILTS, MIXED BEDS, LIMESTONE SANDSTONE CONGLOMERATE
DEVONIAN OR EARLIER
GARRISON HILLS GNEISS
2 SIMMONS BROOK BATHOLITH
CAMBRIAN AND PRE-CAMBRIAN
1 SHALE SLATE SANDSTONE SILICIC AND MAFIC VOLCANICS
GREAT BAY DE L'EAU

1 of 1


BELLE BAY
N
FAULT
SYNCLINAL AXIS
0
5
MILES
STUDY AREA

1

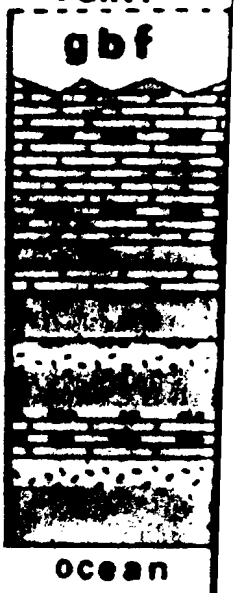
SALTWATER POND

2

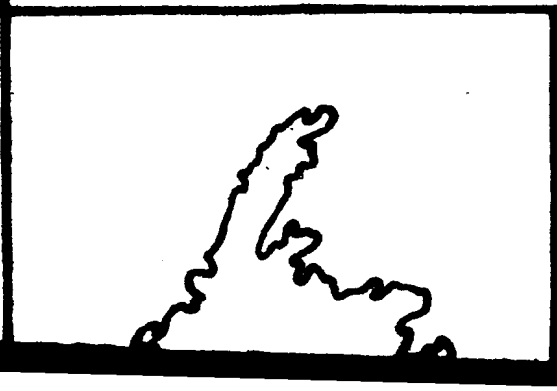
WHITE POINT

3

BACON POINT



1 of



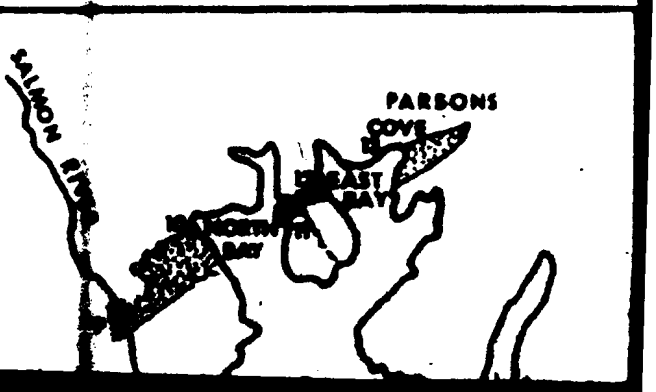
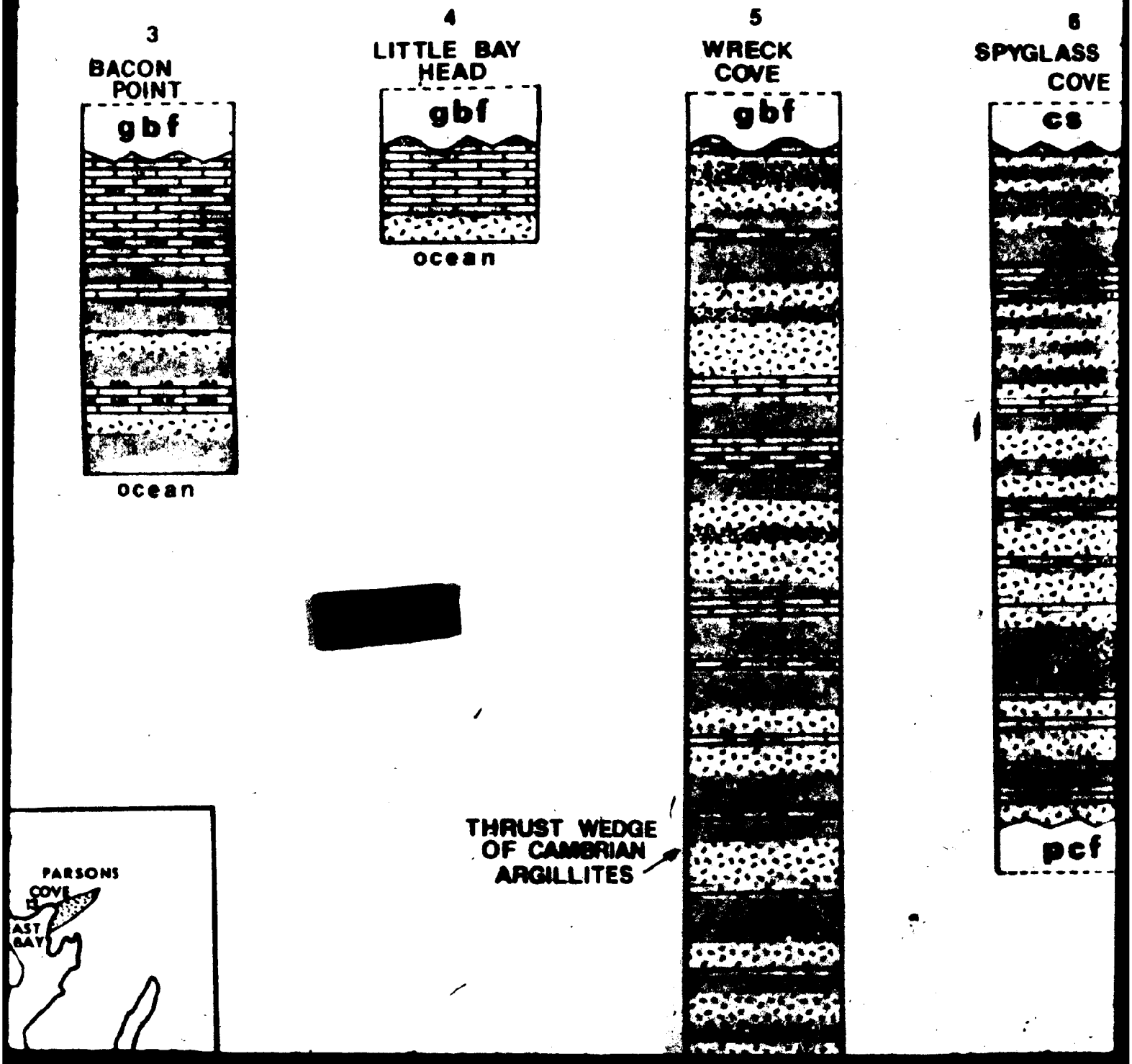
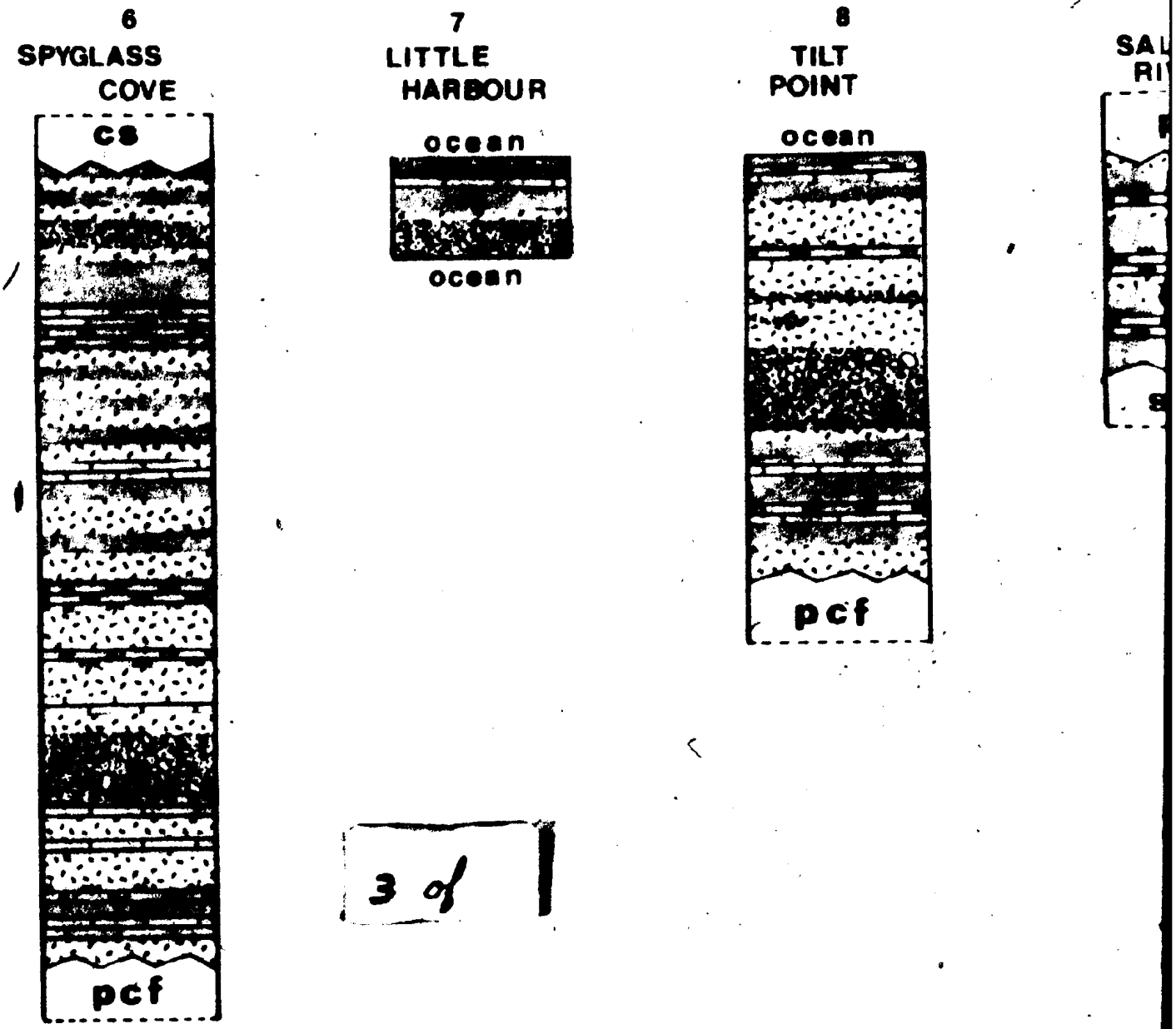


FIG:3

DIAGRAMATIC SEDIMENTARY S



DIMENTARY SECTIONS OF THE CINQ-ISLES FORMATIO

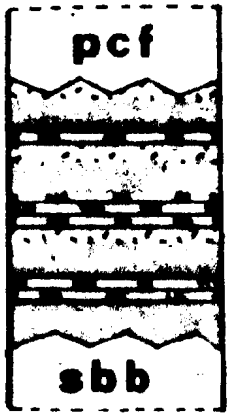


3 of

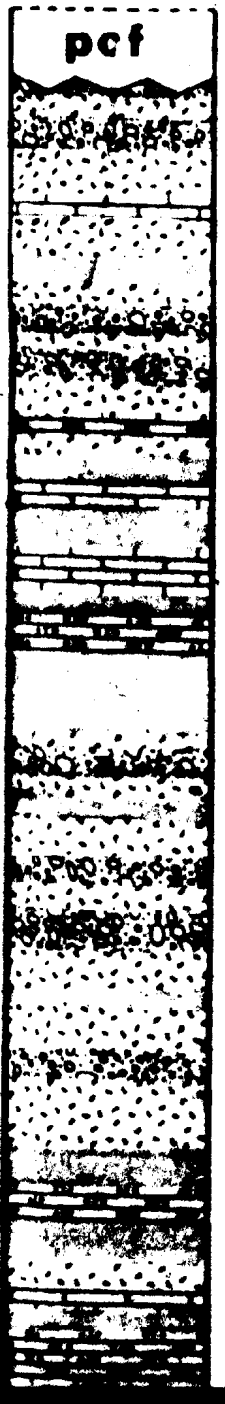
SCALE OF COLUMNS

FORMATION

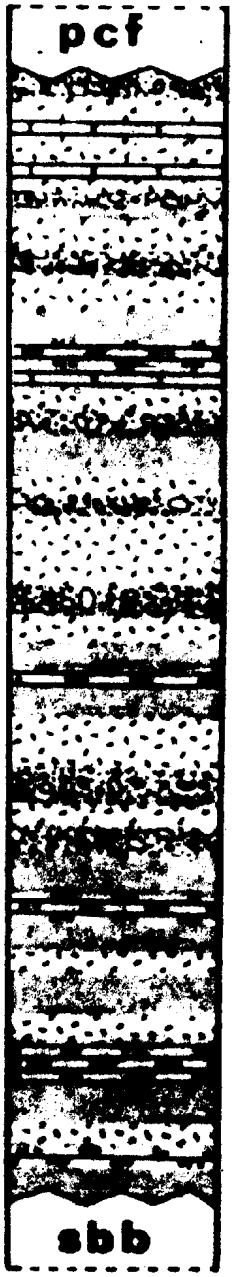
9.
SALMON
RIVER



10
WEST OF
NORTH BAY

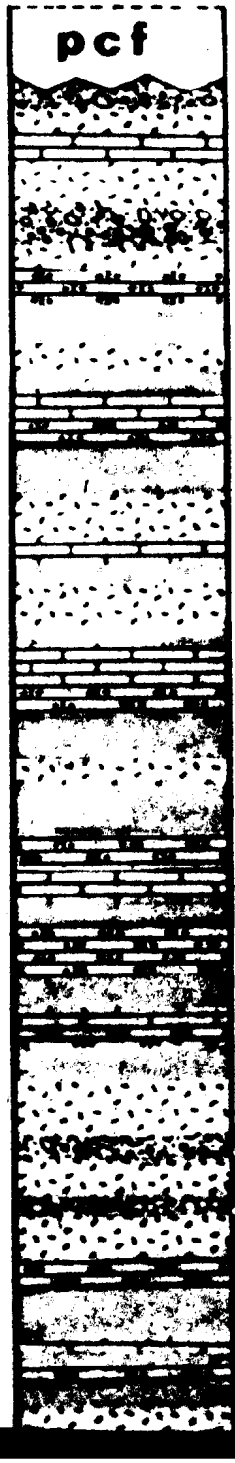


11
EAST OF
NORTH BAY

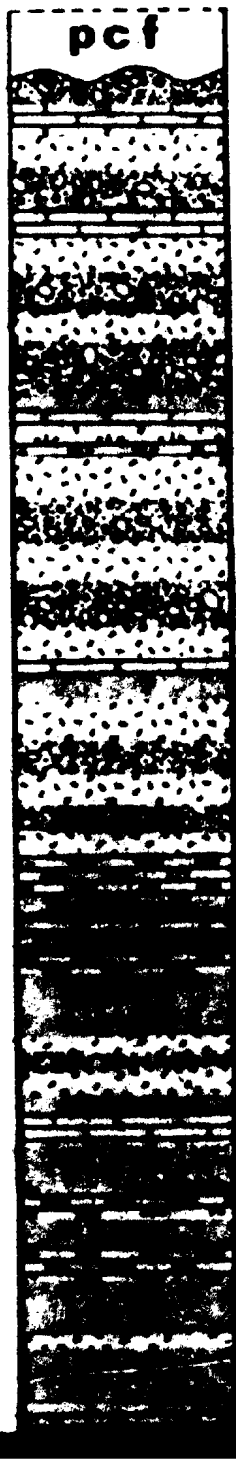


4 of

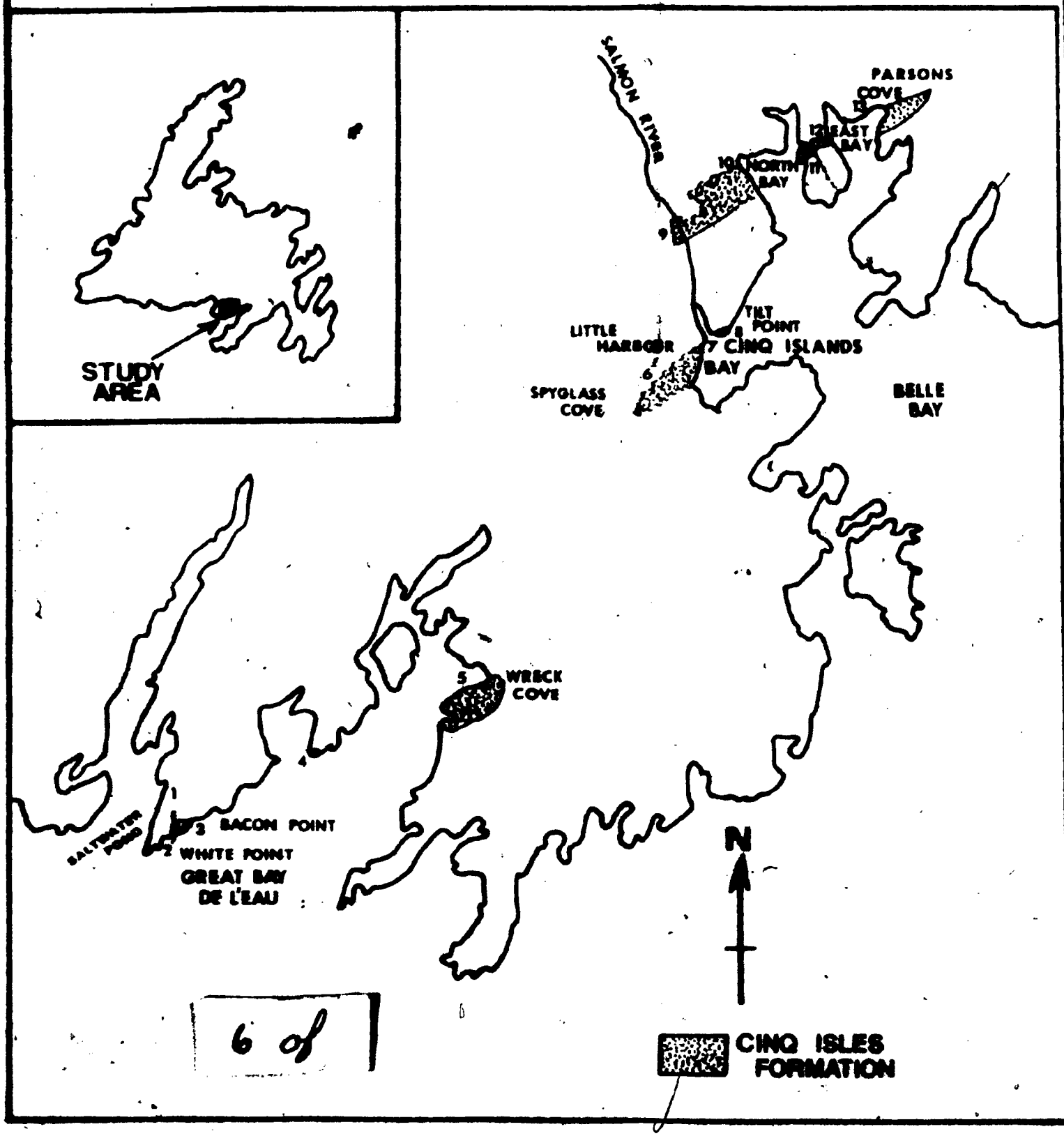
12
WEST OF
EAST BAY



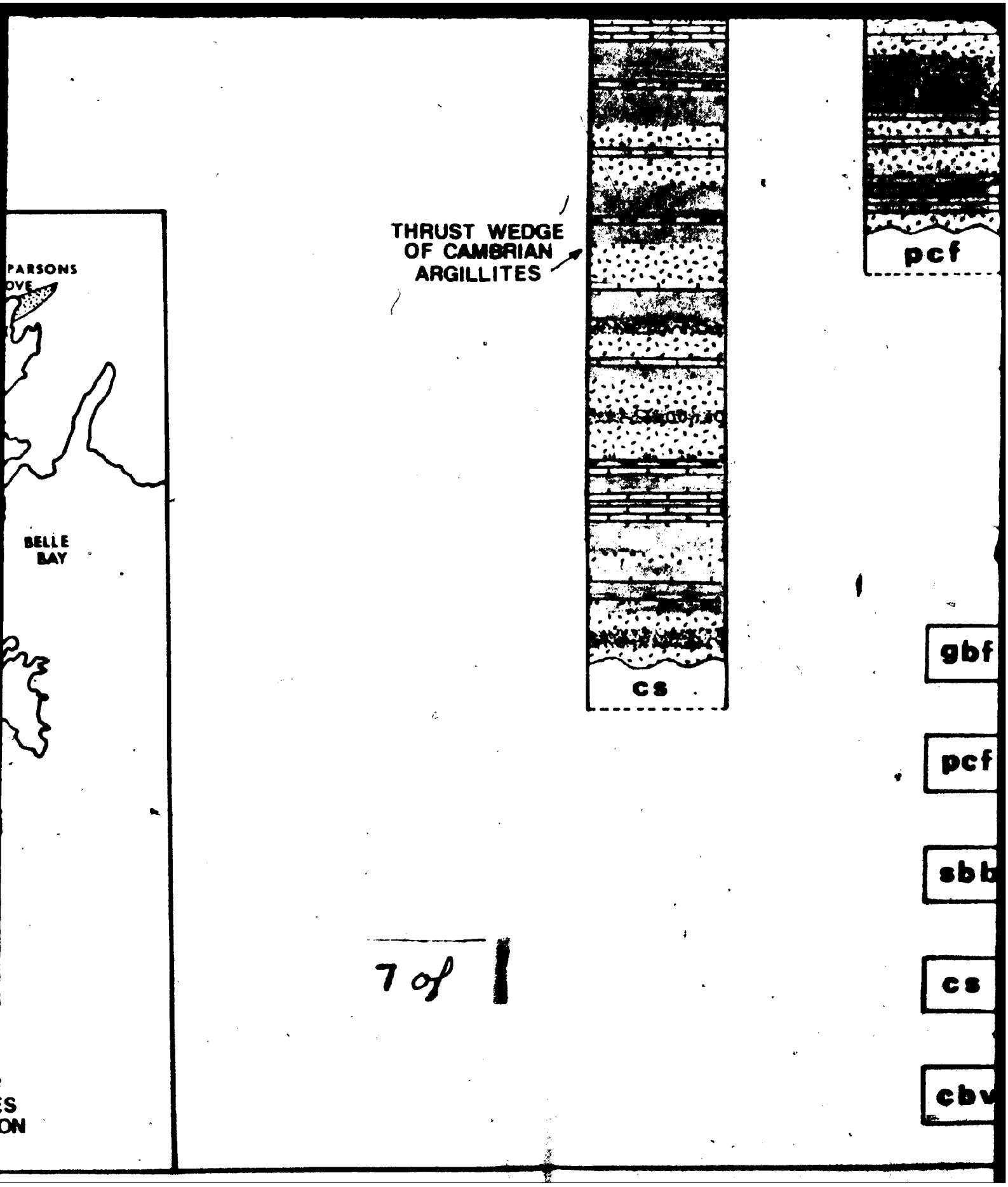
13
EAST OF
EAST BAY



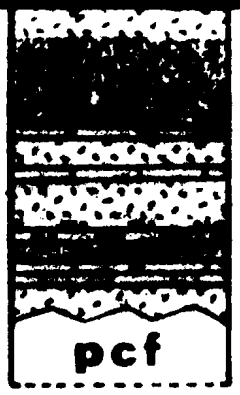
5 of


STUDY AREA
SALMON RIVER
PARSONS COVE
EAST BAY
NORTH BAY
TILT POINT
LITTLE HARBOUR
CINQ ISLANDS BAY
SPYGLASS COVE
BELLE BAY
WRECK COVE
BACON POINT
WHITE POINT
GREAT BAY DE L'EAU
N
CINQ ISLES FORMATION

6 of


PARSONS
BELLE
BAY
THRUST WEDGE
OF CAMBRIAN
ARGILLITES
pcf
cs
gbf
pcf
sbb
cs
cbv

7 of 1



8 of 1

SCALE OF COLUMNS

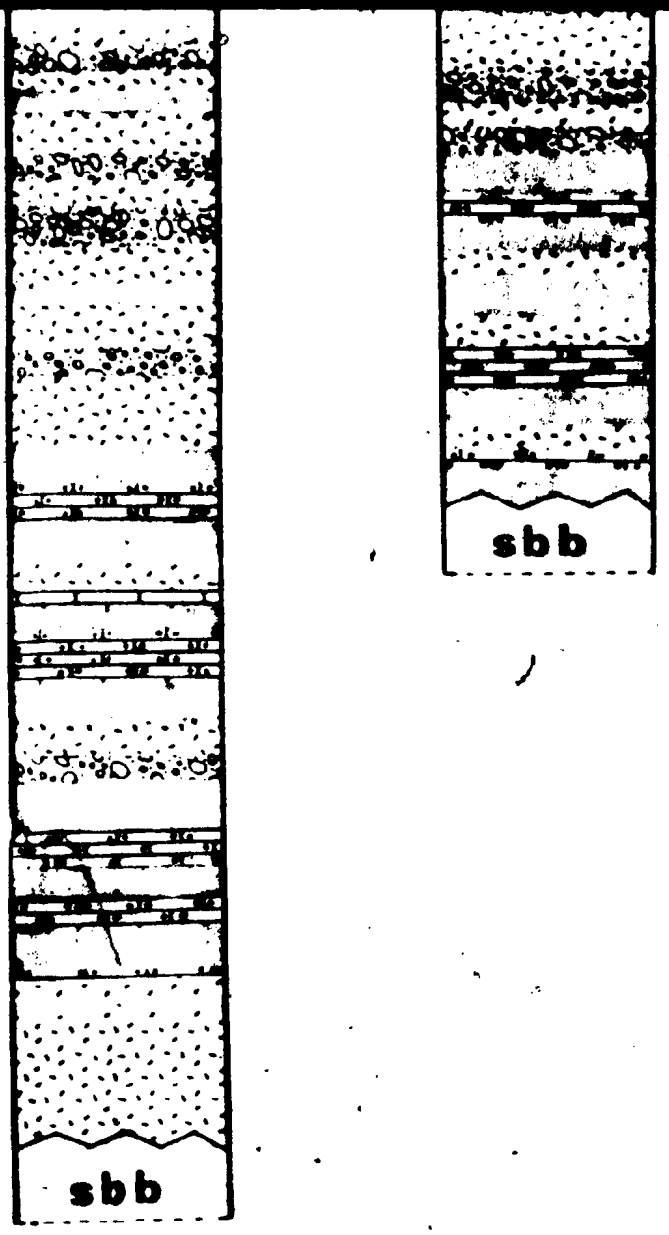
2cms TO 100feet.

UNCONFORMABLE CONTACT.

FAULT CONTACT.

CINQ ISLES SEDIMENTS

gbf	GREAT BAY DE L'EAU FORMATION		CONGLOMERATE
pcf	POOLS COVE FORMATION		GRIT & SANDSTONE
sbb	SIMMONS BROOK BATHOLITH		LIMESTONE
cs	CAMBRIAN SEDIMENTS		MIXED BEDS
cbv	CONNAIGRE BAY VOLCANICS		SILT & SHALE



S

et.

FAULT
CONTACT.

ES SEDIMENTS

ONGLOMERATE

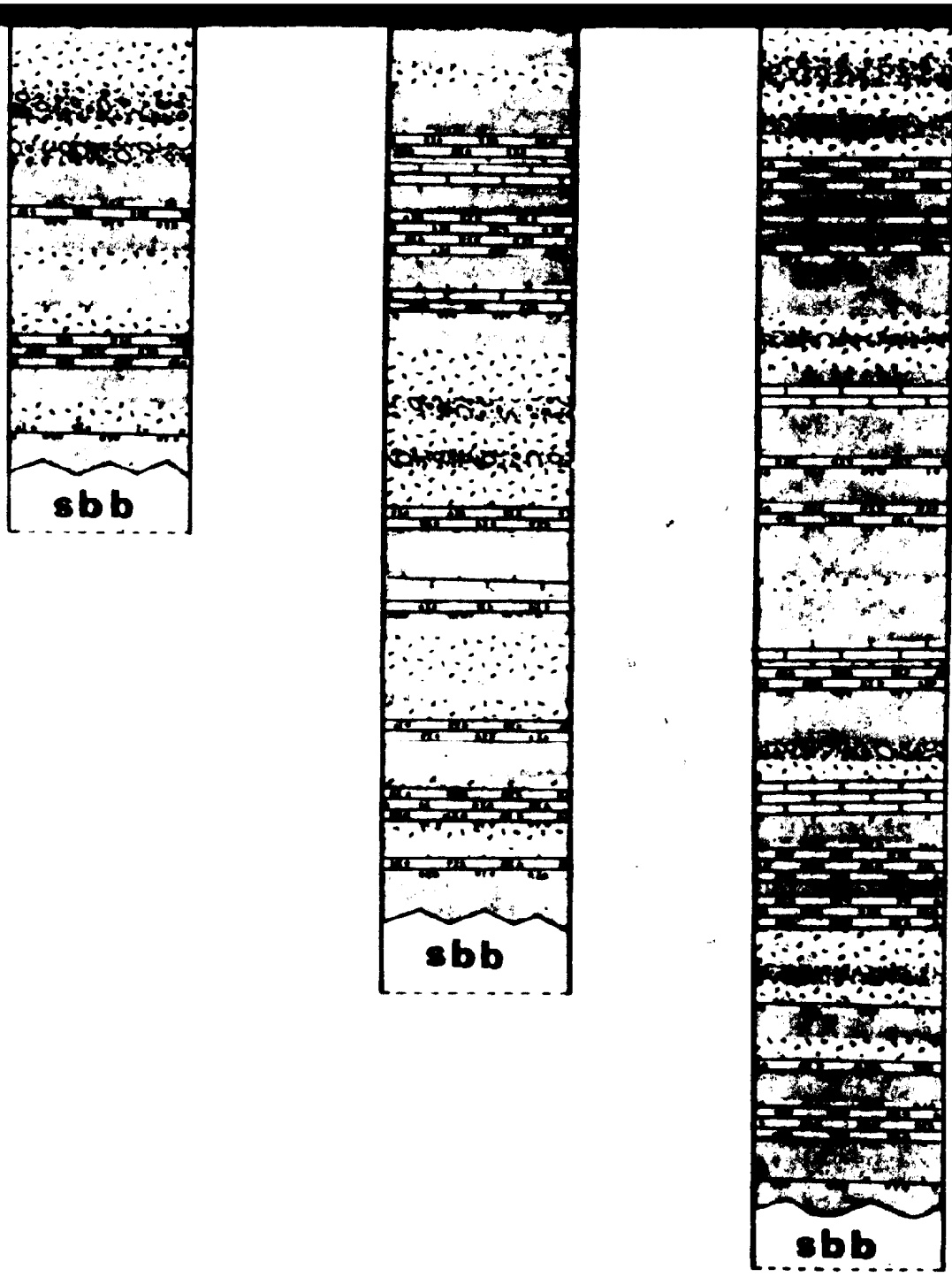
RIT & SANDSTONE

MESTONE

XED BEDS

LT & SHALE

9 of 1


sbb
sbb
sbb