VAN COPY

Union College Department of Geology

1991 Summer Field Trip

The Geology of Newfoundland

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1991 UNION COLLEGE GEOLOGY DEPARTMENT FIELD TRIP

THE GEOLOGY OF NEWFOUNDLAND

This guidebook was prepared to aid your understanding of the rocks in Newfoundland during our fieldtrip. It contains several pieces of valuable information that will be indispensable during the trip. The first section is an introduction to the regional geology of Newfoundland and will give you a good idea as to what we will be seeing and how it might have formed. The second section is our itinerary. Please refer to this on a daily basis so you have an idea as to what we will be doing. The itinerary also has some suggested reading should the urge strike you; all reading material will be in a metal file box, somewhere in the van. The third section of this guide is a reference list, partially annotated, which is arranged according to the different terranes in Newfoundland. The final section contains the figures. These figures represent a collection of maps, stratigraphic columns, diagrams, and other information that will be handy along the way. The first couple of figures are in the beginning of the guide. So, put on your boots, load your camera and enjoy the trip!

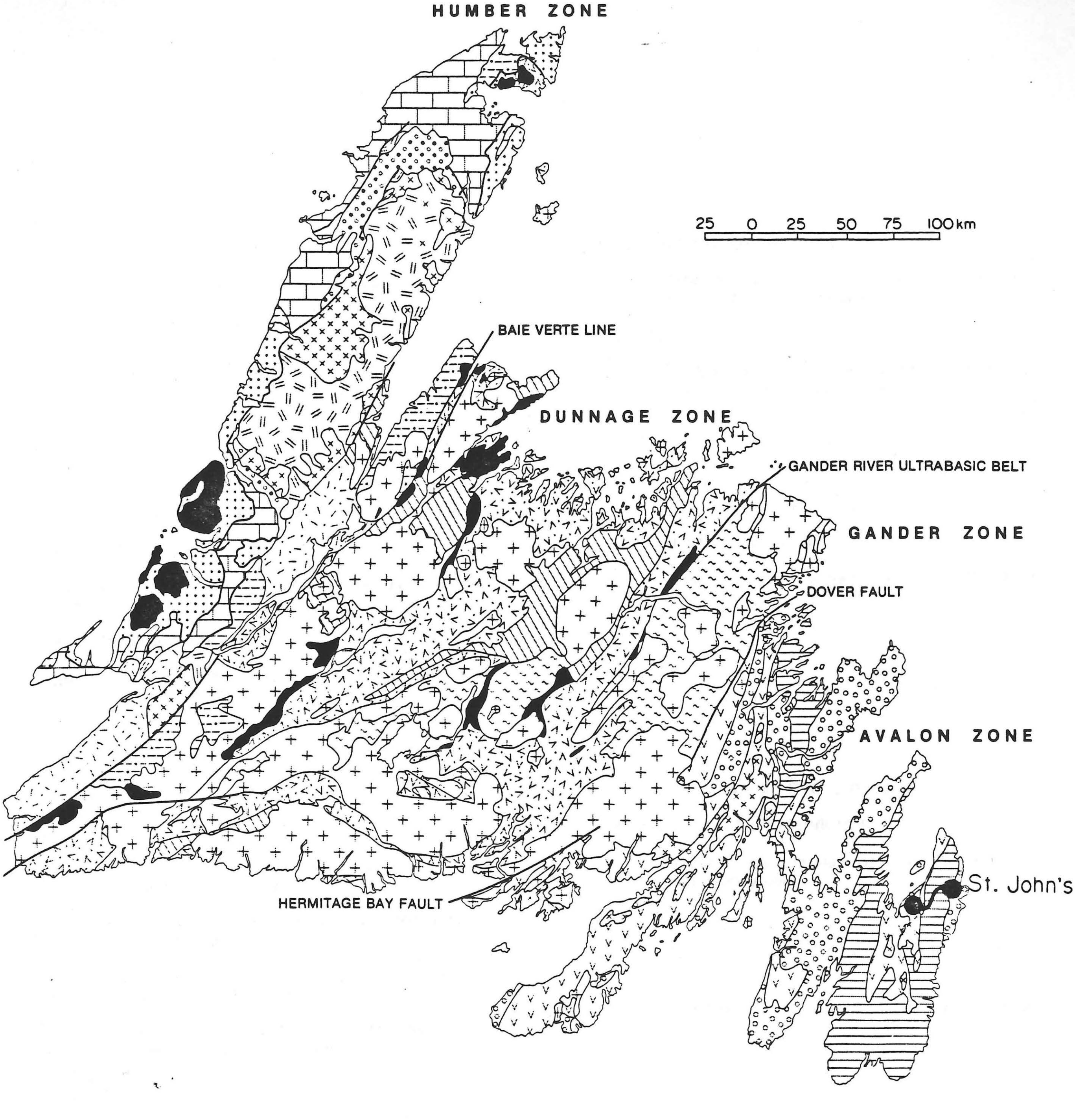
HUMBER ZONE
25 0 25 50 75 100 km
BAIE VERTE LINE
DUNNAGE ZONE
GANDER RIVER ULTRABASIC BELT
GANDER ZONE
DOVER FAULT
AVALON ZONE
St. John's
HERMITAGE BAY FAULT

Fig. 1

INTRUSIVE ROCKS

ORDOVICIAN TO DEVONIAN

Granitic and gabbroic intrusions

PROTEROZOIC II TO CAMBRIAN

Granitic and gabbroic intrusions

DEVONIAN TO CARBONIFEROUS

Subaerial, lacustrine, fluvial and deltaic clastic sedimentary rocks; minor limestone

SILURIAN

Shallow marine and subaerial clastic sedimentary rocks; volcanic and volcaniclastic rocks

DUNNAGE ZONE

CAMBRIAN TO SILURIAN

Marine clastic sedimentary rocks; island-arc volcanic and volcaniclastic rocks

CAMBRIAN TO ORDOVICIAN

Ophiolitic mafic – ultramafic rocks, pillow lava and related intrusions

GANDER ZONE

CAMBRIAN TO ORDOVICIAN

Clastic metasedimentary rocks and migmatitic equivalents

HUMBER ZONE

PROTEROZOIC III TO ORDOVICIAN

Autochthonous and parautochthonous clastic and metasedimentary rocks

Platformal limestone and dolostone; includes clastic sedimentary rocks

Allochthonous sedimentary, mafic volcanic and minor metamorphic rocks

Basal clastic and carbonate sedimentary rocks; includes mafic volcanic rocks

PROTEROZOIC II AND III

Orthogneiss, paragneiss and amphibolite

AVALON ZONE

PROTEROZOIC III TO ORDOVICIAN

Subaerial and marine clastic sedimentary rocks; minor limestone

PROTEROZOIC III

Marine and deltaic clastic sedimentary rocks

Mafic and felsic volcanic and volcanoclastic rocks

INTRODUCTION

The geology of Newfoundland is spectacular. Our sixteen day trip will take us to many classic localities on the island with an emphasis on the geology of western Newfoundland (Fig. 1). You are urged to actively participate in various discussions in the field and you may browse through the vast collection of papers that we will have in the van during the trip. Fortunately, we are a small group and logistics should not be a problem. Please bear in mind, however, that you are part of a group that represents Union College, and you are in a foreign country. We will be camping and cooking dinner almost every night. After breakfast in camp, we will make lunches if a day hike is planned. In order to facilitate camping duties, please set up camp and help with dinner quickly and efficiently. Several localities are protected and we will not be able to collect rocks or fossils; please resist the urge.

The Geology of Newfoundland is one dominated by rocks that record two important **orogenic** (mountain building) events along the margin of North America; the Middle Ordovician **Taconic Orogeny** (Ca. 450 Ma) and the Devonian **Acadian Orogeny** (ca. 480 Ma; see Figs. 2,3). Good introductory papers can be found under the "general" heading in the reference list but I recommend Van Der Pluijm (1987). A more detailed analysis of the general tectonic evolution of Newfoundland can be found in Dewey et al., (1983), Pickering et al., (1988), and Keppie (1989). The island is divided into several **terranes** (fault bound pieces of crust with a unique geologic history) that have boundaries which run nearly north-south (Fig. 1). Our excursion will take us to the four main terranes on the island from west to east. The most profound event to have affected the region is the Taconic Orogeny, which occurred about 450 Ma (million years ago) in the Middle Ordovician. We will examine the stratigraphy of the continental margin as it recorded events both prior to and during the Taconic orogeny. Simply put, the rocks that precede the Taconic orogeny record shallow water and quite conditions; these rocks are mostly fossiliferous limestones. **Synorogenic** deposits (accumulated during tectonic events) tell of a rapidly sinking margin and emerging mountains to the east. The characteristic deposit of this episode is interbedded sandstone and mudstone that were deposited in deep basins and are commonly referred to as **flysch.** One important characteristic of the flysch is that the sediments contain clasts (sand grains) of ophiolite material which indicates that while the flysch was being deposited the ophiolites were uplifted and eroding. If you are interested in this topic read through Hiscott (1984).

We will also examine the structural ramifications of the Taconic Orogeny. Faulting and folding produced significant deformation in the sedimentary and volcanic sequences. Part of this deformation resulted in pieces of ocean crust or **ophiolites** that were **thrust** westward onto the continental margin. Ophiolites are rarely exposed but when they are they give us a unique opportunity to examine ocean crust

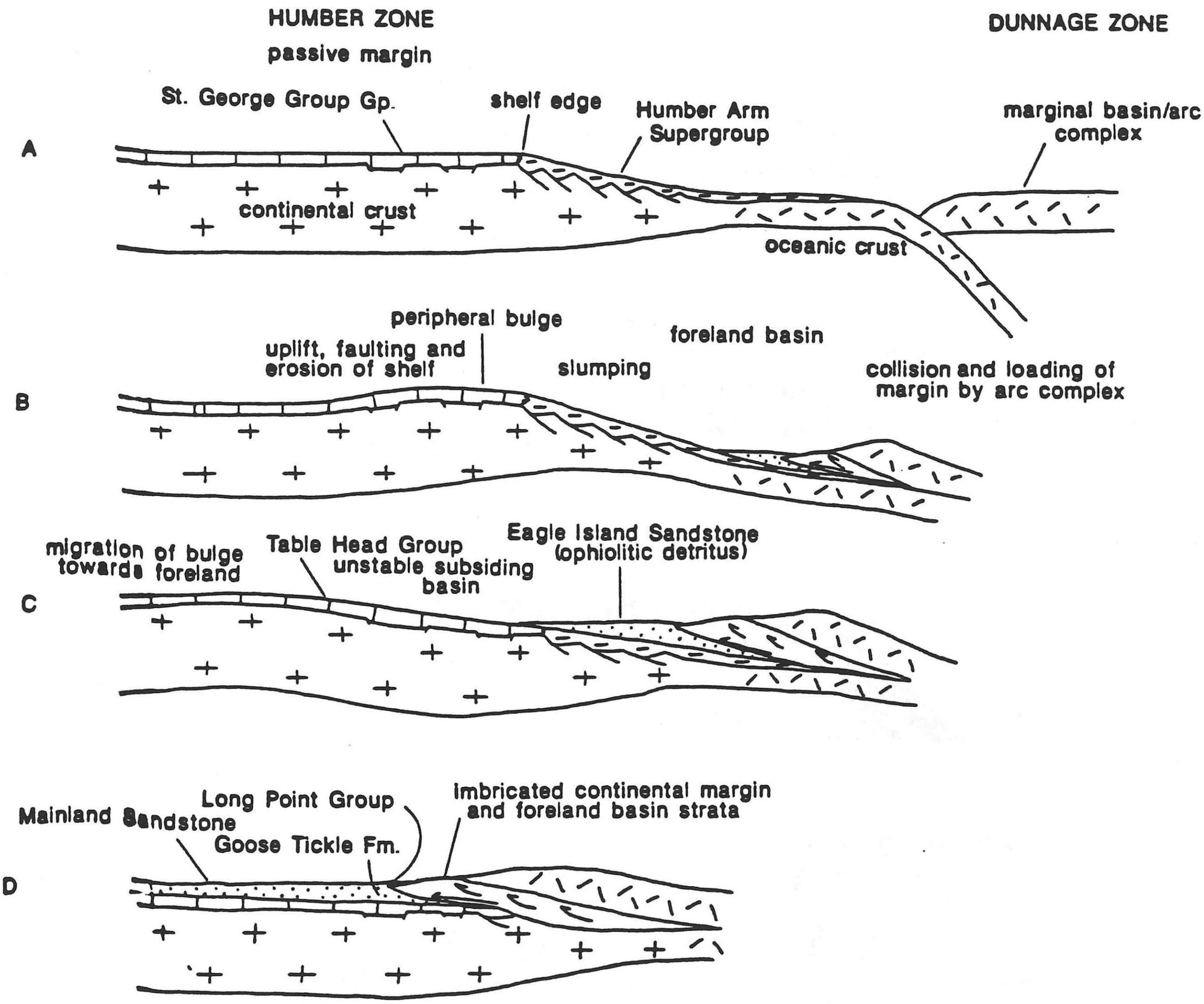

Figure 2: Schematic diagram showing the destruction of the ancient continental margin of North America (Humber Zone) by collision and overthrusting of an arc/marginal basin complex (Dunnage Zone). Loading of the margin during overthrusting results in flexing of the crust and generation of a foreland basin which migrates ahead of the advancing thrust stack. A) Tremadoc to early Arenig; B) late Arenig; C) Llanvirn; D Llandeilo to Caradoc.

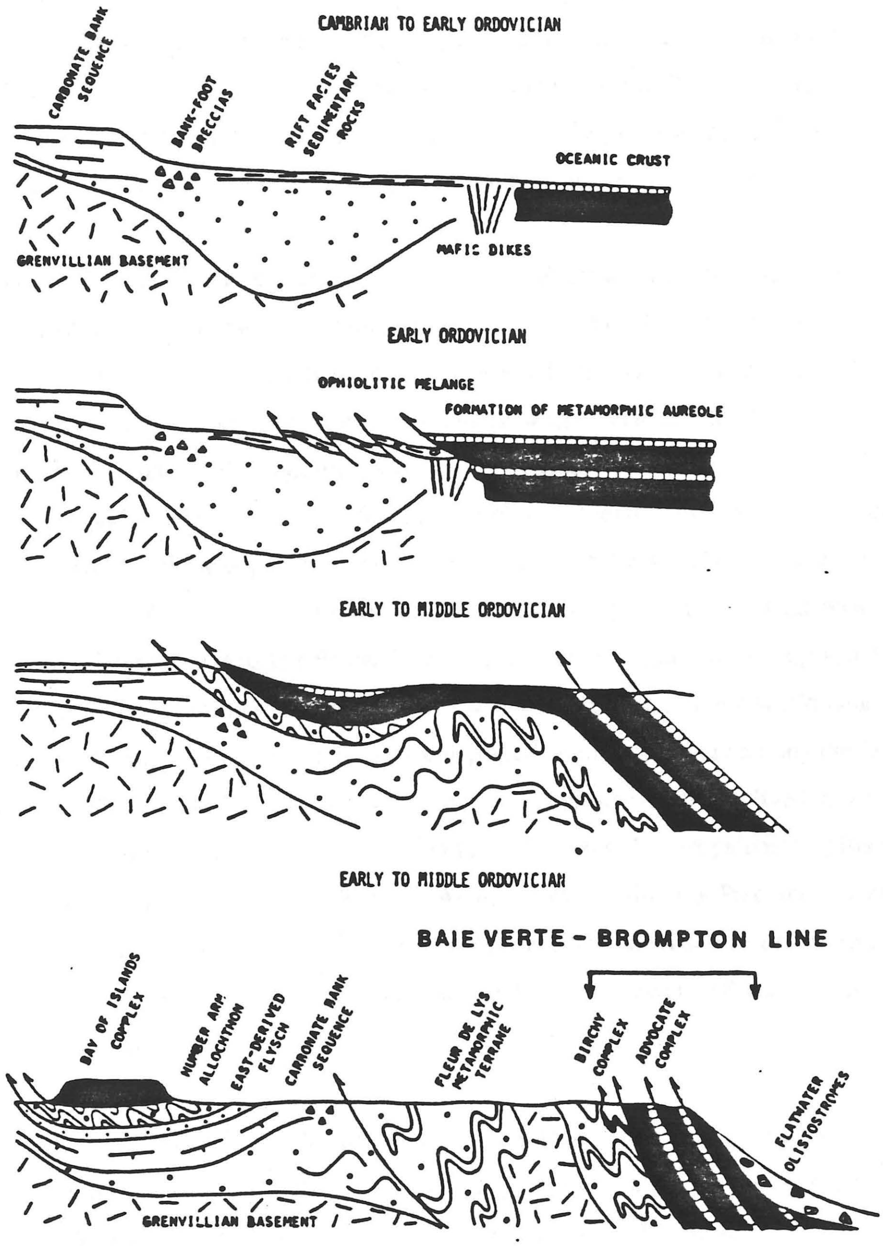

Figure 3. Model for the destruction of the ancient continental margin of eastern North America showing the Baie Verte-Brompton Line as the root zone for the west Newfoundland ophiolites (from Williams and St. Julien, 1982).

and infer the processes that created it (a good review of ophiolites can be found in Moores, 1982). The Taconic orogeny was caused by the collision of an **Island Arc** with the North American margin. Rocks of the central part of the Island probably represent this island arc which is mainly characterized by sedimentary and volcanic rocks (see Strong 1977). Within this "island arc" sequence are sedimentary deposits called **mélange**, a French word for mixture. At first glance these rocks bear a vague resemblance to raisin pudding with coherent rocks (raisins) stuck in an incompetent matrix (pudding). Mélanges are formed in many different ways, some form in a sedimentary environment (large slumping and mass movements) and some form structurally (rocks are torn apart by faulting and diapirism).

The Avalon Peninsula, on the eastern part of Newfoundland which we will visit last, is underlain by the Avalon terrane. Geologists infer that the Avalon terrane was accreted to North America during another orogenic event called the **Acadian Orogeny,** which occurred during the Devonian (ca. 380 Ma). The main suture zone between the Avalon terrane and terranes to the west is relatively localized along the Dover fault. We will see this fault and the mylonites that developed along it. **Mylonites** are ductily deformed rocks that have experienced crystal plastic flow under high strain conditions; simply stated, they record a taffy-like movement of rocks at depth along a fault zone. Although the accretion of the Avalon terrane to North America produced folding, faulting, and a distinct sedimentary record, by for the most impressive aspect of the Avalon terrane is its late Precambrian (Ediacarian) and Cambrian stratigraphic record. The Avalon terrane has three unique sequences which we will visit. The first is a world famous fossil locality that contains abundant and diverse fossils of soft-bodied animals that were among the first multicellular life on Earth. These Ediacarian fauna, named for the time during which they lived, are very similar to those in the famous Burgess shale in British Columbia. These fossils give paleontologists a rare glimpse into early life. The second unique rock type on the Avalon terrane is tillite of Precambrian age. This tillite is interpreted to have been deposited by glaciers and they represent the oldest record of glaciation on earth. Finally, the Avalon terrane has Cambrian limestones that have abundant and diverse trilobites, an extinct arthropod similar to the horseshoe crab today.

The final orogenic event that affected Newfoundland is the Alleghenian orogeny, which occurred during the Carboniferous (circa 320 ma). The Alleghenian orogeny is well displayed in the southern Appalachians, but its character is somewhat different in Newfoundland. In Newfoundland, the Alleghenian orogeny is characterized by **strike-slip faulting** (two pieces of crust slide horizontally past one another). This deformation resulted in several impressive strike-slip faults (i.e. the Cabot fault which separates the Humber terrane from the Dunnage zone in southwest Newfoundland) and widespread nonmarine sedimentation. These nonmarine sediments were deposited in rivers and lakes and the climatic conditions were probably rather arid because a common element of these sedimentary deposits is **gypsum** which is produced when seawater is subjected to intense evaporation. We will see these rocks briefly during our first morning on the Island. Below is a brief outline of the different terranes that make up the Island of Newfoundland.

HUMBER ZONE

The Humber zone (Figs. 4,5) comprises the Grenville basement (*circa* 1 billion years old), which is similar to rocks in the Adirondacks, and a lower Paleozoic (Cambrian and Ordovician - *circa* 550 to 450 Ma) sedimentary cover that was deposited on a **passive continental margin** (no tectonic activity). Collectively, the Humber zone contains rocks with two distinct structural styles. The **Autochthonous** rocks (in place) are largely undeformed and relatively flat lying sequences that rest unconformably on the Grenville basement rocks (Fig. 6). The **Allochthonous** rocks (and the parautochthonous rocks - those that have moved to their present position on thrust faults) are are structurally complicated because they have experienced significant tectonic transport on thrust slices or nappes during the Middle Ordovician Taconic Orogeny (Figs. 6,7). The highest thrust slices contain world famous ophiolites that include the Bay of Islands Ophiolite, which is actually part of the Dunnage zone described below.

We will spend considerable time examining the rocks of the Humber Zone and the structurally overlying Ophiolites. Sites to be visited include a) Port au Port Peninsula (Figs. 8,9,10), b) the Bay of Islands and Gros Morne National park (Figs. 10,11,12,13,14), c) rocks around Cow Head (Figs. 15,16,17). Resting above rocks of the Humber Zone are upper Paleozoic nonmarine sedimentary rocks. These rocks, which are widespread in western Newfoundland are inferred to have been deposited during the Alleghenian orogeny, which, in Newfoundland, was probably characterized by strike-slip faulting (two pieces of crust slide past one another - similar to the San Andreas fault). These rocks are well exposed south of Port au Port Peninsula where we will be spending the first night on the Island.

DUNNAGE ZONE

To the east of the Humber zone, comprising most of the Island of Newfoundland, is the Dunnage Zone (Fig. 1). The Dunnage Zone contains vestiges of an oceanic domain and includes marine sedimentary and volcanic rocks the locally rest above an Ophiolitic basement. The ophiolites in the Dunnage zone are interpreted to represent ocean crust from a now closed ocean basin that geologists call the Iapetus Ocean. Geochemical and geochronological studies indicate that these rocks represent a Cambro-Ordovician Island Arc and associated marginal (flanking) basins. These volcanic arcs probably lay to the east of the Iapetus ocean. Technically, the ultramafic rocks of the Humber Zone (i.e. the Bay of Islands Ophiolite) belong to the Dunnage zone even though they rest structurally above rocks of the Humber Zone; their juxtaposition probably occurred during the Taconic Orogeny (Figs.2,3). Ordovician mélange are quite common in the Dunnage zone (i.e. the famous Dunnage Mélange) and we will examine these mélanges and volcanic rocks on the Baie Verte peninsula (Figs. 18,19) and near New World Island (Figs.20,21,22,23,24).

GANDER ZONE

The Gander zone consists of a relatively thin package if poly deformed and metamorphosed clastic rocks of pre-Middle Ordovician age as well as a suite of intrusive rocks (i.e. granites). These metasedimentary rocks probably represent a deformed and metamorphosed continental margin sequence that was involved (at deep levels) in the Taconic Orogeny. These metamorphic (greenschist to amphibolite facies metamorphism) and plutonic rocks are interpreted to be a **culmination**, meaning that they represent very deep levels of rocks that have been been brought to the surface. As a result they are of higher metamorphic grade than the rocks around them. These rocks are also interpreted to have been a prism of sediment that build up on the margin of a continent - perhaps the eastern margin the Iapetus. We will see the metamorphic and plutonic rocks of the Gander zone near Cape Freels (Fig. 25) and to the south where we will examine the Dover fault (see Fig 1).

AVALON ZONE

The easternmost part of the Island of Newfoundland is underlain by the Avalon terrane. The Avalon terrane consists of late Precambrian igneous and sedimentary rocks that are overlain by lower Paleozoic shallow marine sedimentary and volcanic rocks. Unlike the other terranes, it has a relatively intact and complete stratigraphy. The Avalon terrane is quite large - it extends some 250 km offshore to the present-day margin of the continental margin. The Dover fault separates the Avalon terrane from the Gander terrane to the west (Fig. 25). The main movement of this fault is interpreted to have coincide with Acadian deformation; the fault is intruded by the 360 ma Ackley granite, thus putting an upper limit on the timing of deformation in this region. As mentioned, the Avalon terrane has several famous localities which include the Cambrian trilobite-bearing strata of Cambrian age (Fig. 27), glacial deposits of Precambrian age, and the Ediacarian fauna of Mistaken Point (Fig. 28,29). Note that while the other terranes in Newfoundland have a good record of Middle Ordovician Taconic deformation, the Avalon terrane has no such record; Avalonia was probably far away from the North American margin until the younger Acadian orogeny.

ITINERARY

This brief itinerary is designed to keep you informed as to what we are doing and when we are doing it. The field stops and possible readings are also listed for each day; I suggest that you glance at some of the papers *before* you go in the field. Not listed here are the various fieldguides that will steer us on our course. Ask me if you would like to see the field guide far a particular area, because these field guides commonly give a nice brief summary of each area.

25 August: Assemble in the parking lot to the north of Butterfield Hall at 6:00 AM. and be ready for immediate departure. Remember this will be a Sunday and we will not be able to stop at any banks in the United States - have your money in order before leaving! We will drive to the New River Beach campground just over the border in New Brunswick. Driving time will be 12 hours. *Please have your passport or drivers license ready for the border crossing; do not let your identification get packed in the rooftop carrier!*

26 August: Drive from New Brunswick border to either Beaver Mountain or Battery Park Campground, Nova Scotia. Driving time is approximately 12 hours.

27 August: Depart campground by 8:00 am and drive 3 hours to North Sydney, Nova Scotia. After lunch in Sydney, we will board the ferry for Port au Basques at 1:00 PM. Sailing time is about 11 hours, and we will arrive at about 7:00 at night. Drive about 1 hour to Highlands, which is on the east coast of the island. Camp at a private residence.

28 August: We will first looks at exposures along the beach and then we will drive about one hour to Port au Port Peninsula and examine Cambrian and Ordovician sedimentary rocks. The geology of the Peninsula is shown on Figures 8 and 9; the stratigraphy is shown in Figure 10. We will spend the entire day in lower Paleozoic sedimentary rocks. If you are interested in the flysch see Stevens (1970), and Lindholm and Casey (1989). More than you would want to know about the St. George Group is in Knight and James (1988). Camp on the Peninsula at Picadilly Head campground.

29 August: Drive several hours to Gros Morne National Park. The map of the park is shown in Figure 11, the distribution of Pleistocene glacial features is shown in Figure 12; and the general geology of the area is in Figure 4. We will examine some rocks on the way to the park. Stop at the Visitors Center, and then camp at Lomond campground.

30 August: Day hike up Table Mountain and visit Trout River. A geologic map of Table Mountain is shown in Figure 13 and a simplified stratigraphic section through the Bay of Islands Ophiolite is in Figure 14. Camp at Lomond Campground. If you are interested in the Ophiolitic rocks read Calon et al. 1988 (suggested); Dumming and Krogh, 1985; Casey et al., 1985; or Suen and Frey, 1979. If you are interested in the structure of this area, read Bosworth, 1985; Cawood and Williams, 1988; Cawood, 1989; Waldron, 1985;

31 August: Drive up the coast in the National park making several stops including Lobster Cove (see James et al, 1987). Our main destination for the day is the Cow Head Peninsula to see rocks of the Cow Head Group; these rocks are discussed in James, 1981; Kindle and Whittington, 1958; and Hiscott and James, 1984. The geology of the Cow Head Peninsula is shown in Figure 15 and the stratigraphy and inferred depositional setting of these rocks are shown in Figures 16 and 17. Camp at Lomond Campground.

1 September: Drive three hours to Baie Verte. The entire geology of the Baie Verte Peninsula is discussed in a memoir by Hibbard (1983) and is shown in Figure 18. We will examine the rocks at Tilt Cove and Coachmans Cove. The Ophiolitic mélange at Coachmans Cove is discussed in a guidebook by Hibbard (1987); see Figure 19 for a geologic map of the area. Camp at Flatwater Pond Campground.

2 September: Drive three to four hours to New World Island and examine mélange and volcanic rocks. Geologic maps and stratigraphic sections for this area can be found on Figures 20, 21, 22, and 23. The world famous Dunnage Mélange has been studied by many geologists and there are about ten papers on this melange and similar units in the area. I suggest McKerrow and Cocks (1978) to get an idea about the stratigraphy, structure, and depositional setting of the mélanges. Camp at the Dildo Run Provincial park.

3 September: Examine rocks around Frederickton Harbor, where there is a sunken ship, and the mélanges near Carmenville. We may also get a chance to go to Aspen cove to see high-grade metamorphic rocks. See Figures 23,24 25 for maps of the area. Camp at Windmill Bight Campground.

4 September: Examine deformed sediments and granites at Cape Freels (for geologic map of this area see Figure 25), and drive south along coast to exposures of the Dover Fault. A good paper on this area is Dallmeyer et al., 1981. Camp at Bellevue Beach campground which is on the western side of the Avalon peninsula (for a geologic map see Figure 26; for a full color foldout map of the Avalon Peninsula, see King, 1988).

5 September: In the morning we will walk down the Manuels riverbed and examine the classic Cambrian trilobite section (for map see Figures 26 and 27). This stop is detailed in Anderson (1987b) and Boyce (1988). In the afternoon we will go to St. Johns, the largest city in Newfoundland, to take in some sights. Camp at La Manche campground, which is on the eastern side of the Avalon Peninsula (see map - Figure 28). O'Brien and Wardle (1983) have a good summary paper on the tectonic evolution Avalon terrane.

6 September: Examine the soft-bodied fossils in the Mistaken Point Formation, and then later the Precambrian tillite sequences. The Mistaken Point locality is detailed in King et al. (1988), which is a guidebook, and in Hoffeman et al. (1979). Seilacher (1989) discusses the paleontology of the fauna in Ediacarian strata worldwide; several typical fossils are shown in Figure 29. The Precambrian tillite is discussed in Anderson (1987a), which is a guidebook for just that area and Williams and King (1979), which details the recent mapping in that area. Camp at Fitzgeralds Pond campground.

7 September: Drive less than one half hour to the ferry terminal at Argentia, *board ferry at 8:00 AM.* The ferry crossing is 13 hours, and therefore we arrive in Sydney late at night. We will get hotel rooms in Sydney for the night.

8 September: Drive 12-14 hours and camp at New River Beach campground in New Brunswick.

9 September: Drive 12 hours to Schenectady. We will not know exactly when we will arrive but you will be able to call ahead (during that day). You would be best off if you plan to spend the night in Schenectady.

NEWFOUNDLAND REFERENCES

The following references and their brief annotation detail the geology that we will be examining during the trip. The references are in the file box, somewhere in the van. Please feel free to read any of these papers during the trip.

GENERAL

Van Der Pluijm, B A., 1987. Timing and spatial distribution of deformation in the Newfoundland Appalachians: a "multi-stage collision" history: Tectonophysics, v. 135, p. 15-24.

A new plate tectonic model that addresses some of the recent work that has been done in this part of the world. This paper has a brief overview of preexisting models.

Keppie, J.D., 1989. Northern Appalachian terranes and their accretionary history; Geological Society of America Special Paper 230. p. 159-192.

Completely summarizes the Paleozoic history of the Northern Appalachians.

Dewey, J.F., Kennedy, M.J., Kidd, S.F., 1983. A geotraverse through the Appalachians of northern Newfoundland, in: *Profiles of Orogenic Belts*, Am. Geophysical Union, Geodynamics Series, vol. 10, p. 205-242.

A geotraverse across the Appalachian Orogen in northern Newfoundland is presented in cross-section, and the stratigraphy of the rocks on the cross-sections is outlined.

Murphy, J.B., Nance, R.D., 1989, Model for the evolution of the Avalonian-Cadomian belt: Geology, v. 17, p. 735-738.

The inception and termination of the ca. 670-550 Ma Avalonian-Cadomian orogenic cycle are interpreted in terms of the amalgamation and breakup of a Late Precambrian supercontinent.

Strong, D.F., 1977. Volcanic Regimes of the Newfoundland Appalachians, The Geol. Assoc. Can, Special Paper # 16, p.62-90.

Volcanic regimes of the Newfoundland Appalachians interpreted as having had formed in different plate tectonic environments. Obducted ophiolites of western Newfoundland are oceanic crust produced during seafloor spreading and subduction-related island arc volcanics.

Pickering, K.T., Bassett, M.G., Siveter, D.J., 1988. Late Ordovician-early Silurian destruction of the Iapetus Ocean: Newfoundland, British Isles and Scandinavia - a discussion; Transactions of the Royal Society of Edinburgh: Earth Sciences, 79, p 361-382.

Data suggest that by late Ordovician - early Silurian times the ocean separating Laurentia from Eastern Avalonia and Baltica had partly closed with the consumption of intervening oceanic crust.

Williams, H., 1984. Miogeoclines and suspect terranes of the Caledonian-Appalchian Orogen: tectonic patterns in the North Atlantic region; Can. Jour. Earth Sci., v. 21, p. 887-901.

A regional view of the closing of the Iapetus ocean. This paper outlines the entire Paleozoic and discusses Early Mesozoic rifting.

HUMBER ARM

Hiscott, R.N., James, N.P., 1985, Carbonate debris flows, Cow Head Group, western Newfoundland : J. Sed. Petrology, v. 55, no. 5, p. 735-745.

The Cow Head Group is an allochthonous Cambro-Ordovician sequence of deep-water limestone conglomerates, mudstones to grainstones, minor quartz sandstones and shales. Platy-clast conglomerates and boulder-rich megaconglomerates as much as 100 m thick exhibit features similar to those described for subaerial debris flows.

James, N.P., Botsford, J.W. Williams, H.S., 1986. Allochthonous slope sequence at Lobster Cove Head: evidence for a complex Middle Ordovician platform margin in western Newfoundland, Can. J. Earth Sci., p. 1199-1211.

A large disrupted "raft" within the Rocky Harbour Mélange at Lobster Cove is the upper part of an intact sequence of deep water sediment of Lower to Middle Ordovician age. The 50 m thick section correlates with upper parts of the Cow Head Group and the basal part of the section is a proximal facies of the Cow Head Group. The upper part of section consists of interbedded dolostone and shale. The

upper and basal part of the section is marked by a faunal break and coincides with the emplacement of a megaconglomerate at Cow Head. The megaconglomerate is interpreted to coincides with the onset of the Taconic orogeny in western Newfoundland.

Cawood, P.A., Williams, H, 1988. Acadian basement thrusting, crustal delamination, and structural styles in and around the Humber Arm allochthon, western Newfoundland, Geology, vol.16, p. 370-373.

The leading edge of the Humber Arm allochthon in western Newfoundland coincides with the western limit of both the Taconian (Ordovician) and Acadian (Devonian) deformed zones. Includes a description of deformation of both deformed zones.

Stevens, R.K., 1970, Cambro-Ordovician flysch sedimentation and tectonics in west Newfoundland and their possible bearing on a proto-Atlantic ocean, Geol. Assoc., of Canada, Special paper number 7, p. 165-177.

This paper details the nature and tectonic significance of the syn-tectonic flysch (sandstone and mudstone) to the Taconic orogeny.

Waldron, J.W.F., 1985. Structural history of continental margin sediments beneath the Bay of Islands Ophiolite, Newfoundland; Can J. Earth Sci., 22, p.1618-1633.

Deformed continental margin sediments of the Curling Group underlie the Bay of Islands Ophiolite in the Humber Arm allochthon of western Newfoundland. Within the allochthon, tectonic slices of sediment are separated by zones of melange.

Bosworth, W., 1985. East-directed imbrication and oblique-slip faulting in the Humber Arm allochthon of western Newfoundland: structural and tectonic significance, Can. J. Earth. Sci., vol. 22, p. 1351-1360.

Many of the dominant outcrop-scale structural features in the lower, clastic thrust sheets of the Humber Arm allochthon were not generated during the westerly emplacement of the allochthonous terranes of western Newfoundland.

Horne, G.S., Helwig, J., 1967. Ordovician Stratigraphy of Notre Dame Bay, Newfoundland; Journal ?, p. 388-407.

A sequence on the northeastern coast of Newfoundland that contains the record of deposition within a lower Paleozoic eugeosynclinal belt. Present in the sequence are Ordovician sedimentary rocks and volcanics.

Whalen, J. B., Kenneth, L.C., 1984. The Topsails igneous terrane, Western Newfoundland: evidence for magma mixing, Contib. Mineral Petrol. , vol. 87, p. 319-327.

The Topsails igneous terrane exhibits evidence for the coexistence of mafic and salic magmas in the form of composite dykes and flows, sinuous, boudined mafic dykes cutting granites and net vein complexes. Field data and major and trace element chemical suggest that these magmas mixed to produce limited volumes of more or less homogeneous hybrids.

Lindholm, R.M., Casey, J.F., 1989, Regional significance of the Blow Me Down Brook Formation, western Newfoundland: New fossil evidence for an Early Cambrian age, Geol. Soc. Am. Bull., vol. 101, p. 1-13.

Allochthonous sandstone-shale sequences outcrop directly beneath the ophiolite massifs of the Bay of Islands region of western Newfoundland have been designated the Blow Me Down Formation. On the basis of presumed stratigraphic relations, the Blow Me Down Brook Formation has been interpreted as the youngest formation within the allochthonous Curling Group.

Wilton, D.H.C., 1985. Tectonic evolution of southwestern Newfoundland and indicated by granitoid petrogenesis; Can. Jour. Earth Sci., v. 22, p 1080-1092.

Intrusive history of SW Newfoundland.

Stevens, R.K., 1970. Cambro-Ordovician flysch sedimentation and tectonics in west Newfoundland and their possible bearing on a Proto-Atlantic Ocean; Geol. Assoc. of Can., Special Paper Number 7, p. 165-177.

Ordovician flysch derived from the east overlies Cambro-Ordovician carbonate rocks in west Newfoundland. Transported flysch contains an assemblage resembling sediments of a continental rise. Parts of old crust might be preserved as ophiolites in the upper slices of the allochthons.

James, N.P., 1981. Megablocks of calcified algae in the Cow Head Breccia, western Newfoundland: vestiges of a Cambro-Ordovician platform margin, Geol. Soc. Am. Bull., v. 92, p. 799-811.

A wide variety of Paleozoic carbonate clasts are found in the Cow Head Group; the most abundant are blocks of fine-grained white limestone. Petrographic studies reveal that the composition of the limestone is calcified algae, cement, and fine-grained sediment. The origin of the limestone clasts is unknown.

Hiscott, R.N., 1984. Ophiolitic source rocks for the Taconic-age flysch: Trace element evidence. Geological Society of America Bulletin, v. 95, p. 1261-1267.

Sandstone from the Taconic flysch is analyzed for certain trace elements including Cr and Ni, which are common in ultramafic rocks. Hiscott found the the rocks in Newfoundland are relatively enriched in Cr and Ni suggesting an actively eroding Ophiolitic source terrane.

Kindle, C.H., Whittington, H.B., 1958. Stratigraphy of the Cow Head Region, Western Newfoundland, Bull. of the Geol. Soc. of America, vol. 69, p. 315-342.

Seashore exposures display a succession of limestone conglomerates interbedded with shales and limestones.

Knight, I. and James, N.P., 1988. Stratigraphy of the Lower to Middle Ordovician St. George Group, Western Newfoundland. Geological Survey of Newfoundland, Department of Mines, Government of Newfoundland and Labrador, Report 88-4, 48 pp (book)

This memoir-like document details the type sections of the St. George Group which is a sequence of shallow subtidal to peritidal limestone. Deepening at the top of the section may represent subsidence associated with the Taconic Orogeny.

DUNNAGE

Horne, G.S., 1969. Early Ordovician Chaotic deposits in the Central Volcanic belt of northeastern Newfoundland; G.S.A. Bull., v. 80, p. 2451-2464.

Boulder-bearing argilite near Notre Dame Bay (near New World Island) contain native and exotic clasts that are interpreted to be sedimentary in origin. The Melange is interpreted to have formed during tectonic activity associated with the Taconic orogeny.

Hibbard, J., 1983. Geology of the Baie Verte Peninsula, Newfoundland, Memoir 2, Mineral Development Division, Department of Mines and Energy, Government of Newfoundland and Labrador, 279 pp. (book with maps)

Complete summary of the Baie Verte Peninsula with geologic maps and extensive documentation of mineral occurrences.

Jacobi, R.D., Wasowski, J.J., 1985. Geochemistry and plate-tectonic significance of the volcanic rocks of the Summerford Group, north-central Newfoundland, Geology, vol. 13, p. 126-130.

The chemical analysis of Ordovician volcanic rocks indicates that these rocks are tholeiitic and alkalic basalts. Trace-element and REE abundances indicate that the basalts were generated either at an ocean island or at a mid-ocean ridge.

Lorenz, B.E., Mud-magma interaction in the Dunnage Melange, Newfoundland. Rest unknown.

The Dunnage Melange, part of the back-arc basinal assemblages in north central Newfoundland, is host to a suite of dacite to rhyolitic intrusions. Intrusion occurred during the late stages of melange formation.

Nelson, K.D., 1981. Mélange development in the Boones Point Complex, north-central Newfoundland; Can. Jour. Earth Sci., v. 18, p. 433-442.

The Boones Point complex in Notre Dame Bay is an sedimentary mélange deposited during the Late Ordovician but deformed during the Acadian Orogeny.

Arnott, R.J., McKerrow,W.S., Cocks, L.R.M., 1984. The tectonics and depositional history of the Ordovician and Silurian rocks of Notre Dame Bay, Newfoundland;
Can. J. Earth Sci. 22, p. 607-618.

In the Notre Dame region, ophiolitic rocks underlie a thick sequence of Lower Ordovician volcanic-arc rocks to the north of the Lobster Cove - Chanceport Fault Towards the east, this arc-derived detritus becomes more distal in aspect and passes laterally into the Dunnage Mélange.

McKerrow, W.S., and Cocks, L.R.M., 1978. A lower Paleozoic trench-fill sequence, New World Island, Newfoundland; G.S.A. Bull., v.89, p. 1121-1132

Mélange, shale and and overlying turbidites on New World island (Notre Dame Bay) are compared to deposits in modern trenches. The implication of this work is that the stratigraphy probably represents active tectonic activity during or immediately preceding the Taconic orogeny.

Pickerell, R.K., Pajari, G.E., Jr., and Currie, K.L., 1981. Resedimented volcaniclastics in the Carmenville area, northeastern Newfoundland - depositional remnants of Early Paleozoic oceanic basins, C.J.E.S., v.18, p. 55-70.

The Carmenville mélange is interpreted to be an olistromal (large blocks mixed in a sedimentary environment) melange consisting largely of ophiolitic-type material. The melange may owe its origin to synsedimentary slumping.

Hibbard, J., and Williams, H., 1979. Regional setting of the Dunnage Mélange in the Newfoundland Appalachians; Am. J. of Sci., V. 279, p. 993-1021.

This paper details the famous Dunnage Mélange in the Dunnage terrane. The Dunnage mélange is composed of clastic sedimentary rocks and mafic volcanic rocks set in a black shale matrix. This mélange unit is interpreted to have formed adjacent to an Island arc in the Ordovician and probably represents a change to collisional tectonics.

Kay, M., 1970. Flysch and Bouldery Mudstone in Northeast Newfoundland; The Geol. Ass. of Canada, Special Paper Number 7, p. 155-164.

Lower Paleozoic rocks of northeastern Newfoundland contain flysch and interbedded siltstone and greywacke. Silurian conglomerates contain well rounded igneous and sedimentary boulders, they coarsen in northern sequences, passing into marine conglomerates with shallow marine faunas.The Dunnage Formation contains intrusive rocks, among which are serpentinized mafic rocks and zenoliths of serpentine in intermediate intrusives. It occurs in a structural band several km. wide, and is bounded by the Reach and Dildo faults.

Van Der Pluijm, B A., 1986. Geology of Eastern New World Island, Newfoundland: An accretionary terrane in the northeastern Appalachians; G.S.A. Bull., v.97, p. 932-945.

The stratigraphy is interpreted with respect to a basin of deposition and the structural geology is largely ascribed to Acadian deformation.

Kay, M., 1976. Dunnage Melange and Subduction of the Protacadic ocean, northeast Newfoundland. Geological Society of America Special Paper 175. 49 p.

A classic paper in the dunnage Melange in which Kay interprets the melange to have been formed in a northwest-dipping subduction zone. Many recent interpretations of these rocks place them in a subduction zone that is dipping in the opposite direction.

Coyle, M., Strong, D.F., 1986. Geology of the Springdale Group: a newly recognized Silurian epicontinental-type caldera in Newfoundland, Can. J. Earth Sci., vol. 24, P 1135-1148.

Volcanic-sedimentary facies and structural relationships of the Silurian Springdale Group in west-central Newfoundland are indicatives of a large collapse caldera with area of more than 2000 sq. km..

Kean, B.F., Strong, D.F., 1975. Geochemical evolution of an Ordovician Island Arc of the central Newfoundland Appalachians, American Journal of Sciences, p.97-119.

A cross section of rocks in central Newfoundland through a sequence of rocks of probable Middle Ordovician in age. The sequence shows a lithologic evolution from lowermost dikes, gabbro, and pillow lava upward through deep-water cherts and turbidites into predominantly subaerial air fall tuffs.

Harris, I.McK., 1966. Geology of the Cobbs Arm area, New world Island, Newfoundland. Department of Mines, Agriculture and Resources, Mineral Resources Division, Bulletin 37, 38 p. with maps.

This report details the geology of an area on New world Island that includes Silurian and Ordovician volcanic and sedimentary rocks.

GANDER

Dallmeyer, R.D., Blackwood, R.F., and Odom, A.L., 1981. Age and origin of the Dover Fault: tectonic boundary between the gander and Avalon zones of the northeastern Newfoundland Appalachians; Can. Jour. Earth Sci., v. 18, p 1431-1442.

The Dover fault separates the Gander and Avalon zones of Newfoundland. It is well exposed in the Bonavista Bay area near Cape Freels.

AVALON

King, A.F., 1988. Geology of the Avalon Peninsula, Newfoundland. Newfoundland Department of Mines, Mineral development Division, Map 88-01.

Colored geologic map of the Avalon peninsula.

O'Brien, S.J., Wardle, R.J., King, A.F., 1983, The Avalon Zone: a Pan-African terrane in the Appalachian Orogen of Canada: published by John Wiley & Sons, Ltd.

The Precambrian sequences of the Avalon Zone in Canada are interpreted as a Pan-African orogenic belt incorporated into the Appalachian Orogen during the Paleozoic as its southeastern margin.

Hoffman, H.J., King, A.F., 1979. Late Precambrian microfossils, southeastern Newfoundland; in Current Research, Part B, Geol. Surv. Canada. p. 83-98.

A palynological study of 294 samples from almost all Precambrian stratigraphic units in southeastern Newfoundland was made and the results discussed.

Williams, H., King, A.F. 1979, Trepassey Map Area, Newfoundland: Geological Survey Memoir 389.

A description of late Precambrian rock assemblage. The oldest being the Harbor Main Group, which is overlain by three sedimentary successions, that are the Conception, St. Johns, and Signal Hill Groups.

King, A.F., 1988 Late Precambrian sedimentation and related orogenesis of the Avalon Peninsula: eastern Avalon zone, Field Trip Guide Book, Geol. Ass. Can., p.1-84,

Describes a cross-section through late Precambrian turbiditic to alluvial facies representative of the much larger Avalon Zone of Newfoundland.

Seilacher, A. 1988. Vendozoa: Organismic construction in the Proterozoic biosphere, Lethaia, vol. 22. p. 229-239.

Vendozoa represent an evolutionary experiment that failed with the coming of macrophagous predators.

Elias, P.N., Strong, D.F., 1982. Timing of arrival of the Avalon Zone in the northeastern Appalachians: a new look at the Straddling Granite, Can. J. Earth Sci., vol. 19, p 1088-1094.

The division of the "Straddling Granite" into two distinct geochemical zones, the Indian Point Granite to the west and the Hardy's Cove zone to the east.

OPHIOLITES

Suen, C. J. , Frey , F.A., Malpas, J. 1979. Bay of Islands ophiolite suite, Newfoundland: Petrologic and geochemical characteristics with emphasis on rare earth element geochemistry. Earth and Planetary Science Letters, 45, p. 337-348.

Characteristic geochemical features of the ophiolite suite from the Bay of Islands Complex determined by major and trace element analyses of 13 rocks.

Cawood, P.A., 1989.Acadian remobilization of a Taconian ophiolite, Hare Bay allochthon, northwestern Newfoundland, Geology, vol. 17, p. 257-260.

The Hare Bay fault is a major subhorizontal detachment at the base of the ophiolitic St. Anthony Complex in the Hare Bay allochthon, northwestern Newfoundland. The fault truncates footwall structures related to both initial Ordovician (Taconic) assembly of the allochthon and subsequent Silurian-Devonian (Acadian) deformation.

Dunning, G.R., and Krogh, T.E., 1985. Geochronology of ophiolites of the Newfoundland Appalachians; Can. Jour. of Earth Sciences, v. 22, p. 1659-1670.

This paper details new U/Pb geochronology of trondhjemite from the Bay of Islands complex (486 Ma), gabbro (480 ma) and Sm/Nd ages of about 505 Ma. The Betts cove is dated at 478 Ma to 463 Ma. The Annieopsquotch complex is dated at about 477-481 Ma. Together with previous data, the age spans a narrow range of about 18 ma (480-490 Ma which is Late Cambrian); the ocean crust is interpreted to have been young and hot during emplacement.

Casey, J.F., Elthon, D.L, Siroky, F.X., Karson, J.A., and Sullivan, J., 1985. Geochemical and Geological evidence bearing on the origin of the Bay of Islands and Coastal Complex ophiolites of Western Newfoundland; Tectonophysics, v. 116, p. 1-40.

The geochemical evidence for a seafloor spreading origin of the Bay of Islands and Central complex are presented and these ophiolites are geochemically identical to modern MORBS. Unusual diabases are inferred to have been produced at a transform fault They do not favor a back-arc or forearc setting for these pieces of ocean crust. An interesting tectonic model is presented.

Moores, E.M., 1982. Origin and emplacement of ophiolites; Reviews of Geophysics and Space physics, v. 20, p. 735-760.

A good review of what ophiolites are and how the get on land.

FIELD GUIDES

Anderson, M.M., 1987. Late Precambrian glaciomarine sequence, conception group, Double Road Point, St. Mary's Bay, southeast Newfoundland, *In* Northeastern Section of the Geological Society of America, Centennial Field guide, D.C. Roy (ed.) Geol.. Soc. of Am., Denver, Co, p. 473-476.

Anderson, M.M., 1987. Stratigraphy of Cambrian rocks at Beacon Cove, Duffs, and Manuels River, Conception Bay, Avalon Peninsula, eastern Newfoundland, *In* Northeastern Section of the Geological Society of America, Centennial Field guide, D.C. Roy (ed.) Geol.. Soc. of Am., Denver, Co, p. 467-472.

Boyce, W.D., 1988. Cambrian trilobite faunas on the Avalon Peninsula, Newfoundland (Trip A8), G.A.C, M.A.C., and C.S.P.G. Joint annual meeting, St. Johns, Newfoundland, 76. pp.

Brooks, I.A., 1987. Late Quaternary glaciation and sea level change, southwest Newfoundland, Canada, *In* Northeastern Section of the Geological Society of America, Centennial Field guide, D.C. Roy (ed.) Geol.. Soc. of Am., Denver, Co, p. 445-450.

Calon, T.J., Dunsworth, S.D., and Suhr, G., 1988. The Bay of Islands Ophiolite (Trip B8), G.A.C, M.A.C., and C.S.P.G. Joint annual meeting, St. Johns, Newfoundland, 92. pp.

Cawood, P.A., Williams, H., Obrien, S.J., and O'Neill, P.P., 1988. Geologic cross-section of the Appalachian Orogen (Trip A1), G.A.C, M.A.C., and C.S.P.G. Joint annual meeting, St. Johns, Newfoundland, 160 pp.

Hibbard, J., 1987. Ophiolitic mélange along the Baie Verte Line, Coachmans Harbour, Newfoundland, *In* Northeastern Section of the Geological Society of America, Centennial Field guide, D.C. Roy (ed.) Geol.. Soc. of Am., Denver, Co, p. 457-462.

James, N.P., and Stevens, R.K., Excursion 2B: Anatomy and evolution of a lower Paleozoic continental margin, western Newfoundland, International Association of Sedimentologists, Eleventh International congress on sedimentology, McMaster University, Hamilton Ontario, 75 pp.

James, N.P., Barnes, C.R., Boyce, W.D., Cawood, P.A., Knight, I., Stenzal, S.R., Stevens, R.K., and Williams, S.H., 1988. Carbonates and faunas of western Newfoundland, Vth International Symposium on the Ordovician System, St. Johns Newfoundland, Canada, 123 pp.

King, A.F., Anderson, M.M., and Benus, A.P., 1988. Late Precambrian sedimentation and related orogenesis of the Avalon Peninsula, eastern Avalon Zone (Trip A4), G.A.C, M.A.C., and C.S.P.G. Joint annual meeting, St. Johns, Newfoundland, 84. pp.

Malpas, J., 1987. The Bay of Islands ophiolite; a Cross section through Paleozoic crust and mantle in western Newfoundland, *In* Northeastern Section of the Geological Society of America, Centennial Field guide, D.C. Roy (ed.) Geol.. Soc. of Am., Denver, Co, p. 451-456.

Proudfoot, D.N., Grant, D.R., and Batterson, M.J., 1988. Quaternary geology of western Newfoundland (Trip A6), G.A.C, M.A.C., and C.S.P.G. Joint annual meeting, St. Johns, Newfoundland, 53 pp.

Reusch, D., 1987. Silurian stratigraphy and mélanges, New world Island, north central Newfoundland, *In* Northeastern Section of the Geological Society of America, Centennial Field guide, D.C. Roy (ed.) Geol.. Soc. of Am., Denver, Co, p. 463-466.

Williams, P.F., Elliott, C.F., and Lafrance, B., 1988. Structural Geology and mélanges of eastern Notre Dame Bay, Newfoundland (Trip B2), G.A.C, M.A.C., and C.S.P.G. Joint annual meeting, St. Johns, Newfoundland, 60. pp.

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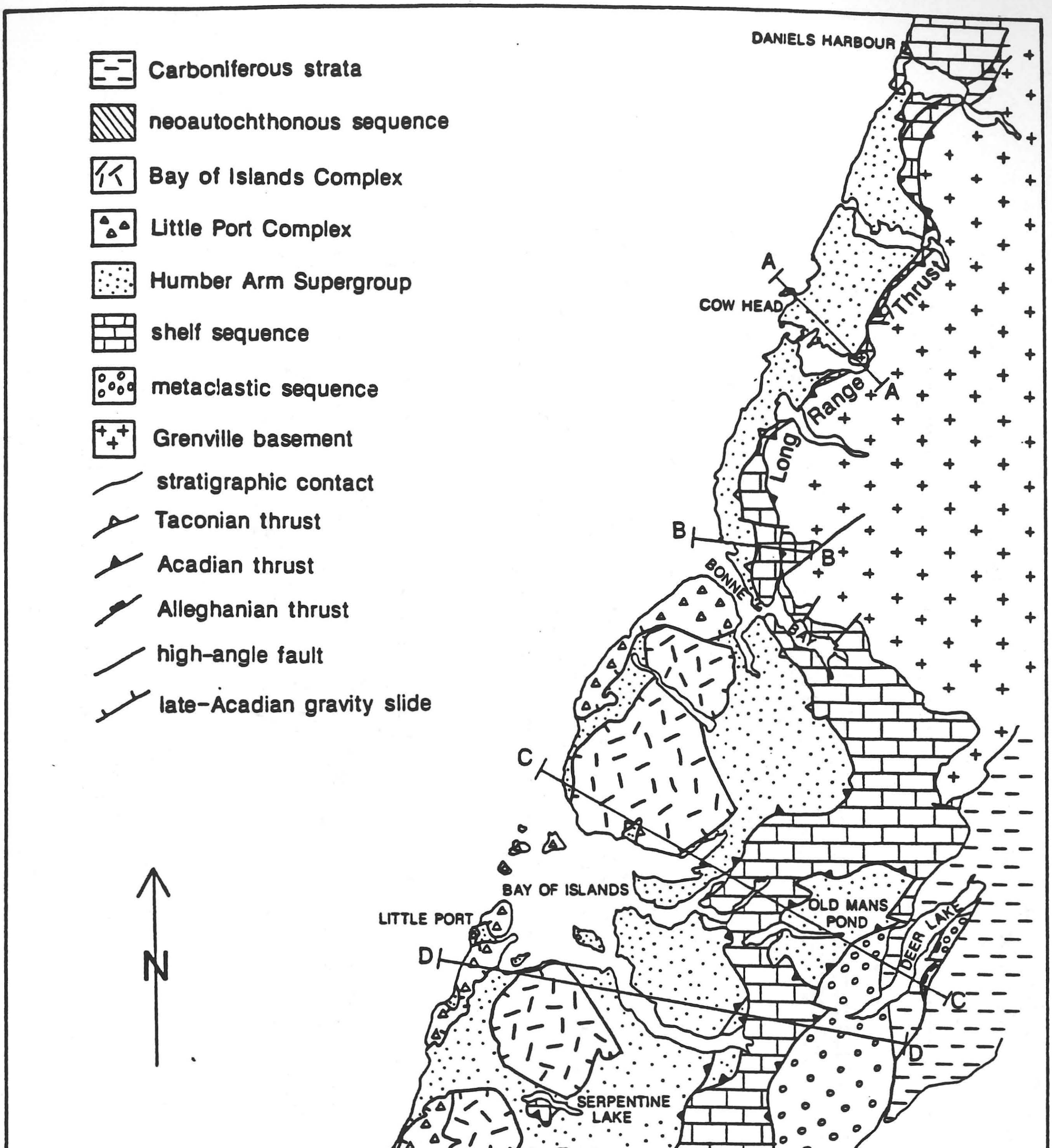


Figure 4. Simplified geologic map of the Humber Arm Allochthon and surrounding units.

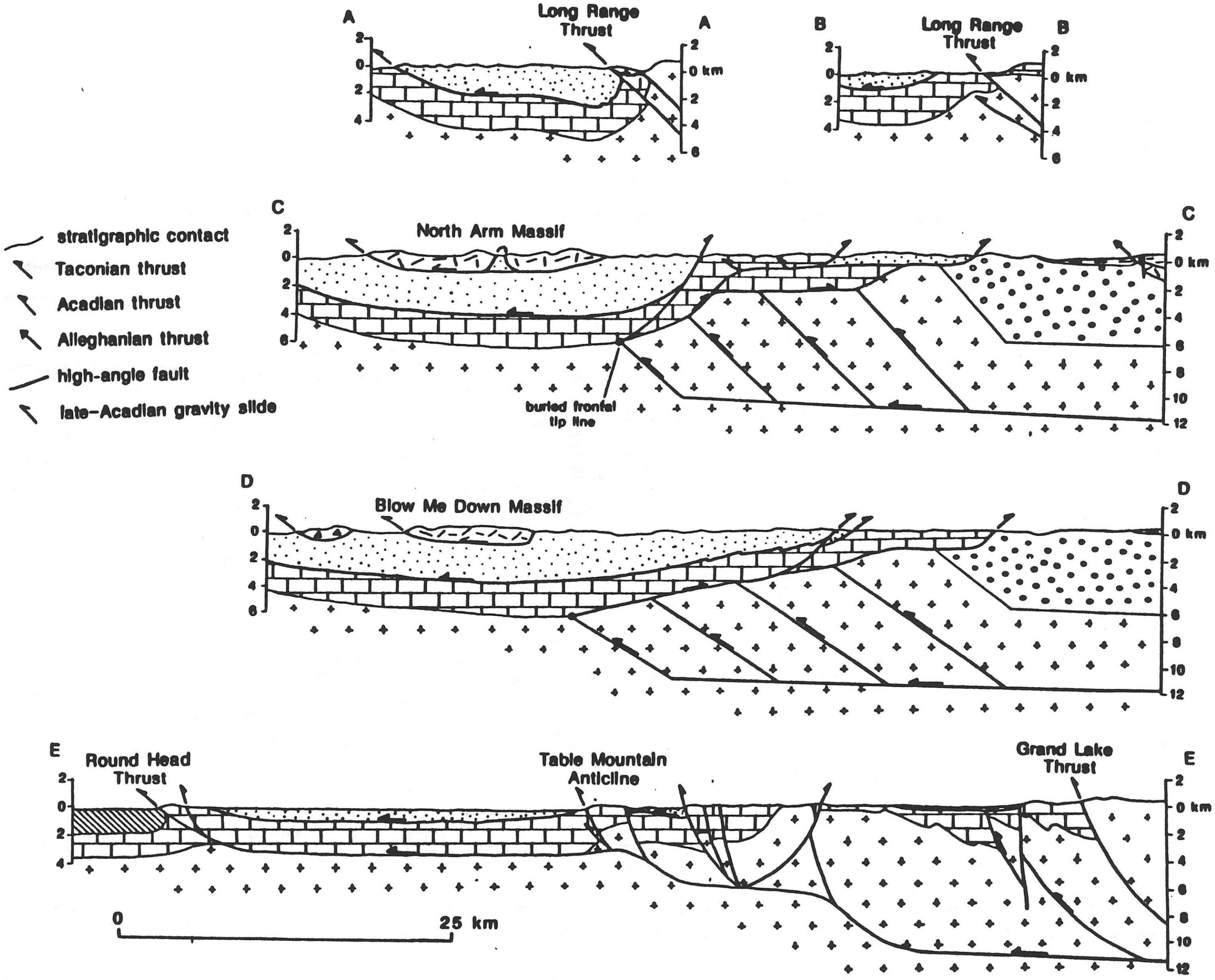


Figure 5: Geologic cross sections across the Humber Arm Allochthon showing variations in style of the Acadian thrust front.

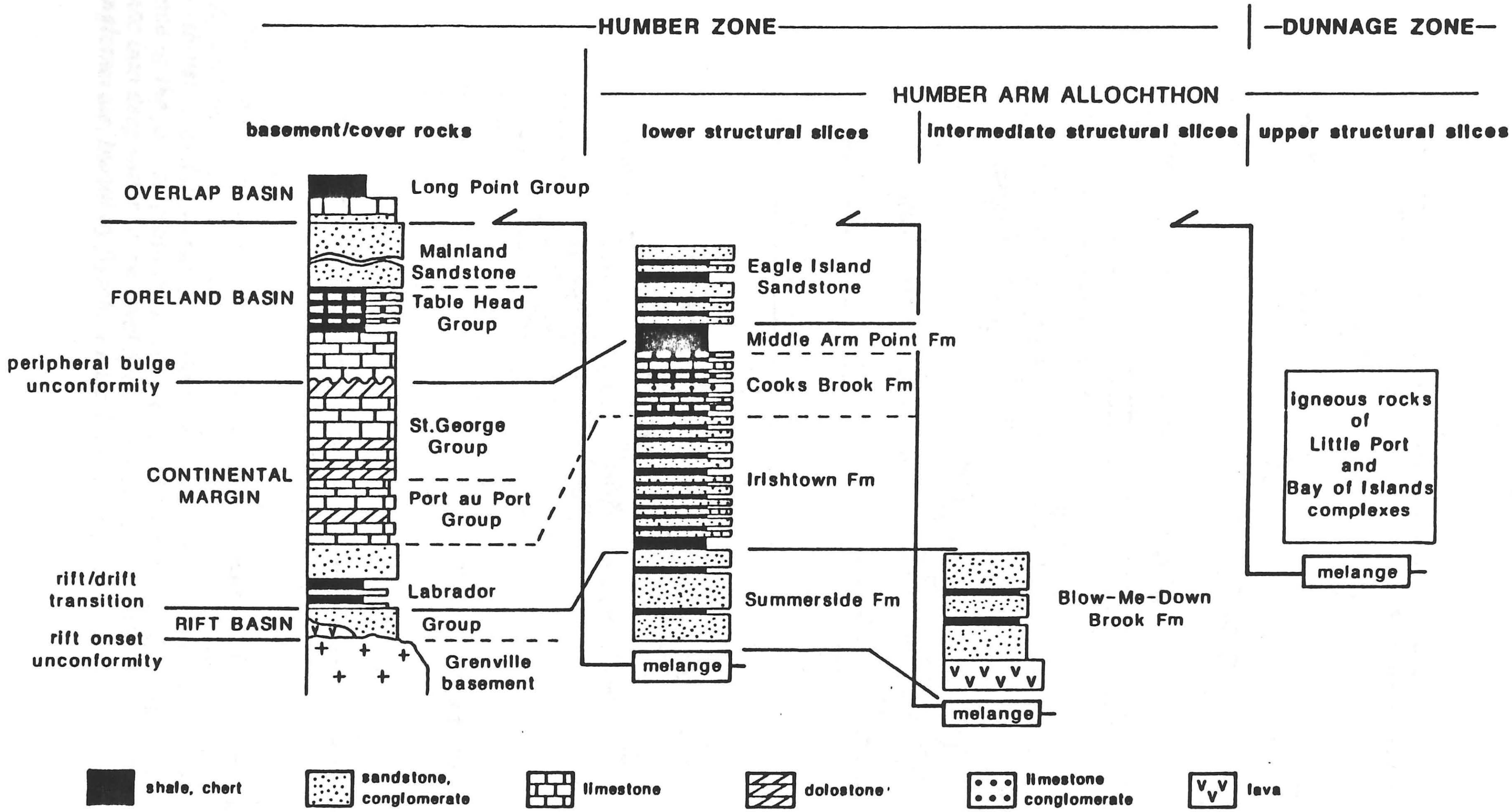


Figure 6: Geologic columns correlating the major stratigraphic units in the autochthonous and transported rocks of central western Newfoundland and their inferred paleogeographic setting.

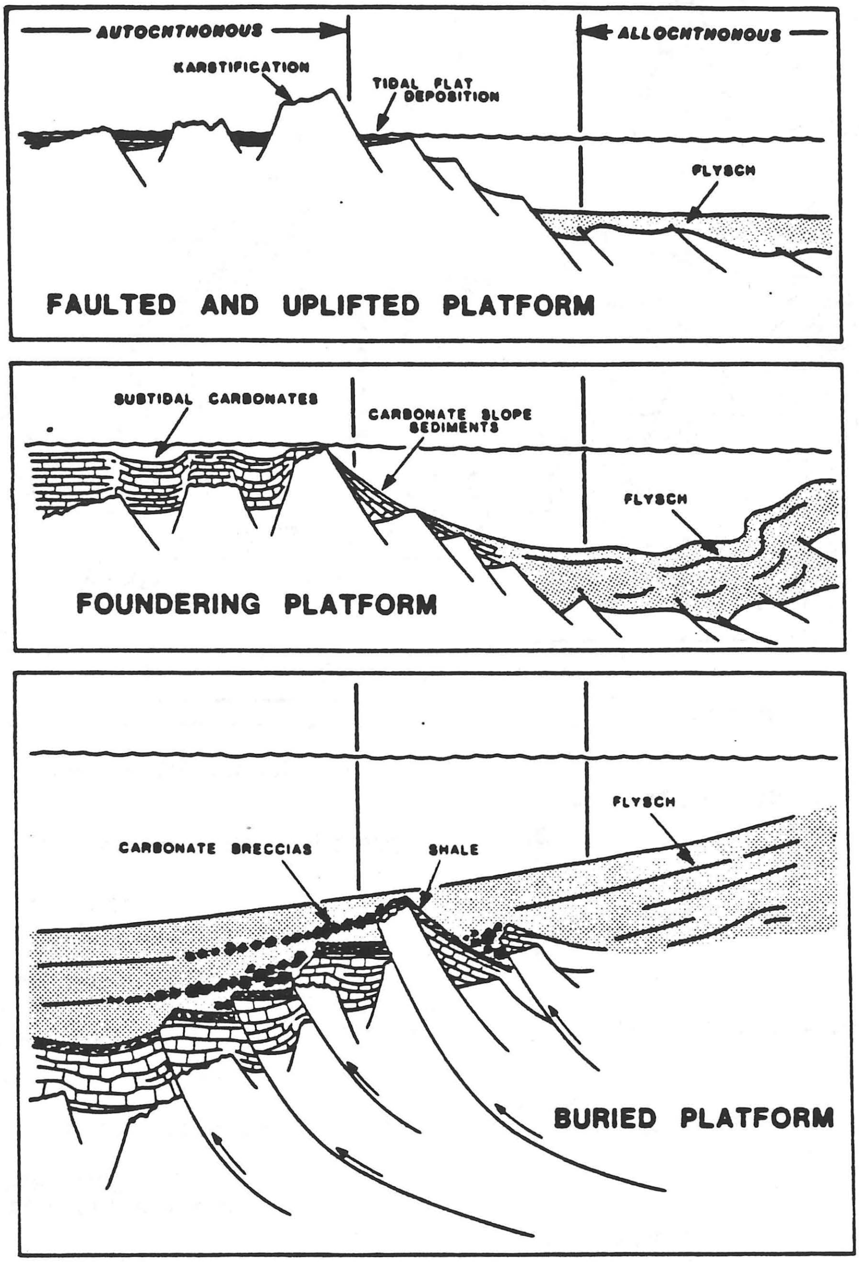


Figure 7: Three interpretive diagrams illustrating the carbonate platform during the final foundering phase; (A) development of a foreland basin to the east and uplift, faulting and karstification in the west; (B) thrusting and deformation of the foreland basin flysch in the east, foundering and rapid subsidence of the faulted platform in the west; (C) thrusting and transport of strata in the east, subsidence into deep water below level of carbonate deposition, thrusting and collapse of scarps to form conglomerate, burial by flysch. Phase 4, events 8 and 9 of Fig. 8.

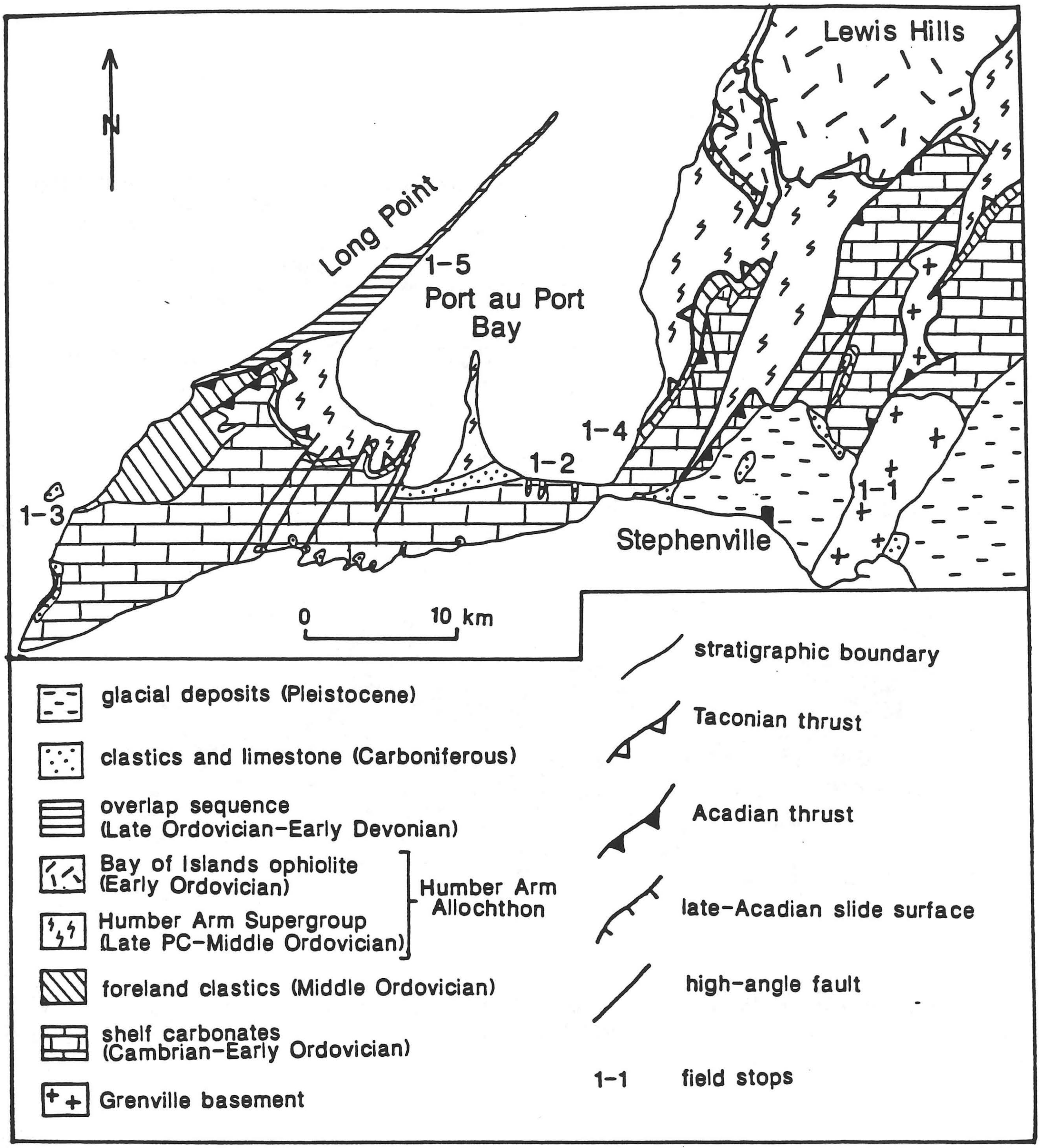


Figure 8: Simplified geologic map of the Port au Port region showing location of Day 1 field stops.

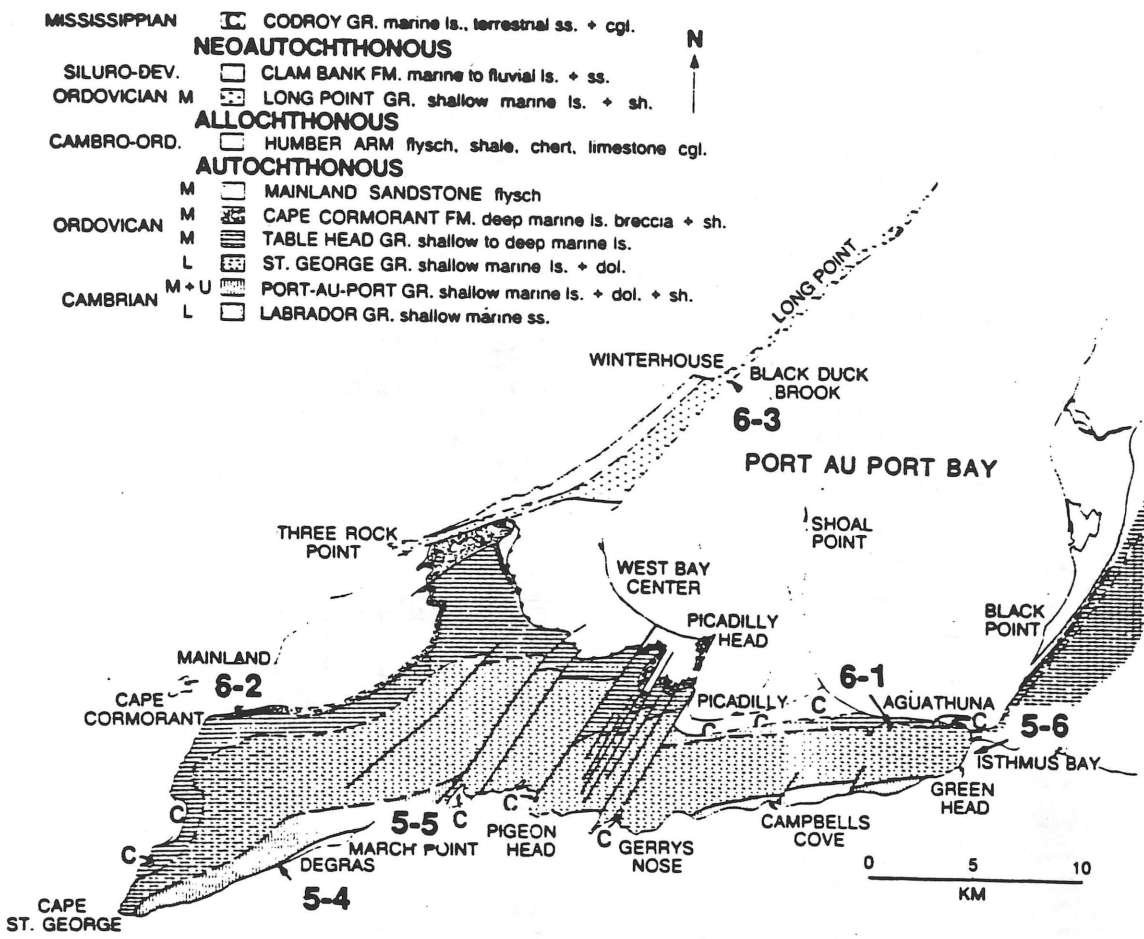


Figure 9: A geological map of Port au Port Peninsula (after Levesque, 1977; Schillereff and Williams, 1979; and the authors). Location of stops indicated.

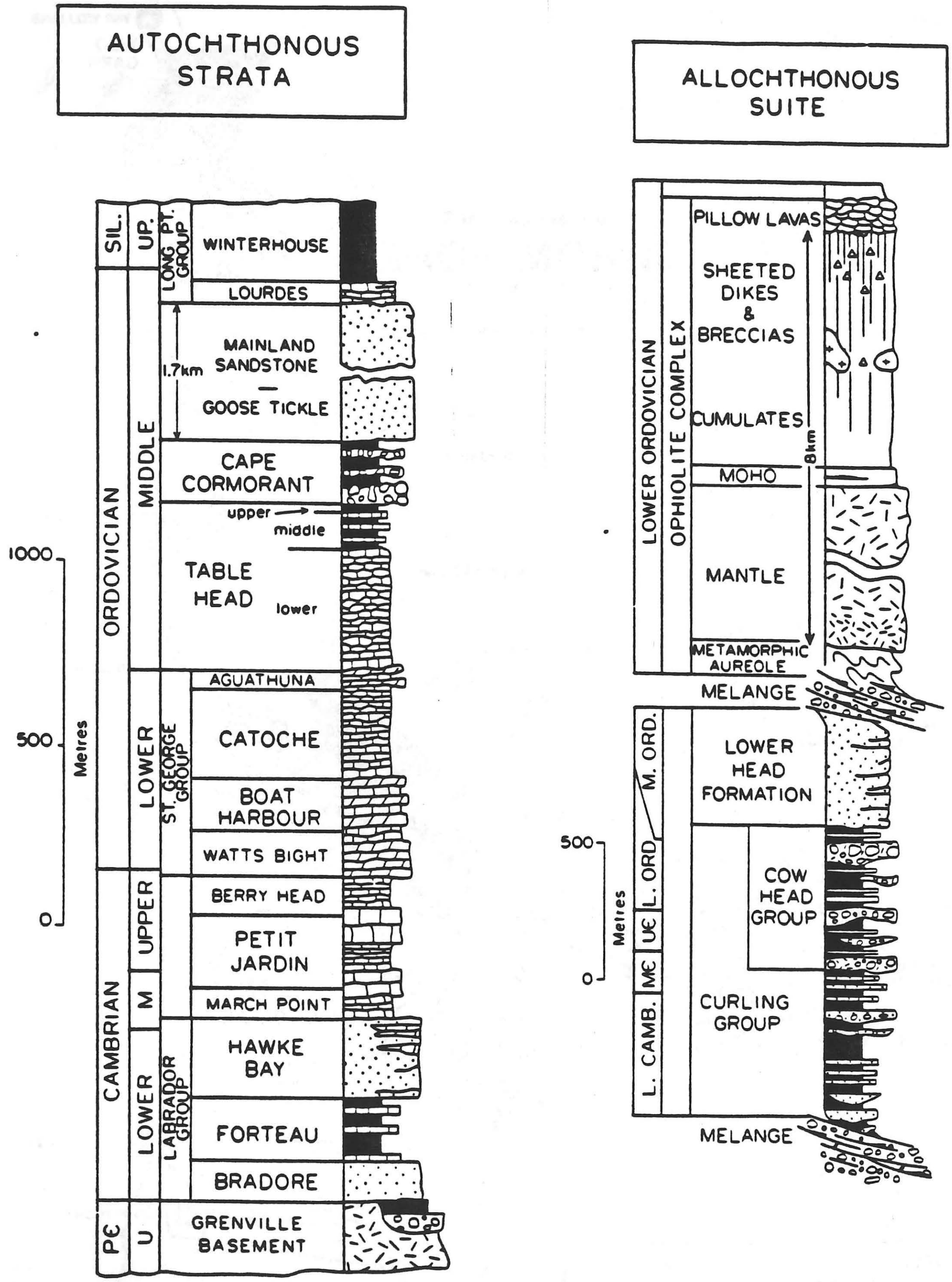


Figure 10: A generalized stratigraphic section of Cambro-Ordovician autochthonous, mainly shallow water strata in western Newfoundland.

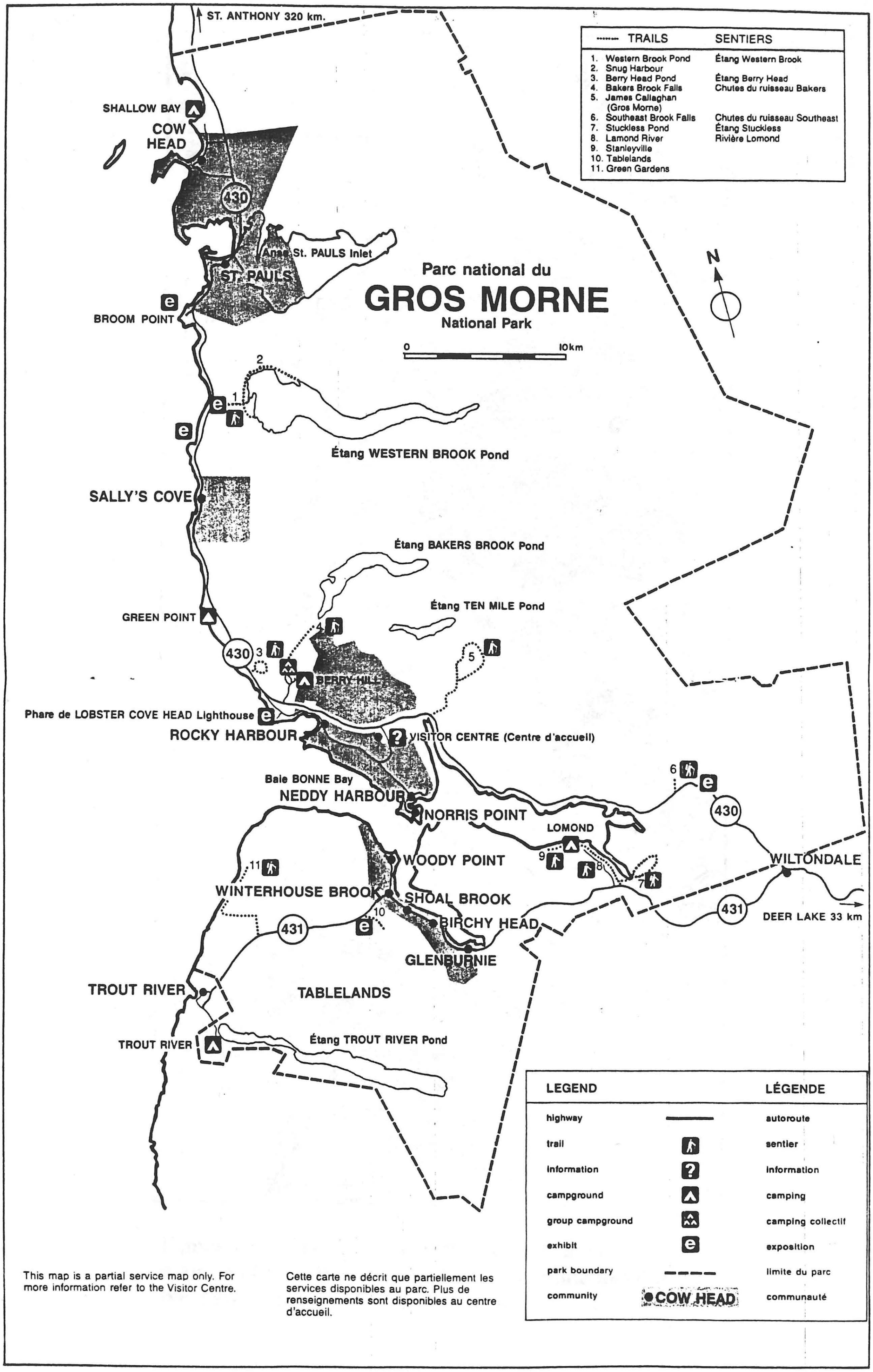

ST. ANTHONY 320 km.
TRAILS SENTIERS
1. Western Brook Pond Étang Western Brook
2. Snug Harbour
3. Berry Head Pond Étang Berry Head
4. Bakers Brook Falls Chutes du ruisseau Bakers
5. James Callaghan (Gros Morne)
6. Southeast Brook Falls Chutes du ruisseau Southeast
7. Stuckless Pond Étang Stuckless
8. Lamond River Rivière Lomond
9. Stanleyville
10. Tablelands
11. Green Gardens
SHALLOW BAY
COW HEAD
430
Anse St. PAULS Inlet
ST. PAULS
Parc national du
GROS MORNE
National Park
0
10km
BROOM POINT
Étang WESTERN BROOK Pond
SALLY'S COVE
Étang BAKERS BROOK Pond
Étang TEN MILE Pond
GREEN POINT
BERRY HILL
Phare de LOBSTER COVE HEAD Lighthouse
ROCKY HARBOUR
VISITOR CENTRE (Centre d'accueil)
Baie BONNE Bay
NEDDY HARBOUR
NORRIS POINT
LOMOND
WOODY POINT
WILTONDALE
WINTERHOUSE BROOK
SHOAL BROOK
BIRCHY HEAD
431
DEER LAKE 33 km
GLENBURNIE
TROUT RIVER
TABLELANDS
TROUT RIVER
Étang TROUT RIVER Pond
LEGEND LÉGENDE
highway autoroute
trail sentier
information information
campground camping
group campground camping collectif
exhibit exposition
park boundary limite du parc
community COW HEAD communauté
This map is a partial service map only. For more information refer to the Visitor Centre.
Cette carte ne décrit que partiellement les services disponibles au parc. Plus de renseignements sont disponibles au centre d'accueil.

Fig. 11

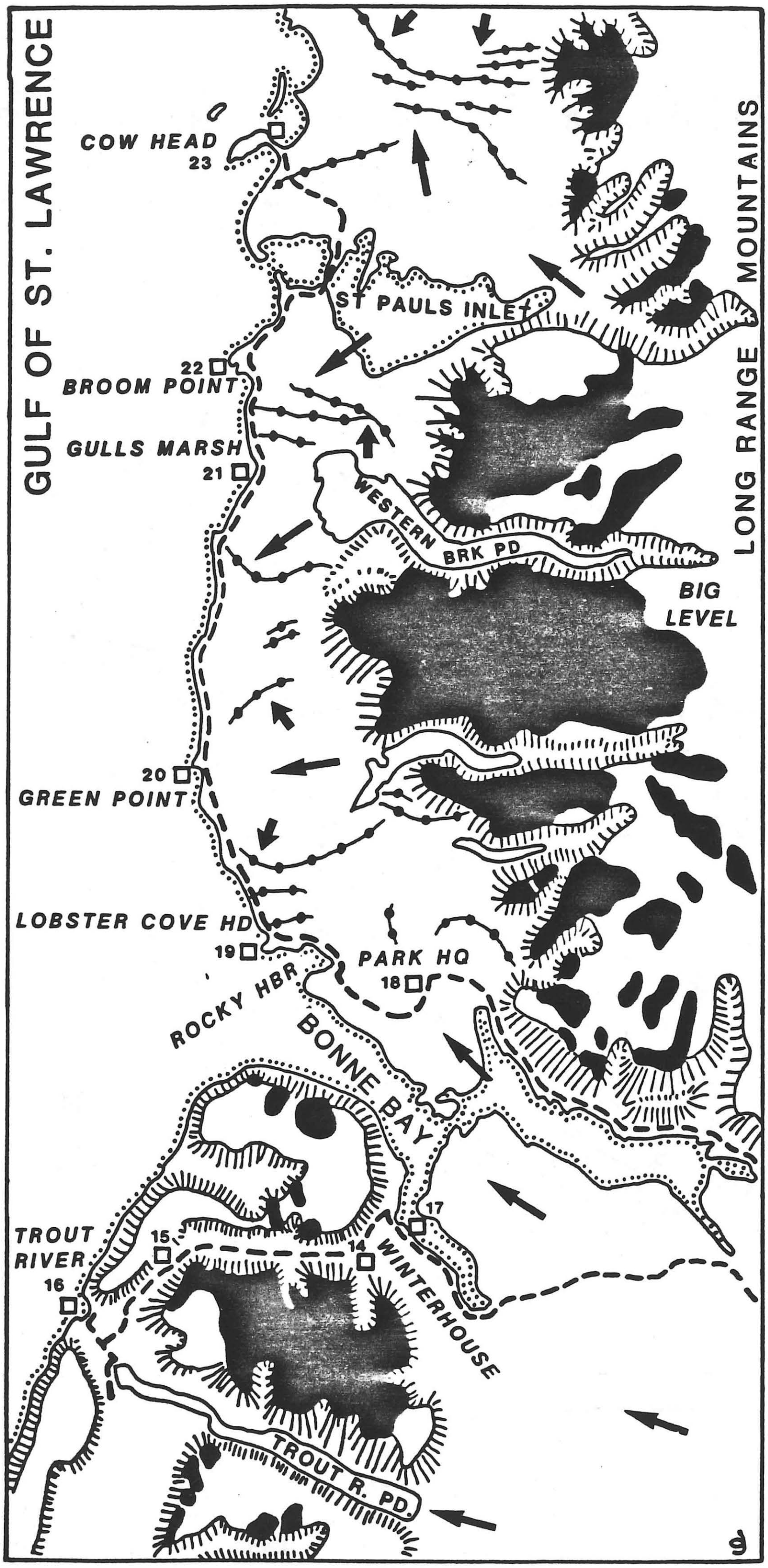


Figure 12: Gros Morne National Park area, showing major end moraines (beaded lines) and nunataks during the Late Wisconsinan glacier advance.

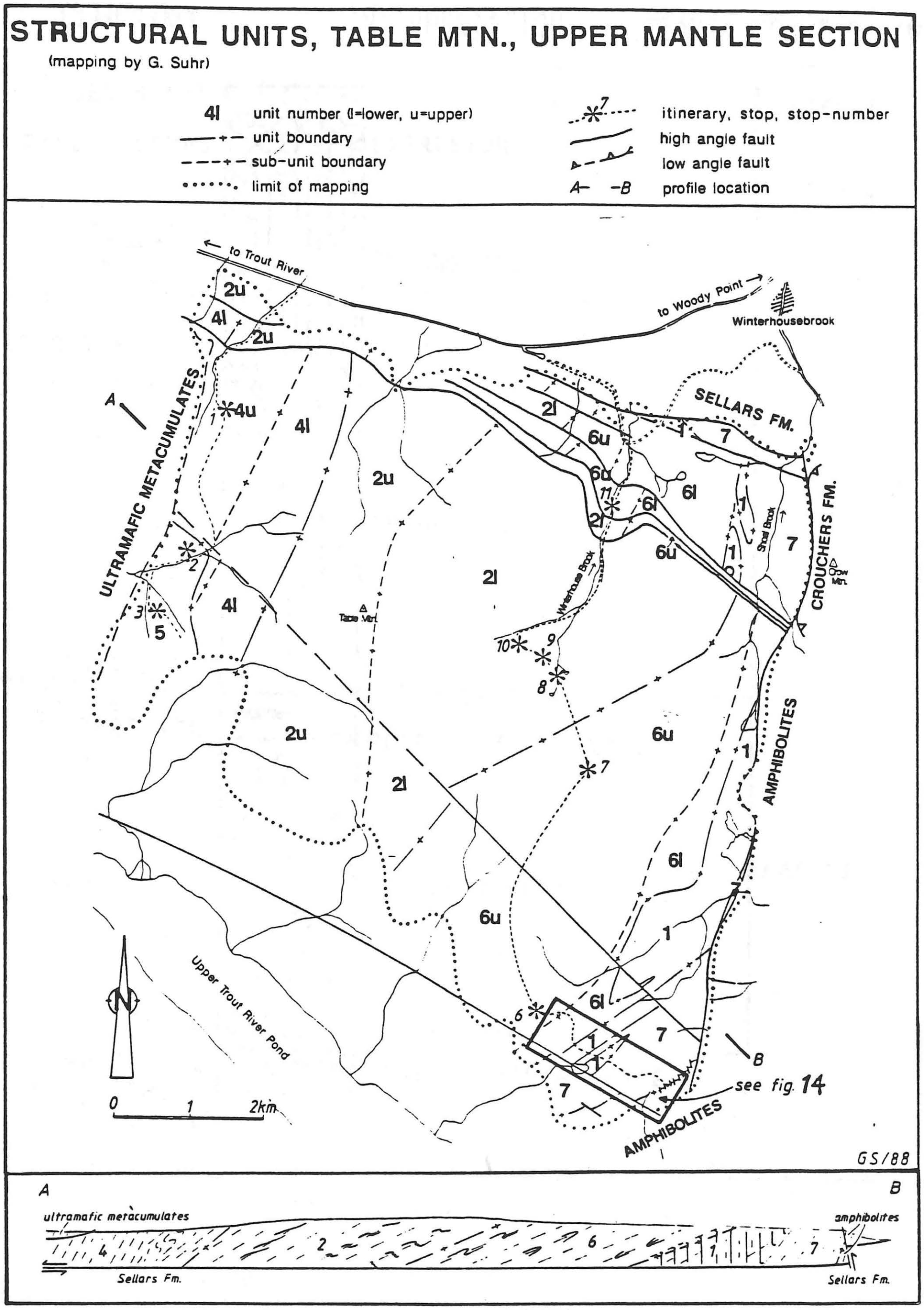
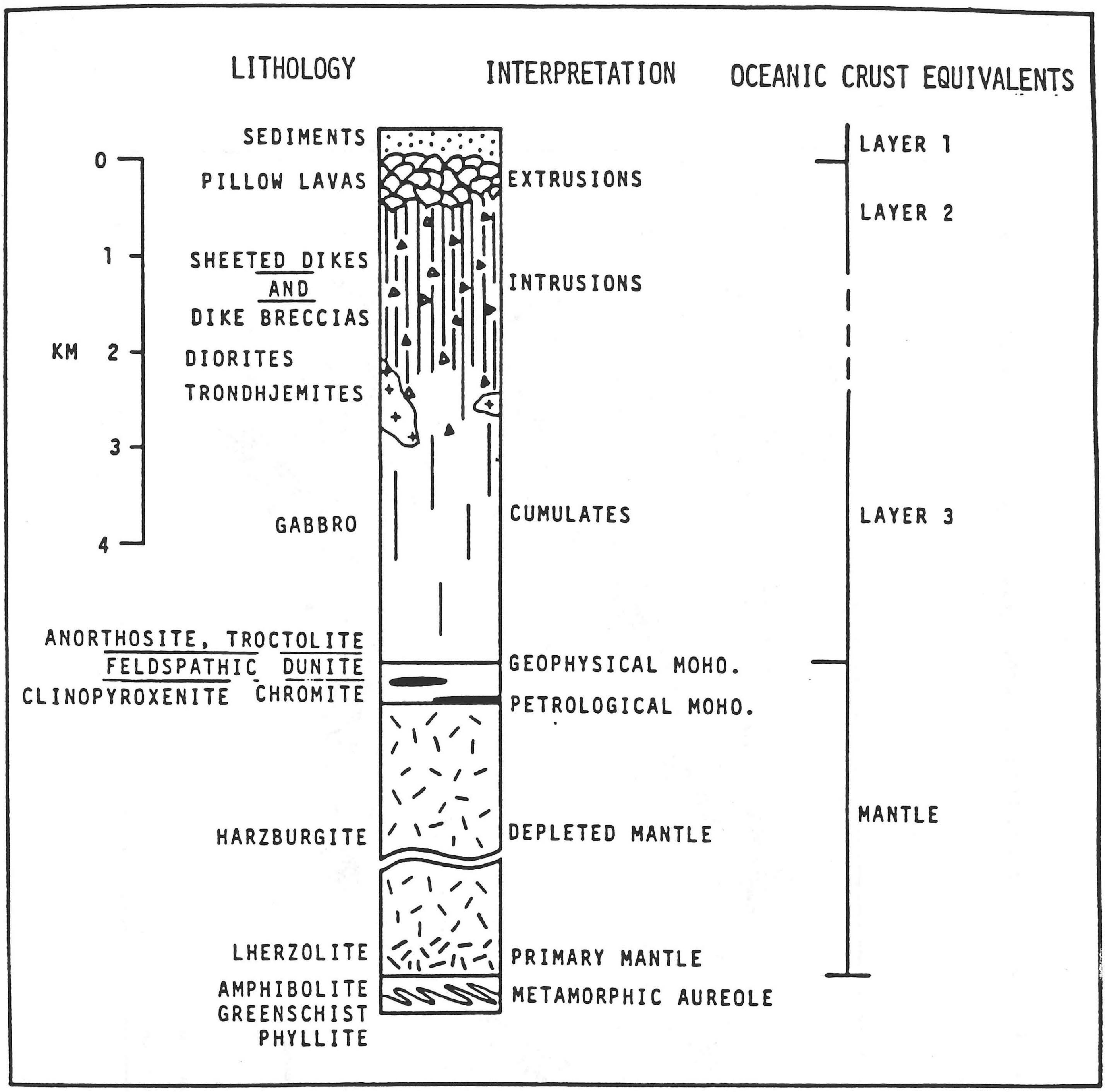


Figure 13: Structural units, cross-sections, and field stops in the Table Mountain mantle section. Dashed lines in cross section indicate foliation, solid lines lithological banding. Location and nomenclature of Crouchers and Sellars formation is after Quinn (1985).



LITHOLOGY
INTERPRETATION
OCEANIC CRUST EQUIVALENTS
SEDIMENTS
0
PILLOW LAVAS
EXTRUSIONS
LAYER 1
LAYER 2
1
SHEETED DIKES
AND
DIKE BRECCIAS
INTRUSIONS
KM 2
DIORITES
TRONDHJEMITES
3
GABBRO
CUMULATES
LAYER 3
4
ANORTHOSITE, TROCTOLITE
FELDSPATHIC DUNITE
CLINOPYROXENITE CHROMITE
GEOPHYSICAL MOHO.
PETROLOGICAL MOHO.
HARZBURGITE
DEPLETED MANTLE
MANTLE
LHERZOLITE
PRIMARY MANTLE
AMPHIBOLITE
GREENSCHIST
PHYLLITE
METAMORPHIC AUREOLE

Fig. 14

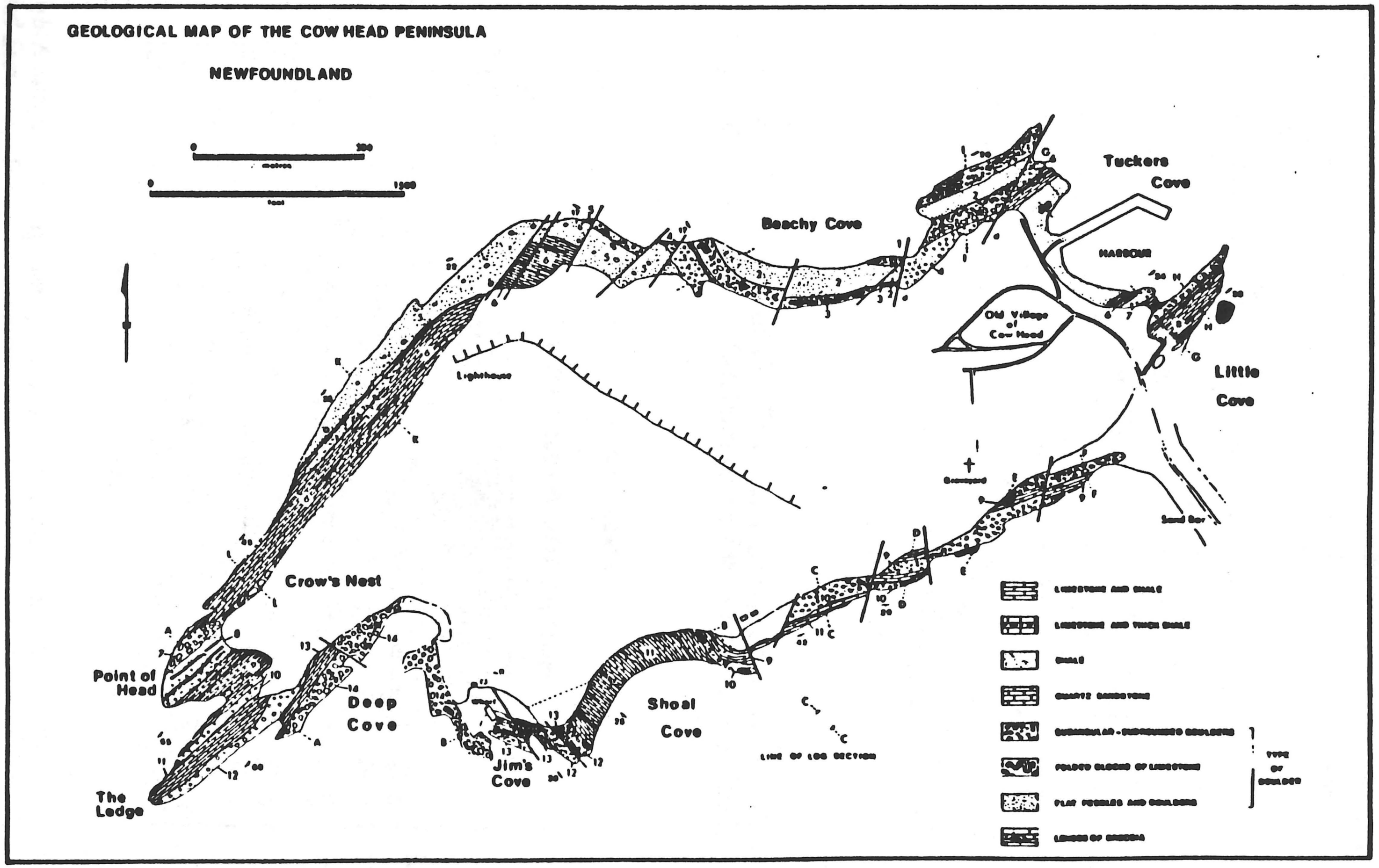


Figure 16 Geologic map of the Cow Head Peninsula (after Fahraeus and Nowlan, 1978).

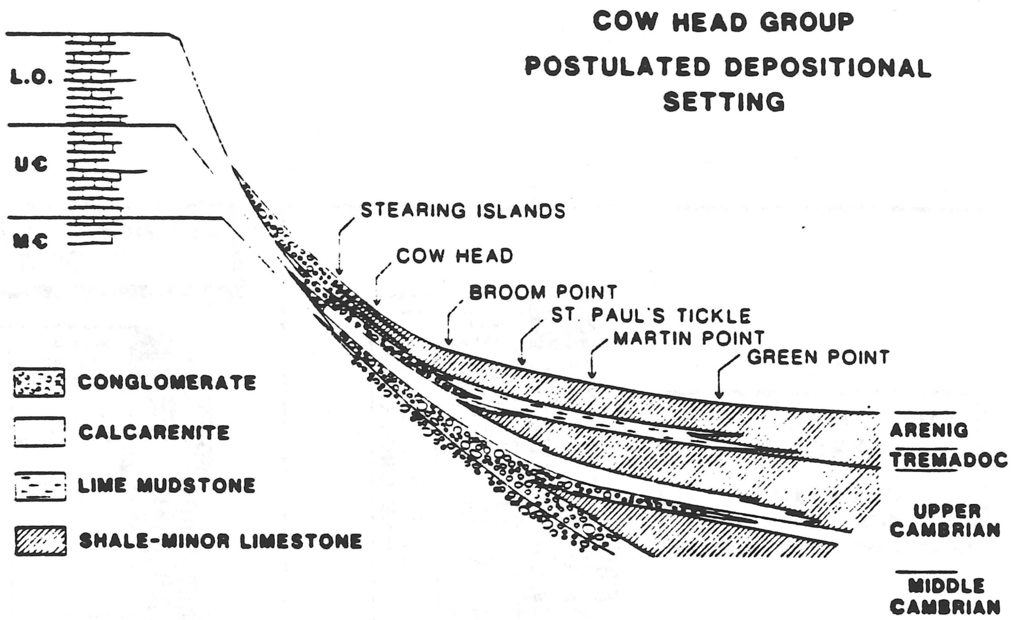


Figure 16a: A simplified sketch of the Cow Head Group as a base-of-slope sediment apron showing palinspastic location of sections (from James and Stevens, 1986).

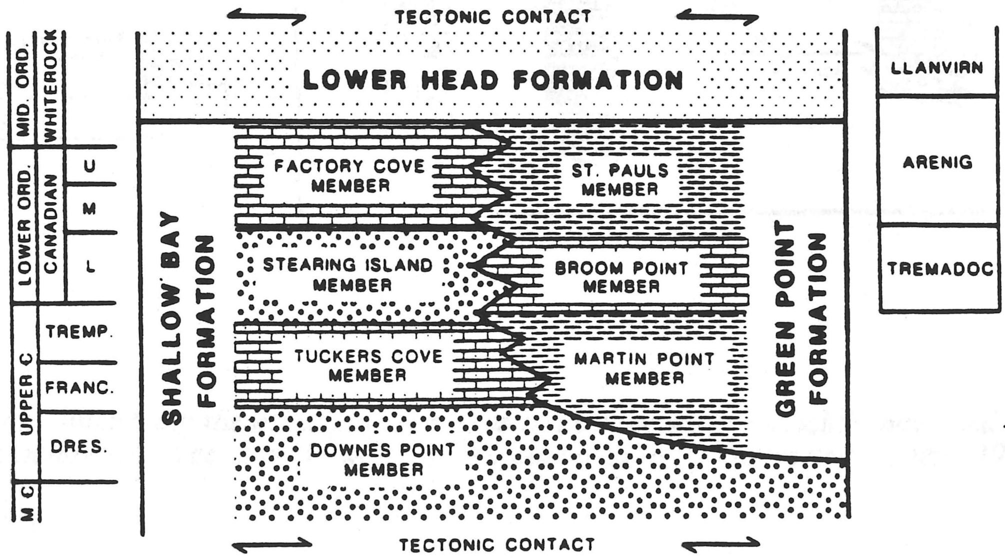


Figure 16b: A simplified diagram of the different stratigraphic units of the Cow Head Group (from James and Stevens, 1986).

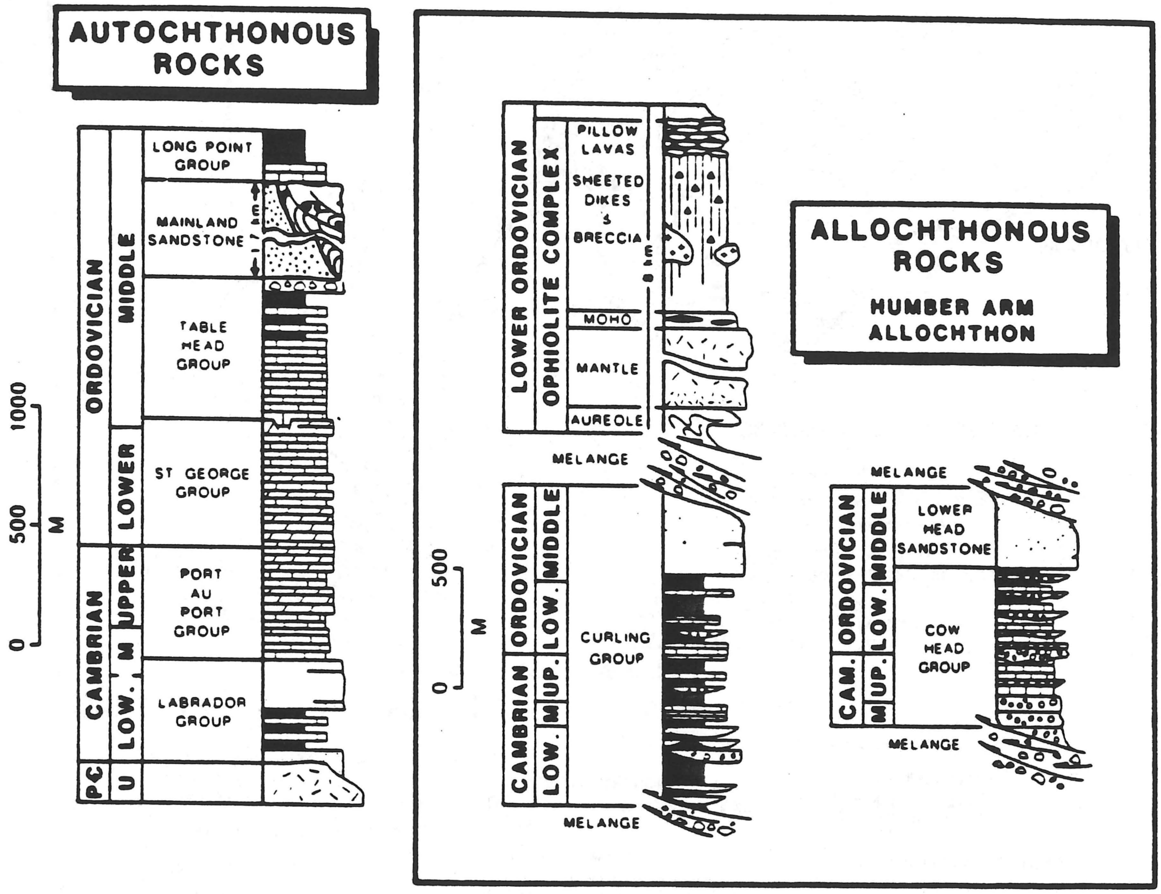


Figure 17: Sketch illustrating the principal rock units in shallow water autochthonous and deep water allochthonous successions in western Newfoundland (after James and Stevens, 1986).

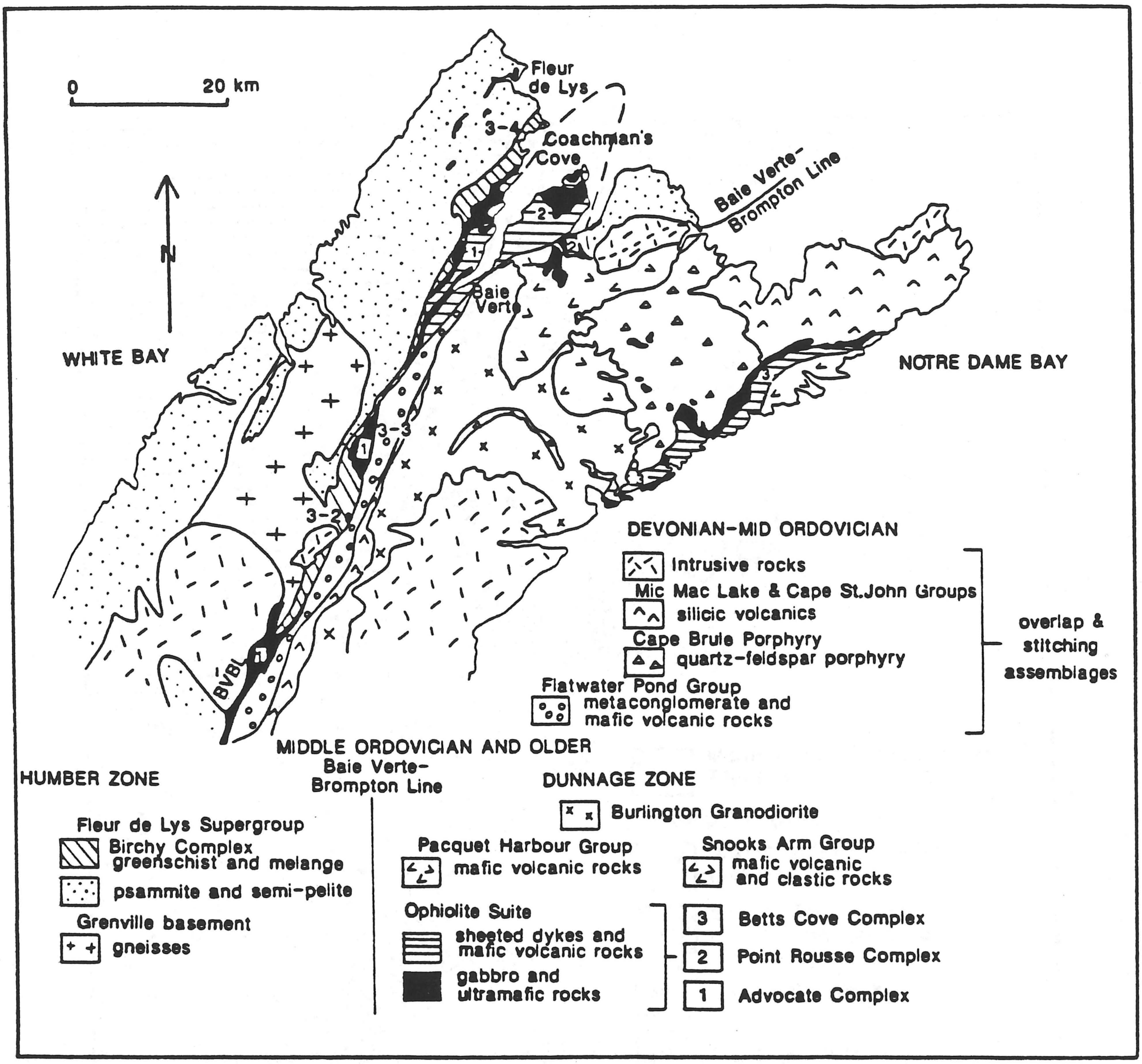


Figure 18: Simplified geologic map of the Baie Verte Peninsula showing the location of Day 3 field stops.

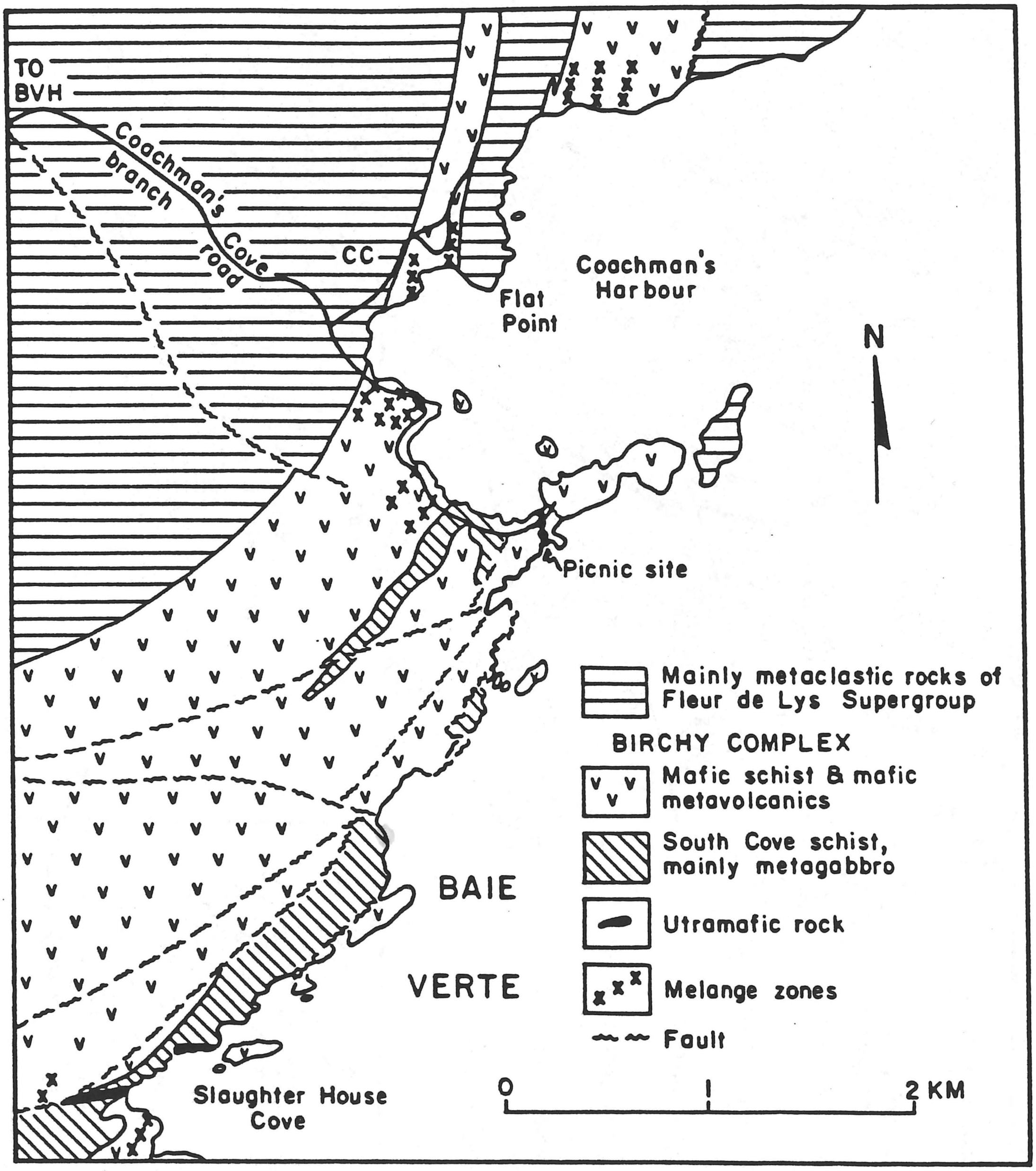


Figure 19: Geologic map of the Coachman's Harbour region (from Hibbard, 1987).

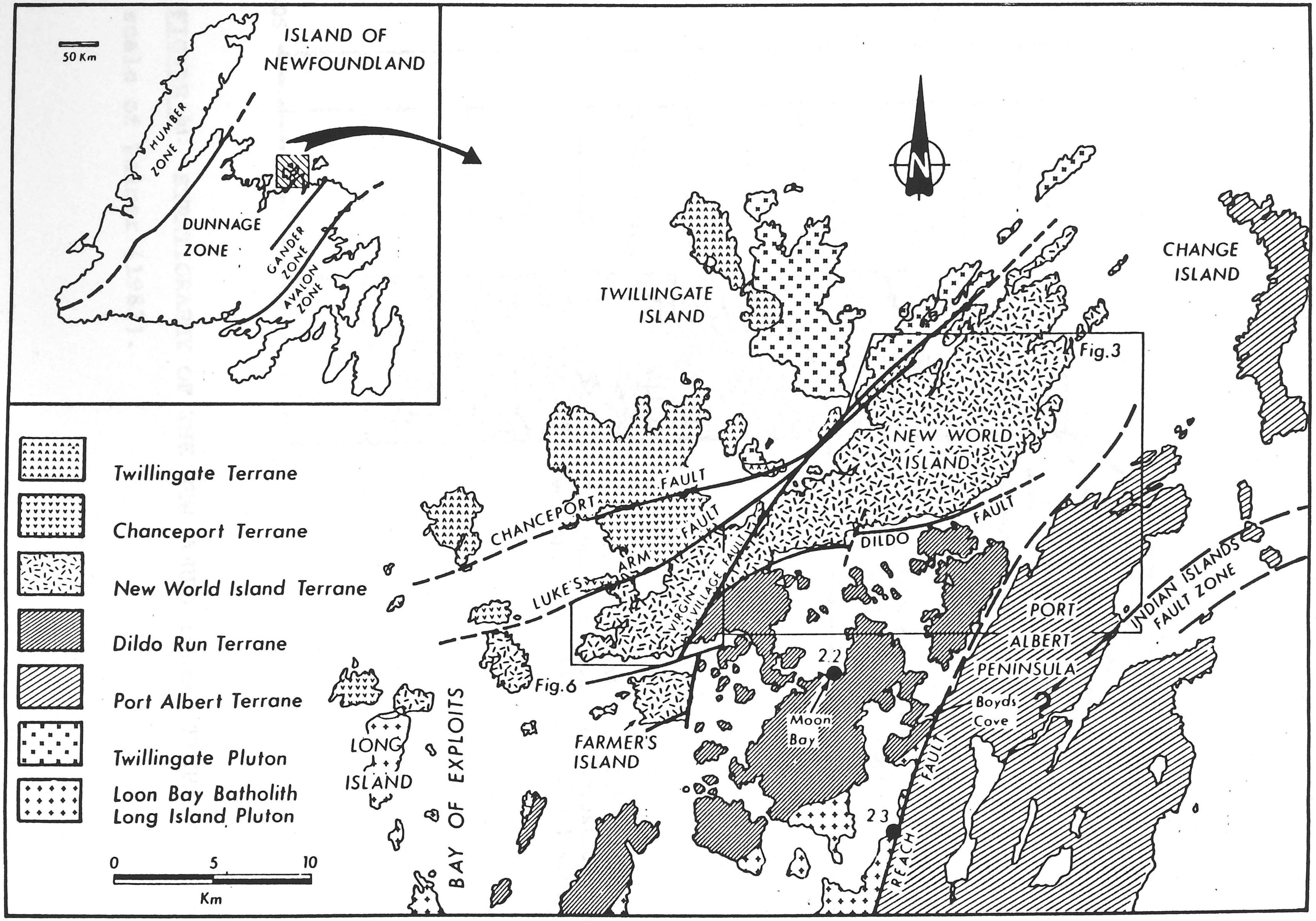

ISLAND OF NEWFOUNDLAND
50 Km
HUMBER ZONE
DUNNAGE ZONE
GANDER ZONE
AVALON ZONE
Twillingate Terrane
Chanceport Terrane
New World Island Terrane
Dildo Run Terrane
Port Albert Terrane
Twillingate Pluton
Loon Bay Batholith
Long Island Pluton
0
5
10
Km
TWILLINGATE ISLAND
CHANGE ISLAND
NEW WORLD ISLAND
Fig. 3
Fig. 6
CHANCEPORT FAULT
LUKE'S ARM FAULT
VIRGIN ARM FAULT
DILDO FAULT
INDIAN ISLANDS FAULT ZONE
REACH FAULT
PORT ALBERT PENINSULA
Boyds Cove
Moon Bay
2.2
2.3
FARMER'S ISLAND
LONG ISLAND
BAY OF EXPLOITS
N

Fig. 20

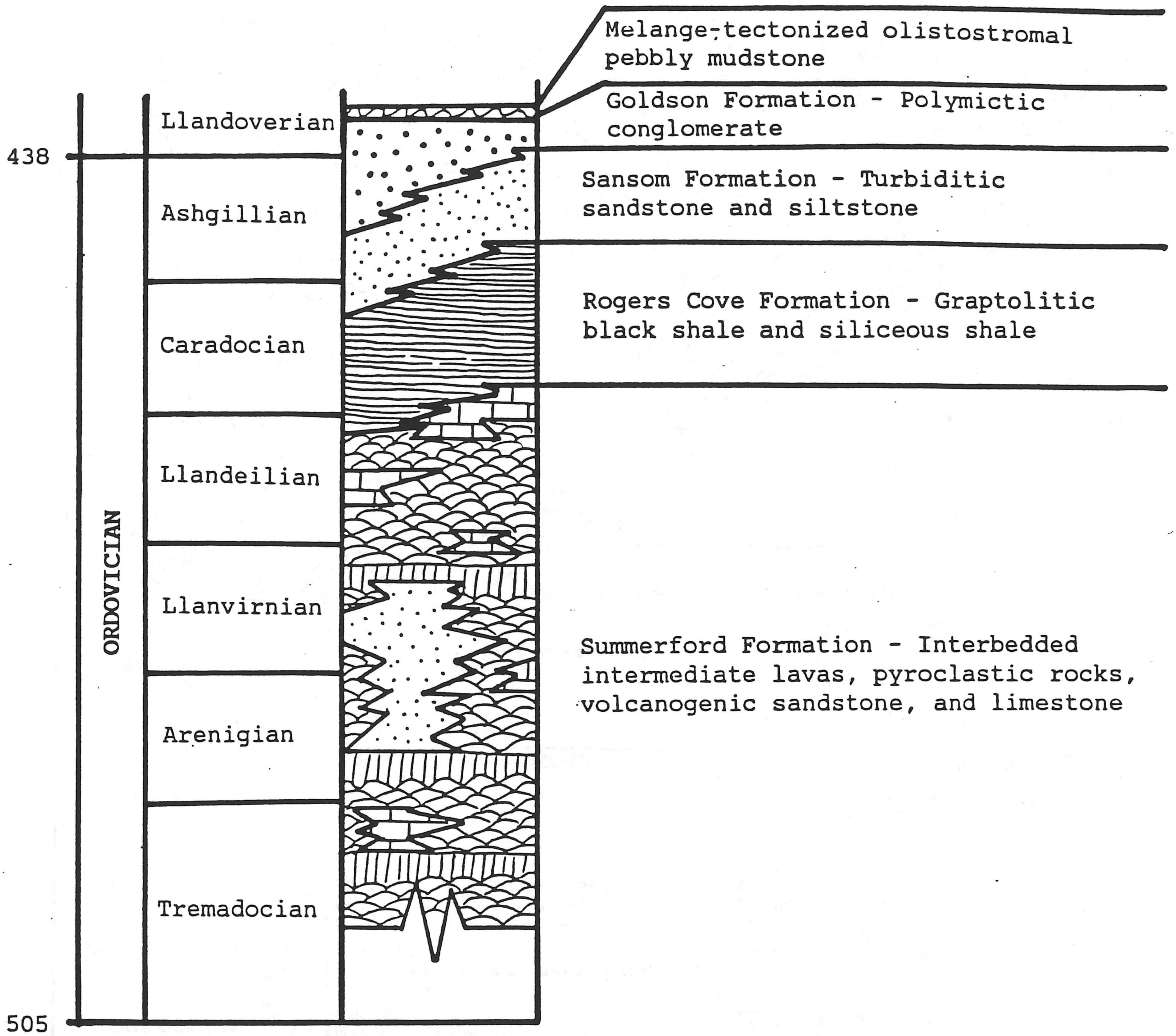


FIGURE 21: STRATIGRAPHY OF THE NEW WORLD ISLAND TERRANE. Time scale of Palmer (1983).

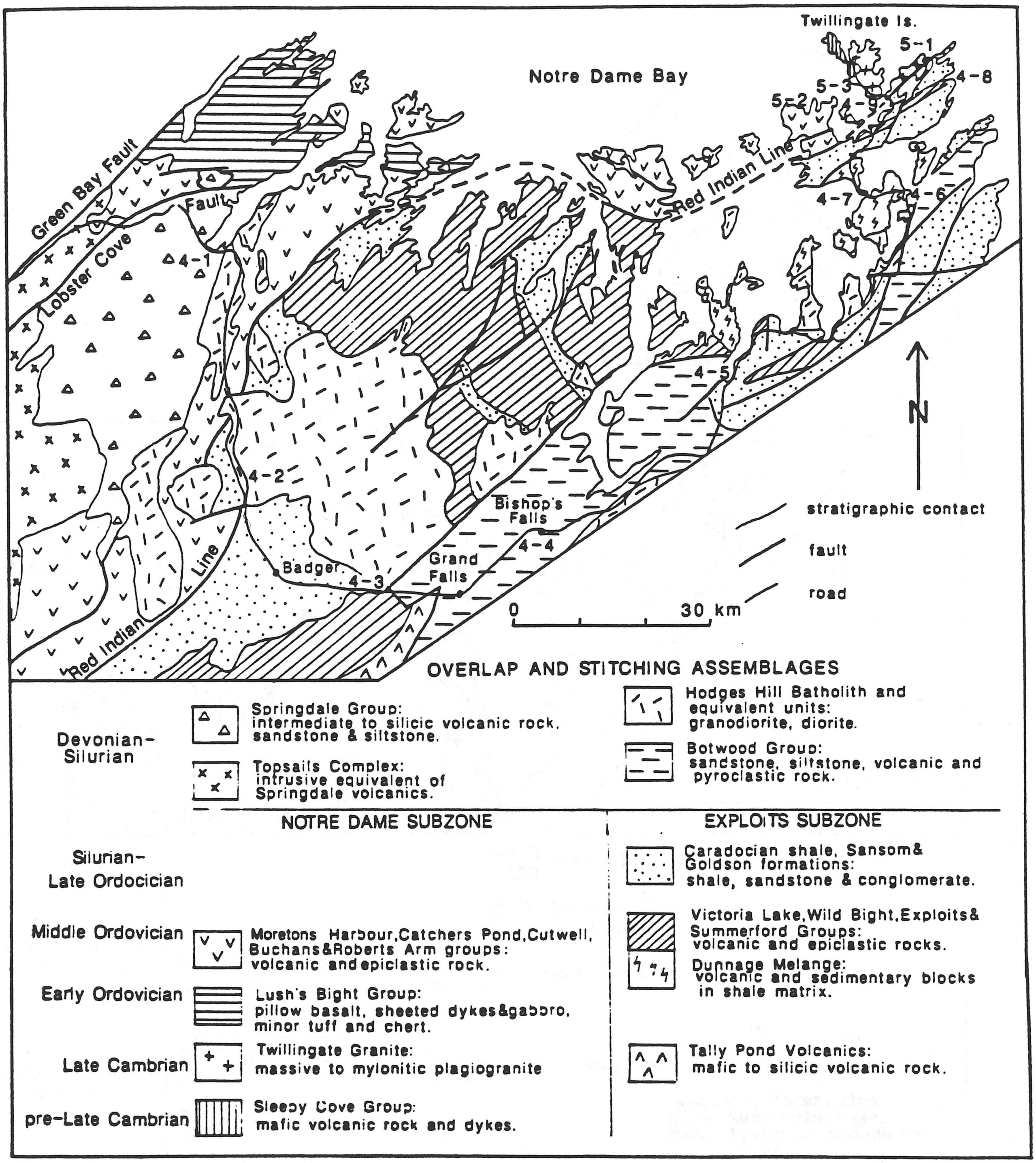


Figure 12: Simplified geologic map of Notre Dame Bay region

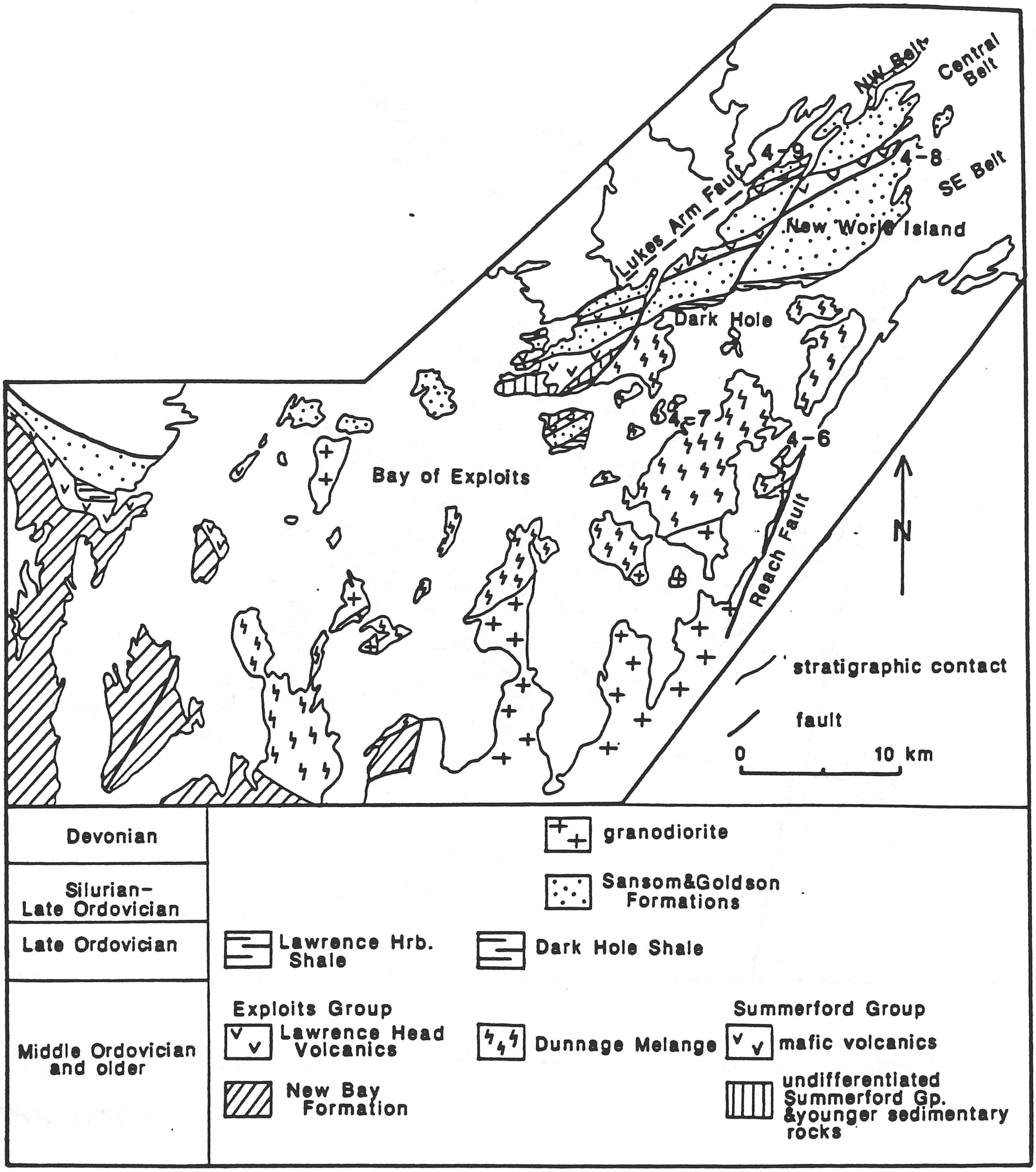


Figure 23: Simplified geologic map of the Bay of Exploits.

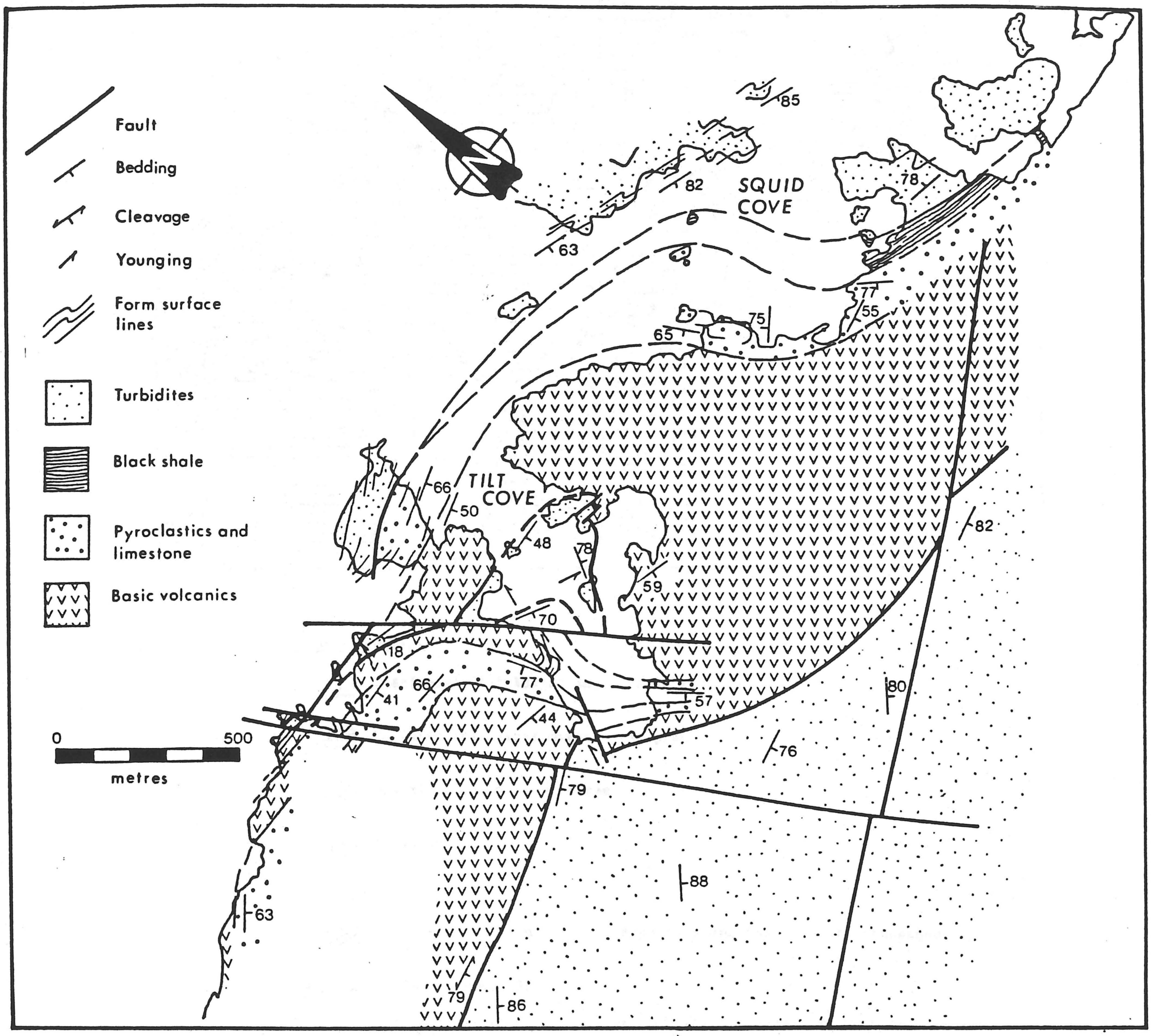
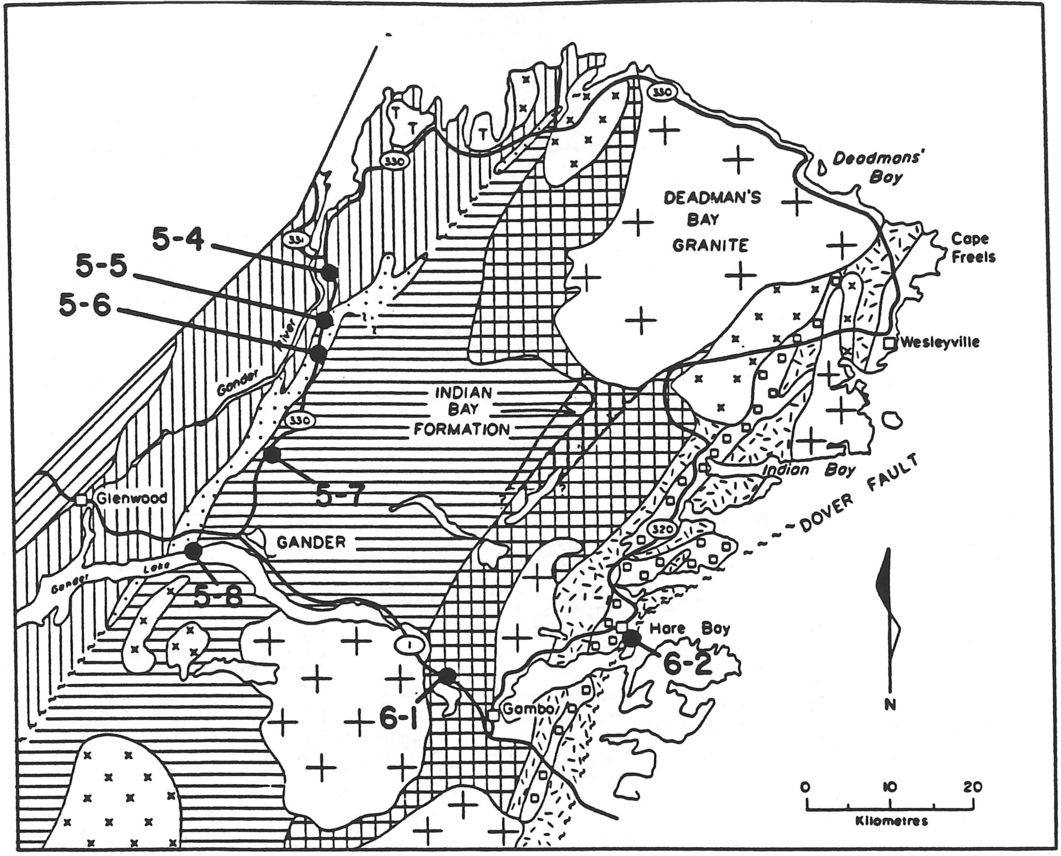


FIGURE 24: GEOLOGICAL MAP OF SQUID COVE (STOP 3.3) AND TILT COVE (STOP 3.4).



SILURO-DEVONIAN

Undeformed, K-feldspar megacrystic granite

Foliated K-feldspar megacrystic granite

Foliated, two-mica granites

Tonalite

SILURIAN

Botwood Group: Red and grey sandstone and shale; minor limestone

EARLY AND MIDDLE ORDOVICIAN

Davidsville Group: Siltstone and shale, greywacke, conglomerate and limestone

ORDOVICIAN OR OLDER

Gander Group: Psammite, semipelite, minor quartzite and volcanic rocks

Square Pond Gneiss: Psammitic and semipelitic paragneiss; minor schist and migmatite

Hare Bay Gneiss: Migmatite with paragneiss inclusions

EARLY ORDOVICIAN OR OLDER

Gander River Ultrabasic Belt: Pyroxenite, serpentinite, magnesite, gabbro, basalts, trondhjemite and volcaniclastics

Figure 25: Geology of the northeast Gander Zone (Gander Lake Subzone)

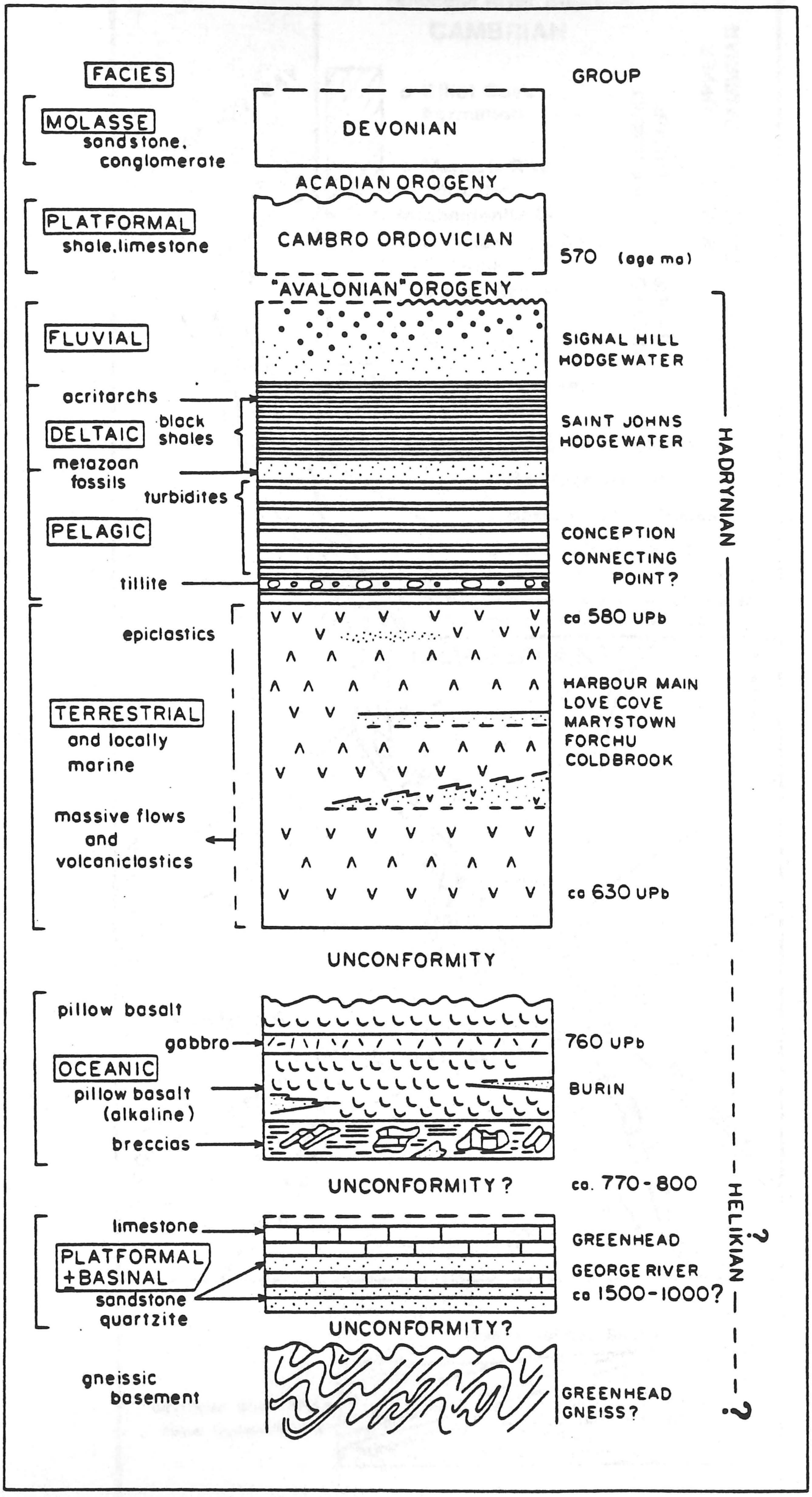


Figure 26: Schematic composite section showing major components of the Avalon Zone and related rocks in the Canadian Appalachians (from O'Brien et al., 1983).

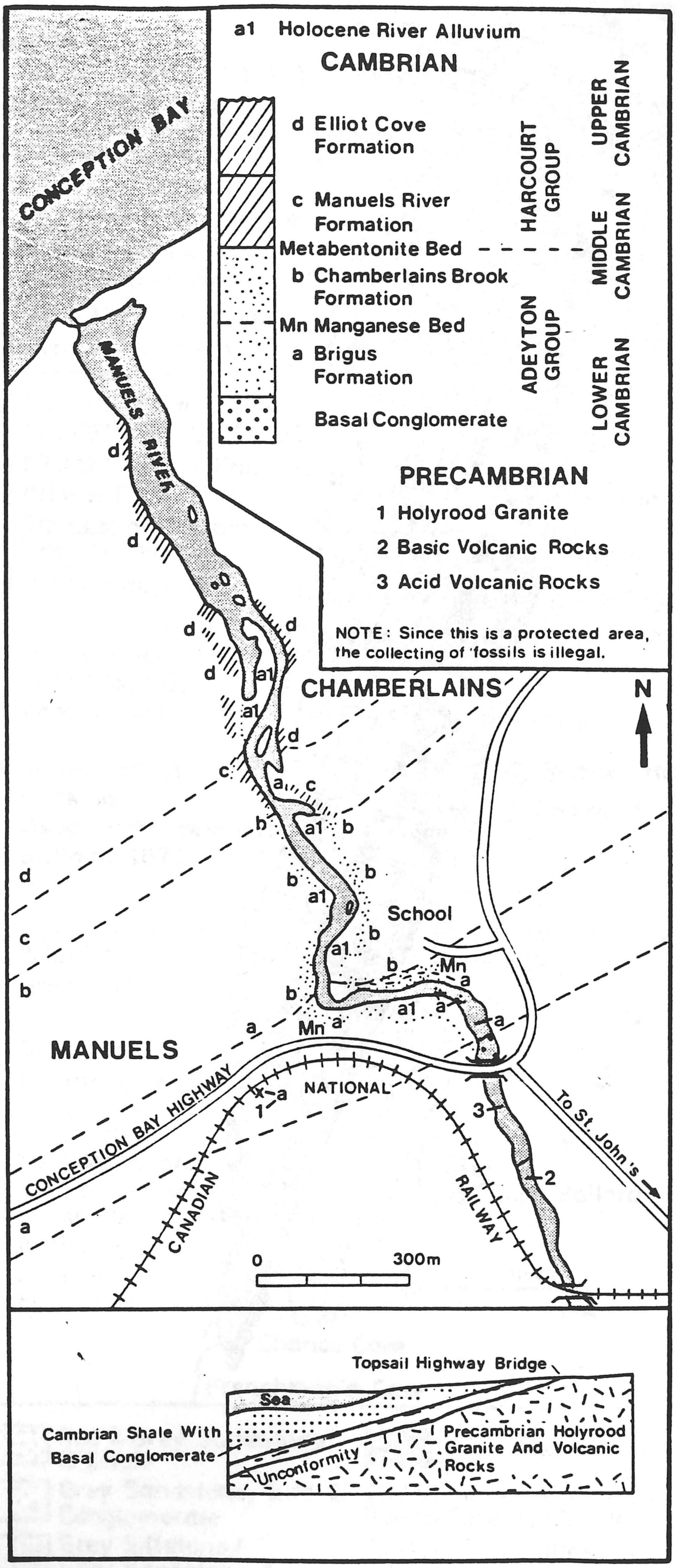


Figure 27: Geology map of Manuels River area.

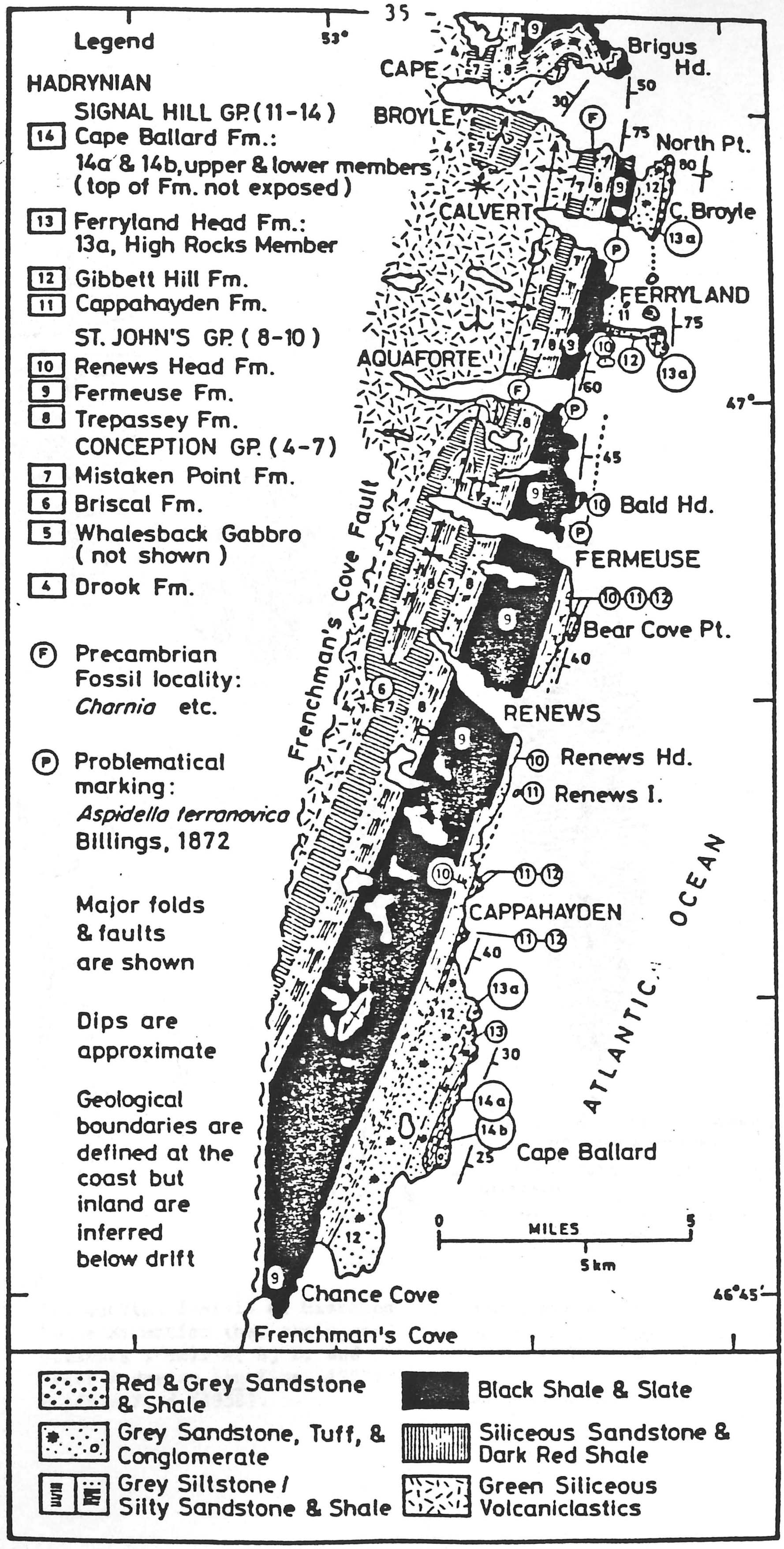
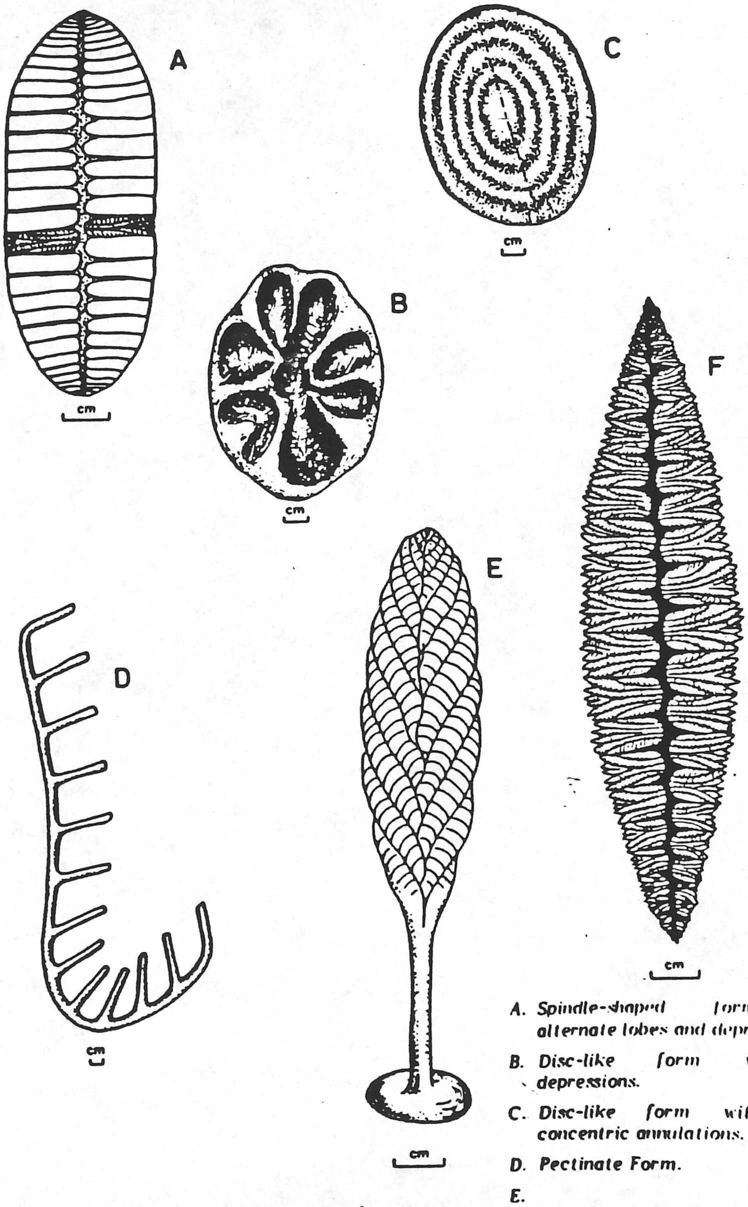


Figure 28: Geological map of the Cappahayden-Ferryland area (after King, 1982).



A. Spindle-shaped form showing alternate lobes and depressions.

B. Disc-like form with radial depressions.

C. Disc-like form with numerous concentric annulations.

D. Pectinate Form.

E. **Charnia masoni** Ford (1958).

F. Sp idle-shaped form showing alternate lobes and depressions (p

Figure 29: Precambrian fossils of Mistaken Point Formation (bar scale represents 1 cm). A, B, D, and F after Anderson (in King, 1982); E after Ford (1958).

SUNDAY 8-25				MONDAY 9-02		
Route	Miles	Cum		Route	Miles	Cum
Schenectady to Mass Pike	53	53		Flatwater to New World Is.	125	125
Mass Pike to I290, Auburn	99	152		Camp at Dildo Run	5	130
I290 to I495	23	175				
I495 to I95, NH border	62	237		TUESDAY 9-03		
I95 to Maine Pike	26	263		Route	Miles	Cum
Maine Pike to Bangor, Rte9	172	435		Dildo Run to Frederickton	88	88
Rte 9 to St. Stephen, NB	100	535		Camp at Indian Bay	90	178
St. Stephen to Campground	40	575				
				WEDNESDAY 9-04		
MONDAY 8-26				Route	Miles	Cum
Route	Miles	Cum		Indian Bay to Cape Freels	40	40
Rte 1 to Sussex, Rte2	60	60		Camp at Bellevue Beach	188	228
Rte 2 to Amherst, Rte 104	84	144				
Rte 104 to Truro	70	214		THURSDAY 9-05		
Truro to Port Hast., Rte 4	104	318		Route	Miles	Cum
Rte 4 to Battery Camp.	32	350		Bellevue to St. Johns	72	72
				Camp at LaManche	35	107
TUESDAY 8-27						
Route	Miles	Cum		FRIDAY 9-06		
Rte 4 to Rte 125, Sydney R	51	51		Route	Miles	Cum
Rte 125 to N. Sydney Ferry	17	68		LaManche to Mistaken Pt	65	65
FERRY TO NEWFOUNDLAND		6 hrs		Camp at Fitzgerald's Pond	130	195
Rte 1 to Rte 405	61	129				
Rte 405 to Highlands	7	138		SATURDAY 9-07		
				Route	Miles	Cum
WEDNESDAY 8-28				Fitzgerald's to Argentia	22	22
Route	Miles	Cum		FERRY TO NOVA SCOTIA		14 hrs
Highlands to Port aux Port	65	65		Hotel in Sydney	20	42
Camp at Piccadilly Head	13	78				
				SUNDAY 9-08		
THURSDAY 8-29				Route	Miles	Cum
Route	Miles	Cum		Rte 4 to Port Hastings	85	85
Pt aux Pt to Gros Morne	150	150		Rte 104 to New Glasgow	70	155
Camp at Lomond	10	160		Rte 6 to Amherst	95	250
				Rte 2 to Sussex, Rte 1	84	334
FRI & SAT 8-30 & 31				Rte 1 to Oak Bay Camp	106	440
Route	Miles	Cum				
Around Gros Morne				MONDAY 9-09		
Camp at Lomond				Route	Miles	Cum
				Rte 9 to Bangor	102	102
SUNDAY 9-01				Bangor to end of Maine Pk	172	274
Route	Miles	Cum		To I495	26	300
Gros Morne to Baie Verte	140	140		I495 to I290	23	323
Camp at Flatwater Park	25	165		I290 to Mass Pike	99	422
				Mass Pk to Schenectady	152	574
NOTE: ALL MILEAGES ARE APPROXIMATE SO DON'T GIVE ME ANY CRAP.						

NEWFOUNDLAND TRIP 8-25-91 TO 9-9-91

Reservations for North Sydney to Port aux Basques: 8-27-91 @ 1330*
RATES: van is $46.25
each person is $15.25 TOTAL: $168.25

Reservations for Argentia to North Sydney: 9-7-91 @ 0900
RATES: van is $99.00
each person is $41.00 TOTAL: $427.00

*Reservations are for the van and 8 people, under the name of Union College. The confirmation number for both trips is: TH1298PW. Phone: (800) 341-7981. We should arrive 1 hour before sailing.

Camping Reservations			Phone
8-25	Sun	New River Beach, NB	(506) 755-3804
8-26	Mon	Beaver Mountain, NS	(902) 863-3343
8-27	Tue	Highlands (Edmunds House)	
8-28	Wed	Piccadilly Head, NF	
8-29	Thu	Gros Morne, Lomond	(709) 458-2066
8-30	Fri	Gros Morne, Lomond	
8-31	Sat	Gros Morne, Lomond	
9-01	Sun	Flatwater Pond	
9-02	Mon	Dildo Run	
9-03	Tue	Indian Bay	
9-04	Wed	Bellevue Beach	
9-05	Thu	La Manche	
9-06	Fri	Fitzgerald's Pond	
9-07	Sat	Hotel, Sydney vicinity	
9-08	Sun	Oak Bay, NB	
9-09	Mon	Schenectady	

In general, reservations are not accepted at Provincial Parks in Canada. In most cases, the camping areas are not full and there should be no problem finding camping sites. There are no phone numbers for the Provincial parks in Newfoundland. Also, ask about fee waiver for universities. Some areas will let us camp for free.