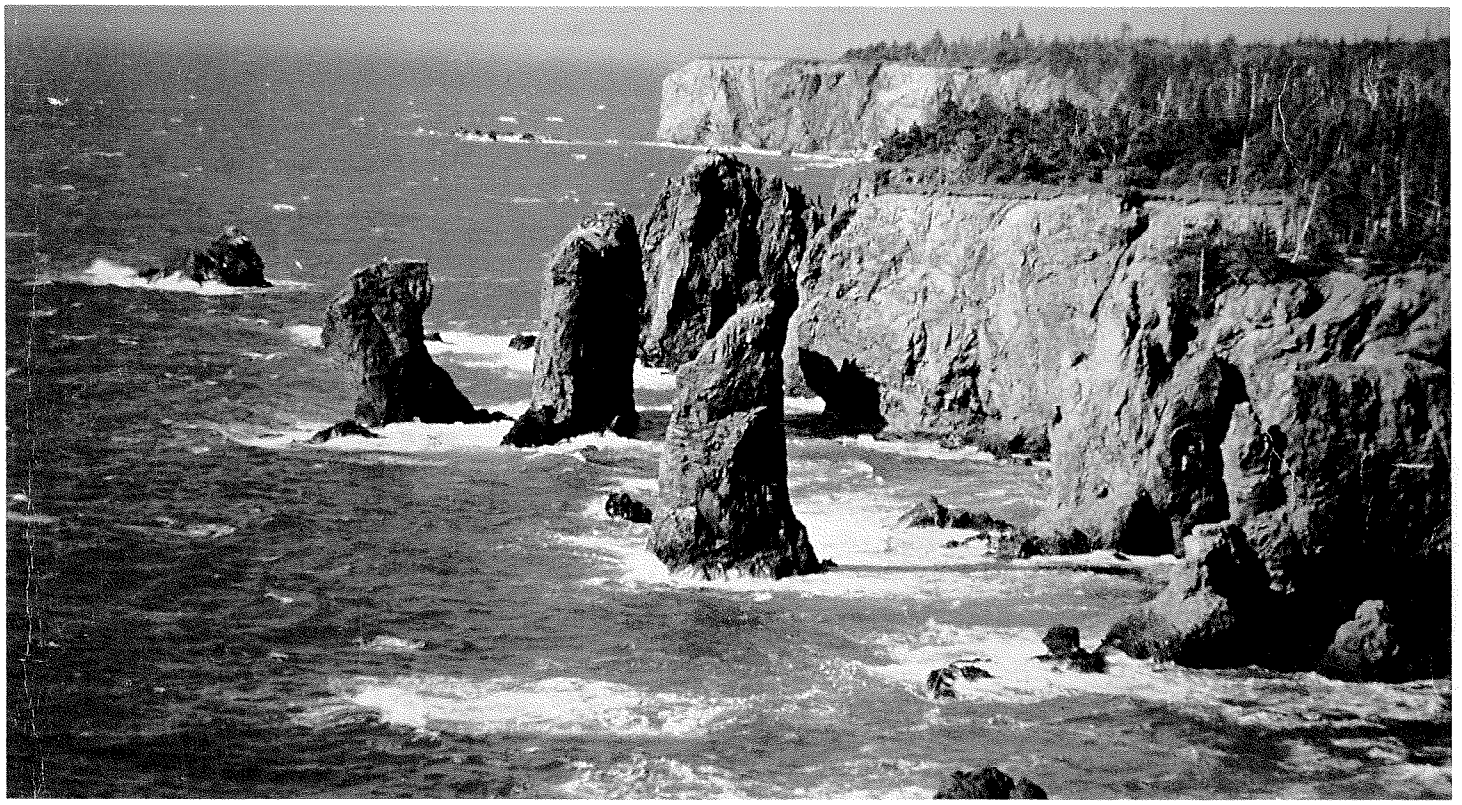
R. TAYLOR.

NATO Advanced Study
Institutes Programme

International Advanced Course on:

# Late Quaternary Sea-Level Correlation and Applications

Centre for Marine Geology
Dalhousie University, Halifax CANADA
July 19-30, 1987



# Quaternary Glaciations, Geomorphology, and Sea-level Changes: Bay of Fundy Region

July 20-26, 1987

In cooperation with
International Geological
Correlation Program
Project 200

R. B. TAYLOR.

NATO ADVANCED STUDY INSTITUTES PROGRAMME

INTERNATIONAL ADVANCED COURSE ON:
LATE QUATERNARY SEA LEVEL CORRELATIONS AND APPLICATIONS
HALIFAX, NOVA SCOTIA

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SYMPOSIUM FIELD TRIP
July 19 to 30, 1987

# QUATERNARY GLACIATIONS, GEOMORPHOLOGY AND SEA LEVEL CHANGES: BAY OF FUNDY REGION

R. R. Stea, Field Trip Co-ordinator

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Field Trip Leaders


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|---|---|
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| A. R. Kelley | University of Maine, Department of Geological Sciences, Orono, Maine, United States of America |
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IN COOPERATION WITH IGCP PROJECT 200

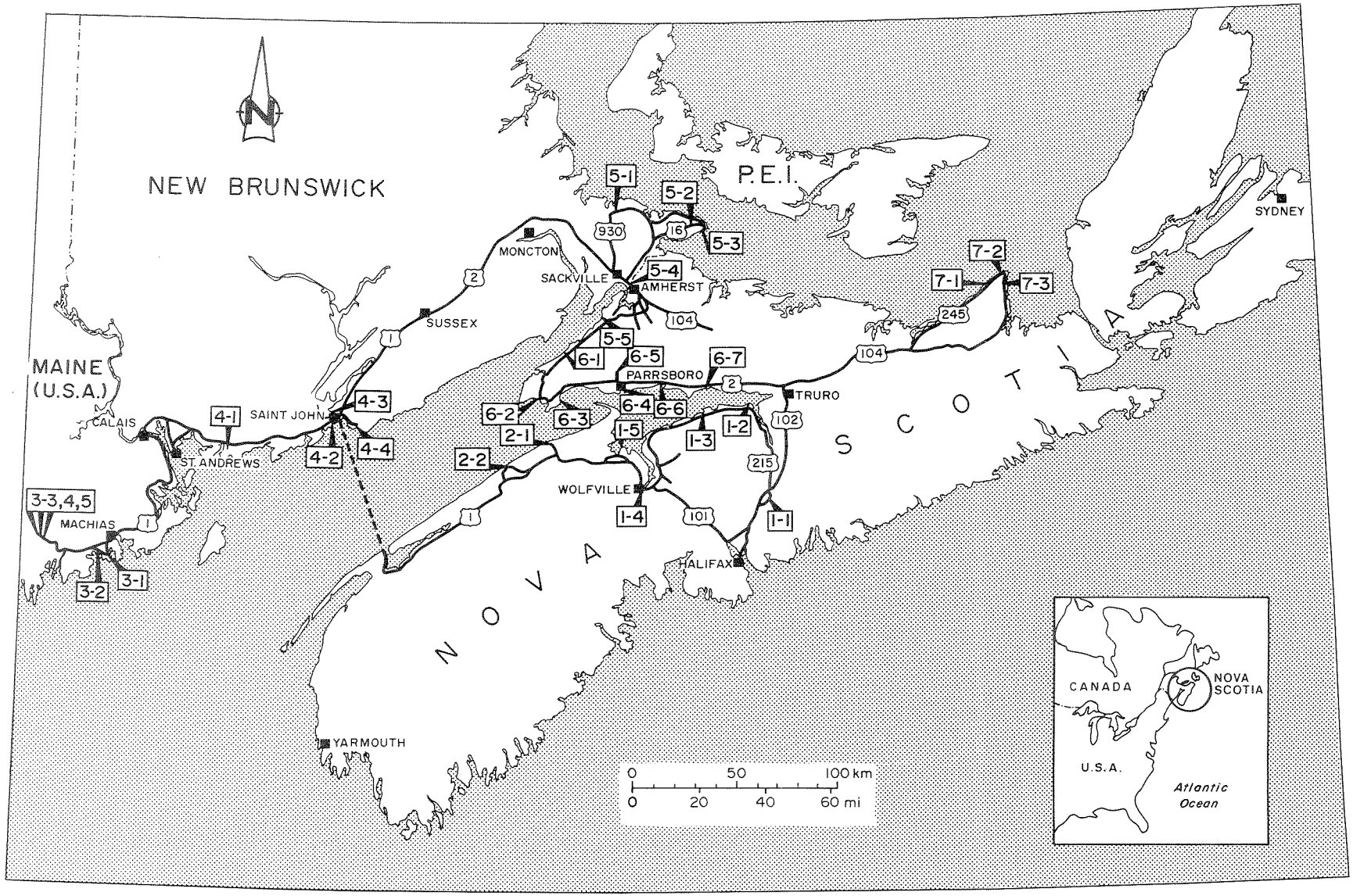


**Figure 1.** Route map of the field trip

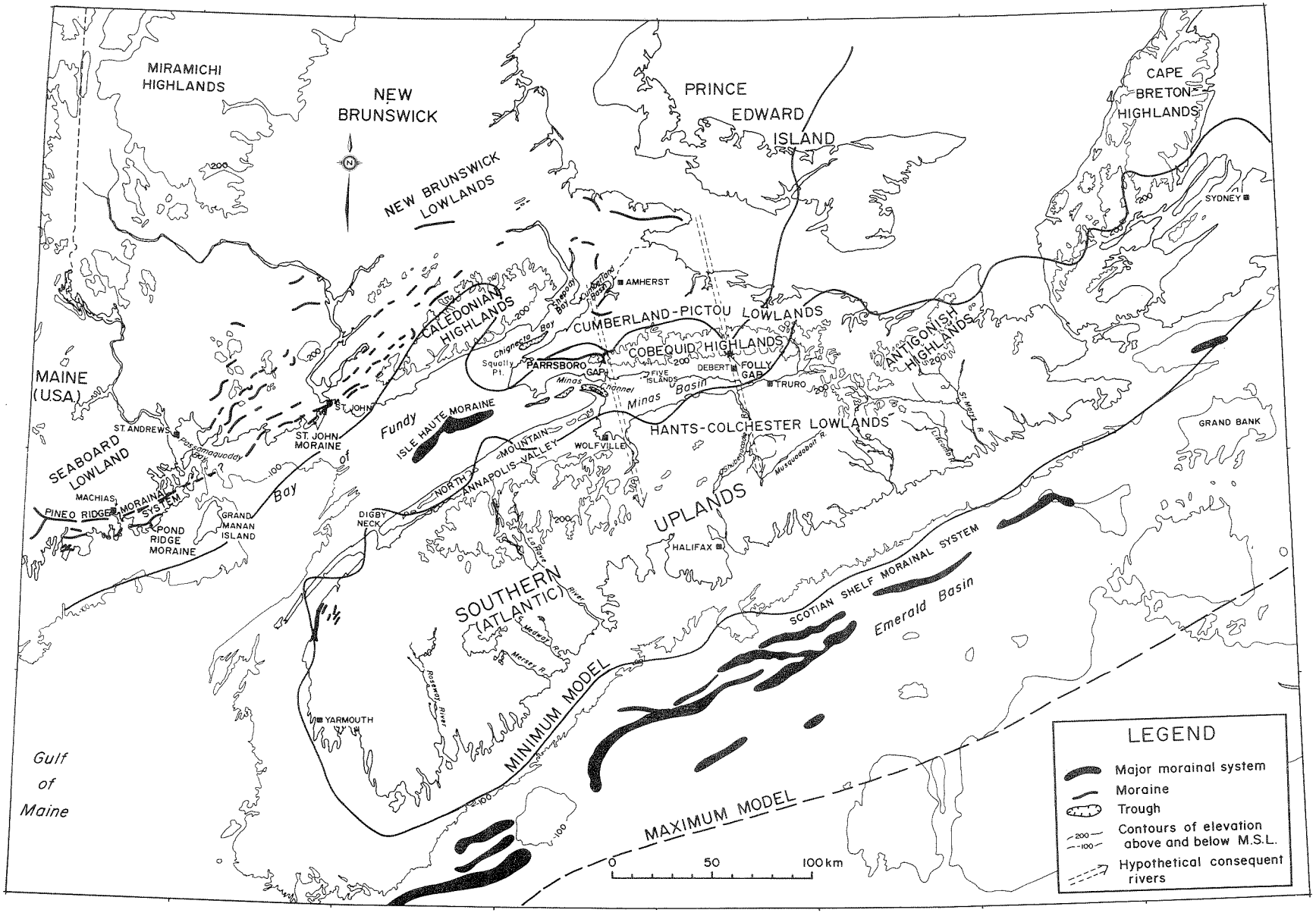


**Figure 2.** Physiography of the Bay of Fundy region showing moraines and maximum and minimum Late Wisconsinan ice configuration models for the Bay of Fundy region

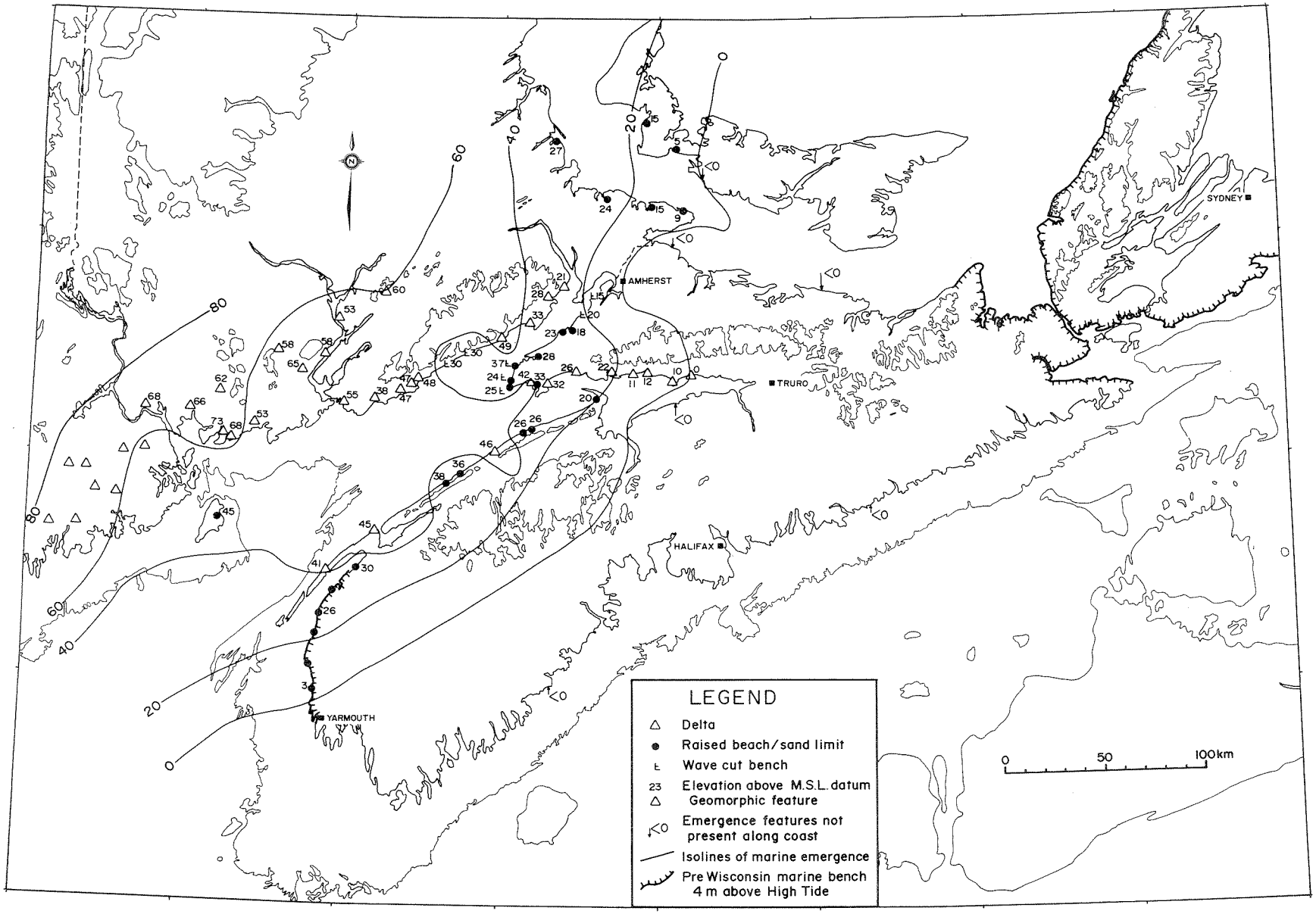


**Figure 12.** Plot of elevation isolines of raised marine features around the Bay of Fundy (data from Welsted, 1971; Grant, 1980; Kelley et al. 1986; Rampton et al. 1984; Wightman, 1980; Stea, 1983). Some data (Grant, 1980, Welsted, 1971) showing high water markers as datum were adjusted to mean sea level datum by using tide tables.

mi); turn right and follow the road for 6 km (3.7 mi); arrive at 1115 hr.

Introduction:

This site is a low coastal cliff at the tip of the Tormentine Peninsula. One metre (3.3 ft) of unaltered till above weathered bedrock is exposed. The modern intertidal rock platform is well developed on weathered sandstone bedrock.

**Stop 5-4. Fort Beausejour**

Leader: D. Scott

Purpose: To observe a complete marsh sequence at low tide and see the effects of sea level on dykes built by early Acadian settlers

Route: Leave Indian Point at 1130 hr; turn left onto Highway 16 at Cape Tormentine; travel south for 45 km (28 mi) and arrive at 1200 hr.

Introduction:

The French built Fort Beausejour in 1751 to defend their territories near the Bay of Fundy. In 1755 the British captured the fort and renamed it Fort Cumberland. It was abandoned in 1833.

The site exposes 12 m (39 ft) of marsh peat that can be examined at low tide. At extreme low tide, tree stumps embedded in glacial till are exposed at the base of the section (Fig. 40). These were dated at 4400 yr B.P. by Grant (1970). Scott and Greenberg (1983) reported a sea level curve for this site based on coring of the marsh. Remnants of the old Acadian dykes and wooden roads are covered by 1 m (3.3 ft) of marsh consistent with a steady 20-30 cm/century (8-12 in/century) rate of sea level rise.

Site description:

It is interesting to compare the stratigraphy gleaned from the drillholes with the exposed section (Fig. 40, 41). The sea level curve from this area (Fig. 42) shows the highest rate of RSL rise anywhere in the Bay of Fundy. The break in slope evident at most localities around 2500 yr B.P. is not as pronounced here as in other localities. The sea level curve from Baie Verte (Fig. 43) is stikingly different from this one and illustrates the complexity of the sea level record here, as pointed out by Scott et al. (1987).

**Stop 5-5. Joggins Section**

Leader: R. R. Stea

Purpose: To examine a type section of Quaternary till sheets showing changes in ice flow direction

Route: Leave Fort Beausejour at 1400 hr and proceed southwestward along Highway 104 for 10 km (6.2 mi); take Exit 4 to Nappan and travel south for 2 km (1.2 mi); turn right onto Highway 302 and follow for 4 km (2.5 mi); turn right on Highway 242 and follow for 10 km (6.2 mi); turn left along shore road for 1 km (0.6 mi); arrive at 1430 hr.

Introduction:

The Joggins section is located at the mouth of McCarron Brook, south of the town of Joggins (Fig. 44). Joggins is famous for its 'fossil cliffs' containing an abundance of Carboniferous plant and animal fossils. Fossil lycopods of tree size are exposed in life position in the cliff faces. Coal was discontinuously mined at Joggins from the 1700s to the mid-1900s.

Wickenden (1941) and Prest et al. (1972) described the Joggins section and found a 20 m (66 ft) section with 3 tills. The tills are distinctly reddish, grey and yellowish. Wickenden proposed that the tills may represent different glaciations or they were formed by lobes of ice advancing from different directions. Prest et al. (1972) attributed the distinct tills to fluctuations in south-southwest flowing ice. Stea et al. (1985) studied the lithology and geochemistry of the section and determined that Wickenden's second hypothesis was more tenable. The section records two Wisconsinan ice flow events (Ice Flow Phases 1 and 2; Fig. 5) that influenced the entire Bay of Fundy region.

Site description:

The stratigraphy and lithology of the section is given in Figure 45. The lowest till

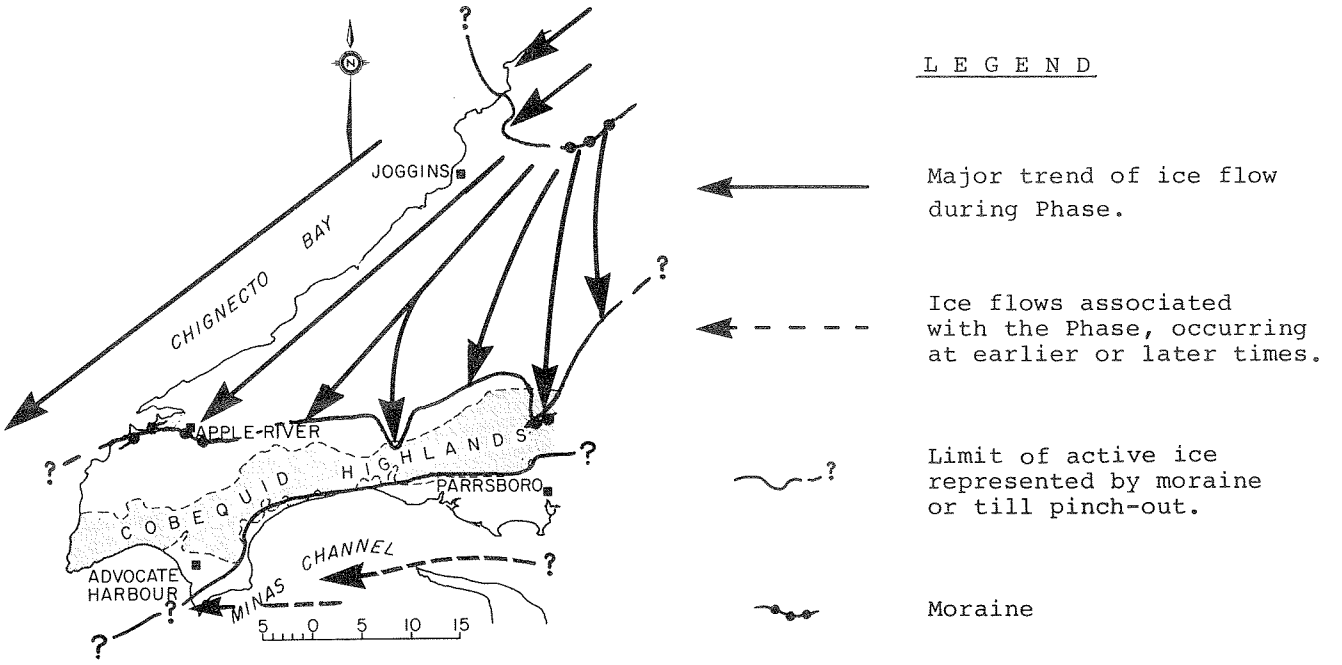


**Figure 39.** Ice retreat positions during the Late Wisconsinan in the Chignecto Peninsula area

(Unit I) is characterized by reddish hues and a high percentage of allochthonous clasts, particularly chloritized, foliated granitoid clasts, maroon siltstones and reddish brown sandstones. This lithological assemblage is consistent with a New Brunswick-Caledonia Highland provenance (J. H. Calder, personal communication, 1983). The unit overlies a bedrock surface with striations trending 110°. A zone of jointing and manganese oxide straining suggestive of alteration by soil processes is located at the top of Unit I.

The upper till units (II and III) are characterized by a predominance of locally derived sedimentary clasts. Unit II has a consistently high percentage of coal and pelecypod limestone derived from coal seams outcropping at Joggins, northeast of the section. Unit III is differentiated by its yellowish colour which is due to the high content of weathered sandstone clasts and sideritic concretions.

Unit I appears to have been deposited by eastward flowing ice. The marked increase in orange mudstones and poorly sorted sandstone clasts upsection in Unit I implies a change in ice flow towards the southeast. Till fabric in the lower part of Unit I is parallel to the underlying eastward trending bedrock striations (Fig. 45).

Units II and III reflect a local provenance. The lithological assemblage of Unit II implies that it was formed by a southwest ice flow that was funnelled into the Bay of Fundy. The lithological assemblages of Unit III cannot be used to determine provenance because of the uncertainty of source rock areas. The fabric of Unit III, however, suggests that it was also deposited by southwest flowing ice (Stea, 1983).

## DAY 6 - CHIGNECTO PENINSULA (JULY 25)

### Stop 6-1. Clam Cove

Leader: R. R. Stea and P. W. Finck

Purpose: To examine the type section for beach deposits of the Five Islands Formation, exposed 23 m (76 ft) above MSL

Route: Leave Sackville at 0800 hr and follow same route to Joggins as for Stop 5 of Day 5; follow shore road for 27 km (16.8 mi); turn right on logging road and travel for 2 km (1.2 mi); a walk may be necessary depending on road conditions; arrive at 0845.

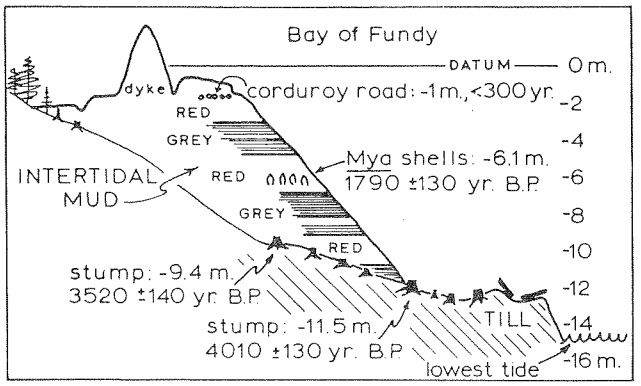


**Figure 40.** Cross-section through Bay of Fundy coast deposits exposed at low tide near Fort Beausejour, New Brunswick, showing submerged forest of stumps and logs rooted in glacial till covered by intertidal salt marsh mud (from Grant, 1975)

Introduction:

The type section for the raised beach deposits of the Advocate Harbour Member is at Clam Cove, along Chignecto Bay (Fig. 46). This coast is characterized by raised beaches attaining a maximum elevation of 37 m (121 ft) above MSL at Squally Point (see cover photo, Fig. 2). The Squally Point site reveals a cliffed rhyolite face truncated on top overlain by 5 m (16 ft) of beach sand and gravels. The altitude of this paleoshore decreases from 37 m (121 ft) to 0 m (0 ft) from the mouth to the head of Chignecto Bay, respectively. The pattern of marine limit, specifically its decrease up the bay, suggests that marine incursion may have been delayed by a retreating ice lobe. Evidence of this retreating ice will be noticed as we pass by Apple River (Fig. 39). The hummocky topography is a result of wasting ice at the margin of a northeastward receding ice mass. Figure 39 shows the inferred stages of this recession and the morainal stands.

The north coast of the Minas Basin east of the Minas Channel has no raised beaches, but extensive outwash plains grading into glaciomarine deltas. This implies that the Minas coast became ice free sometime after the Chignecto Bay coast due to residual ice in the Minas Basin.

Site Description:

Gullying along a logging road reveals a transition of surficial deposits from unaltered stony till to raised beach deposits. The facies consist of a beach berm with rounded stones, to upper shoreface marine sands. The berm ridge can be traced in an arcuate pattern paralleling the modern shore. It reaches an elevation of 23 m (76 ft) above MSL along the logging road. No fossils have as yet been recovered from this site.

## Stop 6-2. West Advocate and Advocate Harbour

Leaders: R. R. Stea, D. M. Wightman

Purpose: To investigate the contact between Advocate Harbour Member sediments (raised beach) and earlier deltaic deposits (Saints Rest member)

Route: Leave Clam Cove at 1030 hr and follow road south for 29 km (18 mi); turn right to West Advocate; turn at first farm road on right; arrive at 1100 hr.

Introduction:

At this scenic stop we will visit the farm of Charles and Donna Reid (Fig. 47). A beach ridge is developed on a delta surface that is located behind the barn. The boundary of two physiographic regions, the Hants-Colchester Lowlands and the Cobequid Highlands (Goldthwait, 1924), can be seen from the upper terrace. The lowlands are composed of Late Carboniferous and Triassic sedimentary rocks, and the highlands are composed of metamorphic and igneous rocks of Hadrynian to Early Carboniferous age (Fig. 3). The highlands are segregated into numerous fault blocks and are bounded on the south by the Glooscap Fault (Donohoe and Wallace, 1978). The fault runs through the northern part of the upper terrace on Charles' property and eventually forms a sea cliff that faces the Minas Channel.

Two genetically distinct gravel deposits are exposed in the Advocate Harbour area. The Saints Rest Member forms a discontinuous fluvial terrace (proglacial delta) from West Advocate east to Spicer Brook (Fig. 47). The fluvial topset beds are underlain by foreset beds of a delta. The fluvial gravel attains a maximum elevation of 47 m (134 ft) in West Advocate Harbour where it overlies and grades into a purple Carboniferous conglomerate.

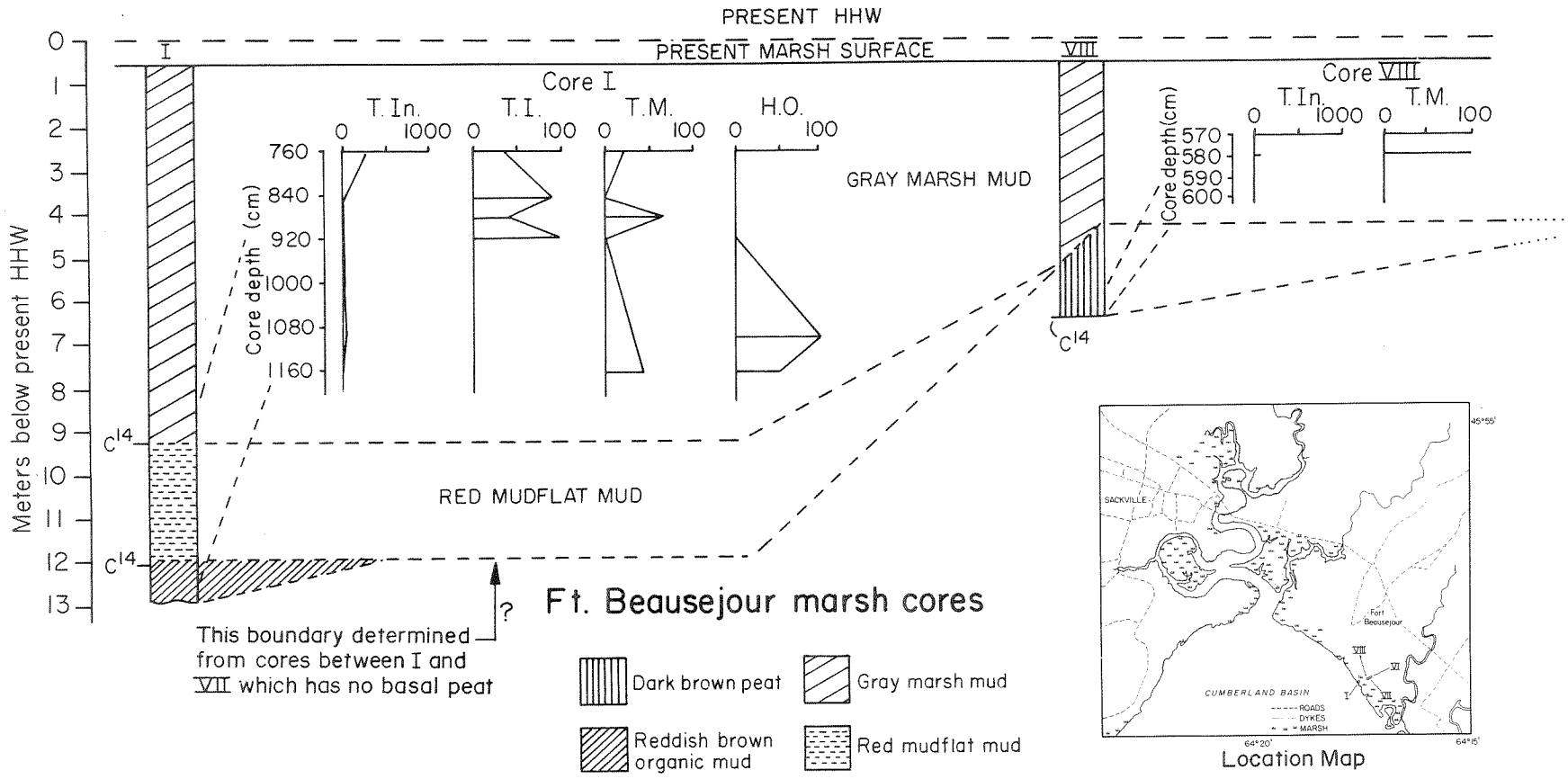


**Figure 41.** Location and core stratigraphy, Fort Beausejour

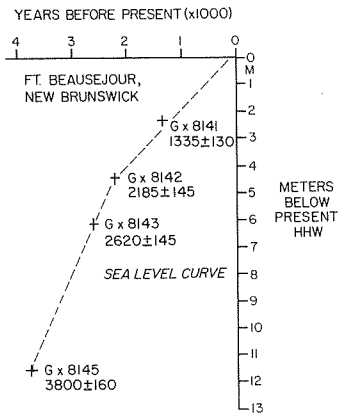


**Figure 42.** Sea level curve for Fort Beausejour

The fluvial terrace is overlain by marine sediments of the Advocate Harbour Member at an elevation of approximately 35 m (115 ft). This contact is represented by a beach berm behind the barn (Fig. 49). These sediments form a raised marine plain which extends 6 km (3.7 mi) (Fig. 47). The Advocate Harbour Member pinches out against Triassic bedrock to the west. To the east the marine gravel and sand is overlain by modern salt marsh.

A raised beach (Swift and Borns, 1967; Wightman, 1980) with an elevation of 29 m (95 ft) forms a ridge on the marine plain in Advocate Harbour (Fig. 47). A second ridge (elevation 35 m; 115 ft) which occurs on the marine plain in West Advocate is also interpreted as a raised beach.

Site Description:

The upper terrace on the Reid's farm reveals the contact between topset cobbly-gravelly sand beds and foreset beds. This deposit is interpreted as a proglacial delta. Descending from the upper terrace we cross a berm ridge which reveals beds of clean gravel, cobble-gravel and sand dipping seaward at 5-10°. Gravel-sized clasts in the raised beach are generally tabular or spheroidal shaped. A trench revealing red and grey stony clays (interpreted to be marine) occurs below the beach in the lower part of the farm.

If there is time, a stop will be made in the gravel pit at Advocate Harbour. Wightman (1980) defined two units in this pit, namely a lower unit representing subtidal to supratidal facies of the littoral zone, and the top unit (composed mainly of coarse gravel) defining the storm ridge of the beach. Wightman (1980) determined that the tidal range during the deposition of these facies was 3.4 m (11 ft).

## Stop 6-3. Spencers Island

Leaders: R. R. Stea, D. M. Wightman

Purpose: To observe a Gilbert-Type delta that has been dated at 14,300 - 12,600 yr B.P.

Route: Leave Advocate Harbour at 1300 hr and follow Route 209 for 10 km (6.2 mi); turn right on shore road at Spencers Island; arrive at 1315 hr.

Introduction:

The Spencers Island section is located 3 km (1.9 mi) east of Advocate Harbour (Fig. 48). The Indian name for Spencers Island means "a small kettle" which is what the island resembles. During the heyday of the wooden sailing ships in the late 1800s the mystery ship the Mary Celeste was built in Spencers Island. In November 1872, it left New York bound for Genoa. Ten people were on board, including the Captain's wife and daughter. Some weeks later a Nova Scotia vessel, the Dei Gratia, came upon the Mary Celeste which

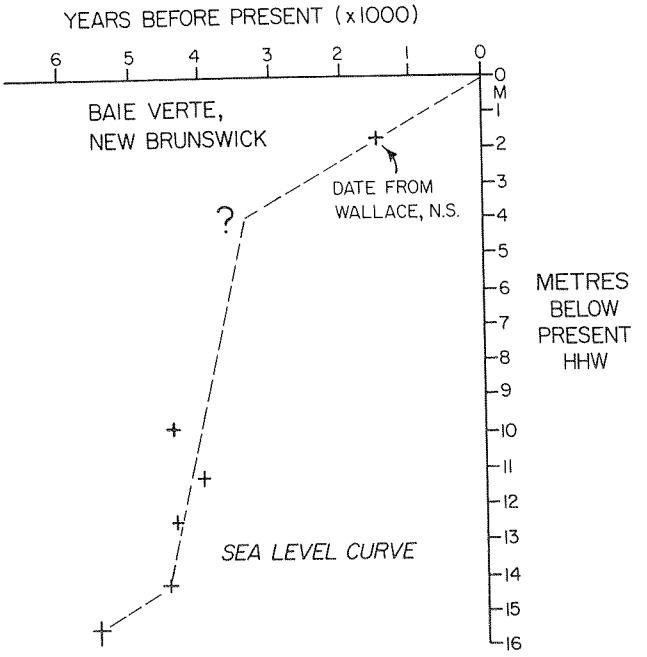


**Figure 43.** Sea level curve for Baie Verte

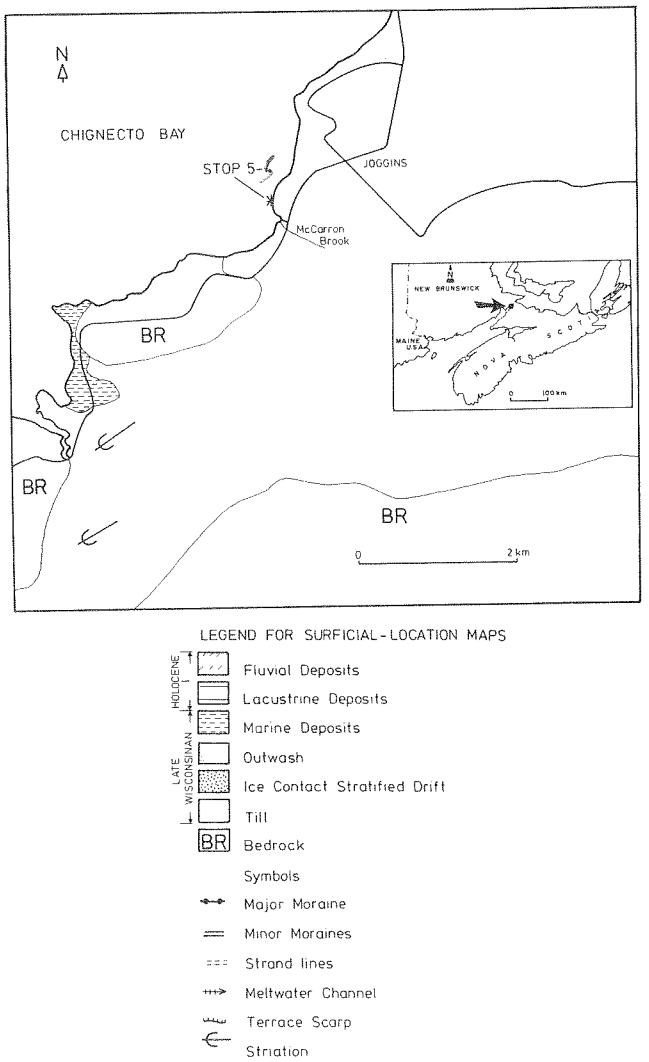


**Figure 44.** Location and surficial geology of Joggins at Stop 4 on Day 5

was sailing erratically. When the crew boarded her they found no one aboard but all sail was set and not a rope was out of place. The sewing of the Captain's wife was laying beside her seat. There was no evidence of looting. What happened to the crew of the Mary Celeste remains a mystery to this day.

This is the only section of the Five Islands Formation that has been dated and the first direct indication of the age of deglaciation at the head of the Bay of Fundy. The Five Islands Formation encompasses glaciofluvial and glaciomarine sediments that form raised and terraced outwash plains and deltas along the north shore of the Minas Basin. The deltas mark prominent ice marginal stand positions from the retreat of the Late Wisconsinan glaciers (Wightman, 1980). Three AMS radiocarbon dates were obtained from 3 samples of periostracum collected by D. M. Wightman. These are 14,300 ± 320 yr B.P. (Beta-12858), 12,600 ± 270 yr B.P. (Beta-12859) and 13,450 ± 300 yr B.P. (Beta-13728). The dates show a significant range. The error margin is given as one standard deviation from the mean or 68% probability. A Z-test of significance between the oldest and youngest dates shows that they are not the same. Tests between the two outlying dates and the middle date show that there is only a 3% probability that either the oldest or youngest dates could be the same as the middle date.

Site Description:

The Spencers Island section has a Gilbert-type delta profile with till at the base grading upwards into a massive clay diamiction. On top of the diamiction are rythmically bedded fine grained bottomset beds overlain by planar, steeply dipping forecut beds and thin, horizontal topset beds (Fig. 49). The topset beds were interpreted by Wightman (1980) as a subaerial outwash. They are distinctively yellowish brown, massive to crudely bedded, and consist of medium to coarse gravel with a sand matrix. The topset beds form part of extensive outwash plains that rim the Minas Basin coastline (Fig. 6). The outwash was termed the Saints Rest Member of the Five Islands Formation by Swift and Borns (1967). The marine deltaic foreset and bottomset beds, as well as regressive beach and sublittoral gravel deposits in the Advocate Harbour area, were named the Advocate Harbour Member by Swift and Borns (1967; Fig. 6).

Fossil bivalve molds were found in the bottomset rhythmites and the massive clay beds. The carbonate shell material was eroded leaving the periostracum, composed of a resistant material known as conchiolin. This material was dated. The most common mold was that of Portlandia arctica (Gray). F. J. E. Wagner (personal communication, 1975) postulated a glaciomarine paleoenvironment for the bivalve

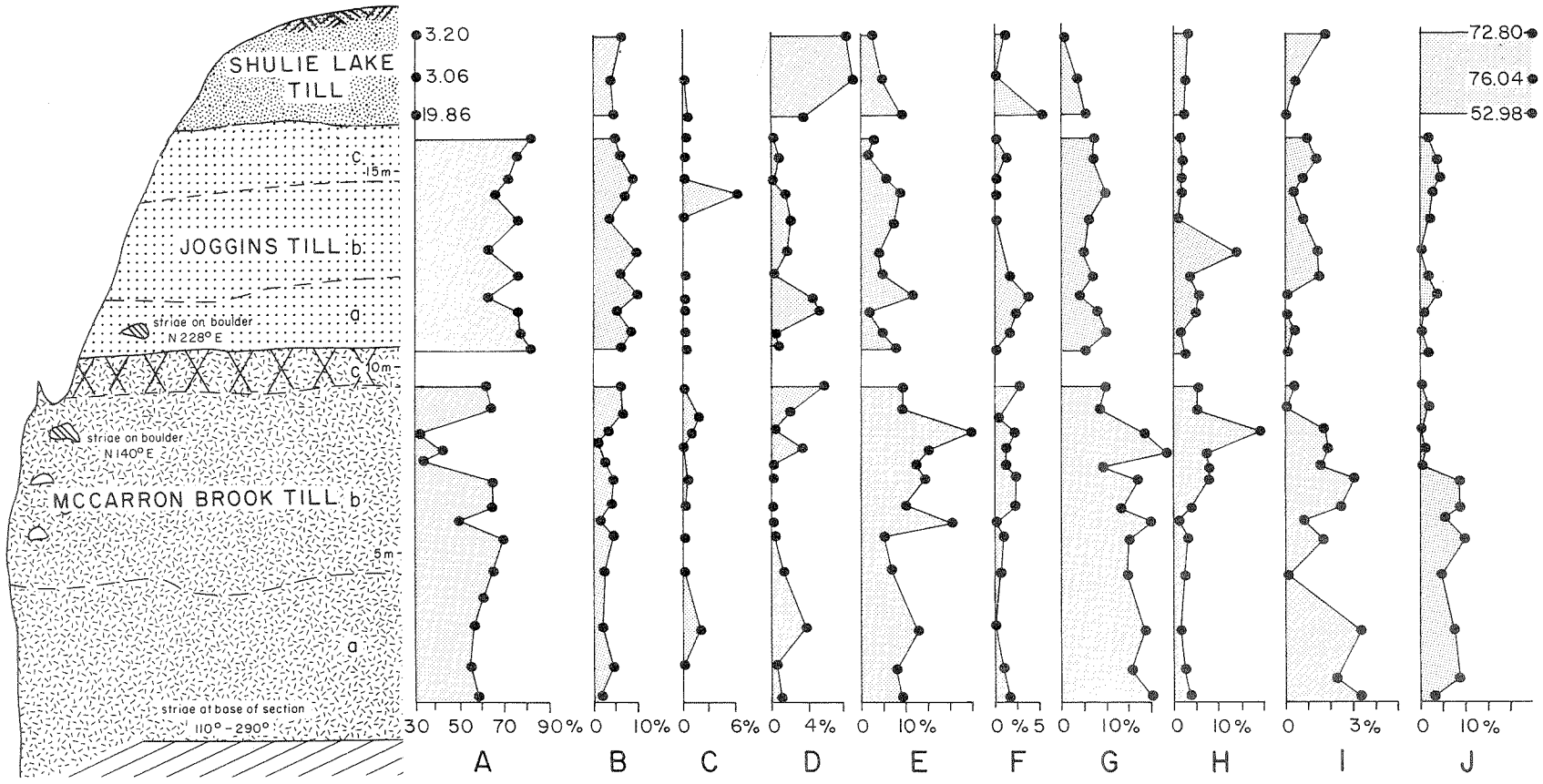


**Figure 45.** Stratigraphy and vertical variation in pebble lithology of McCarron Brook Till section. A - grey sandstone, B - coal, C - pelecypod limestone, D - sideritic sandstone, E - coarse sandstone, F - limestone, G - brown argillite, H - red-brown argillite, I - igneous, metamorphic rocks, J - weathered sandstone.

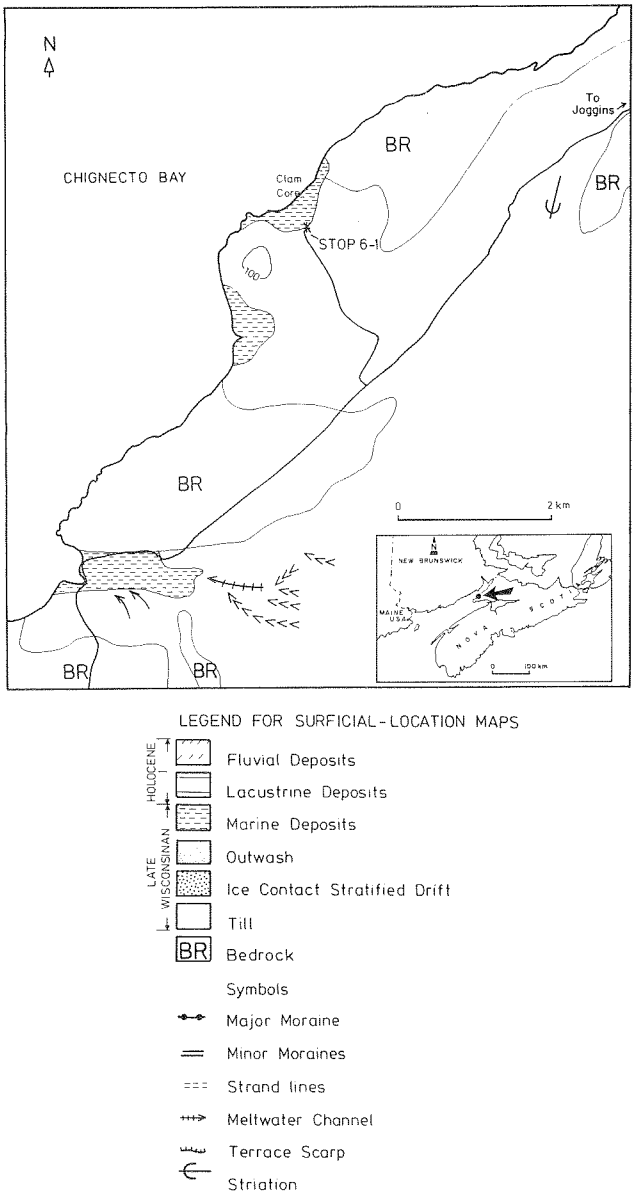


**Figure 46.** Location and surficial geology of Clam Cove at Stop 1 on Day 6

assemblage. The assemblage is considered in situ because of the excellent condition of the molds.

The dates on the shell material record much of the time elapsed during the deposition of the Five Islands Formation. The 1700 yr range of the shell dates probably reflects the difference in age between shells collected from the massive clay unit and the rhythmites. If the shells were derived only from the rhythmite unit it would be unlikely that such an age range would have been produced. Wightman (1980) interpreted the rhythmites as varves, and measured 60 yr of deposition at the section. He based the interpretation on the rhythmic nature of the sediment couplets and the absence of Bouma sequences. If these rhythmites are distal turbidites and not varves, however, the beds may record a much longer period of time.

The massive clay diamicton unit beneath the rhythmites formed first by deposition under ice shelf or in calving bay conditions, or by a readvance of grounded ice. The time of formation is estimated around 14,500 yr B.P. These conditions prevailed as sea level rose and the grounded ice lifted in the Minas Channel. Sea level rise and the formation of a calving bay caused the ice margin to recede landward to the adjacent Cobequid Highlands and into the Minas Basin.

The rhythmites represent bottomsets of a distal deltaic deposit that probably formed in the period from 13,400 to 12,500 yr B.P. During this time the ice stood at or near the mouths of major valleys in the Cobequid Highlands and on the highlands (Ice Margin 1, Fig. 6). If the varve hypothesis is correct then the delta may have formed well after initial 'lift-off' of the ice because only 60 yr of deposition are recorded within the section. The coarser deltaic foreset and outwash fan or topset sediments then prograded over the deeper water rhythmites.

### Stop 6-4. Parrsboro Terraces

Leaders: R. R. Stea, D. M. Wightman

Purpose: To examine terraces on the Parrsboro delta showing evidence for emergence

Route: Leave Spencers Island at 1430 hr; proceed along Highway 209 for 32 km (19.9 mi) to the junction of Highway 2; turn right and travel for 1 km (0.6 mi); arrive at 1500 hr.

Introduction:

The town of Parrsboro (population 1,799) is the largest on the Minas Basin shore (Fig. 50). It is the site of the Rockhound Roundup, an annual event which sees the gathering of rockhounds from all over North America. They

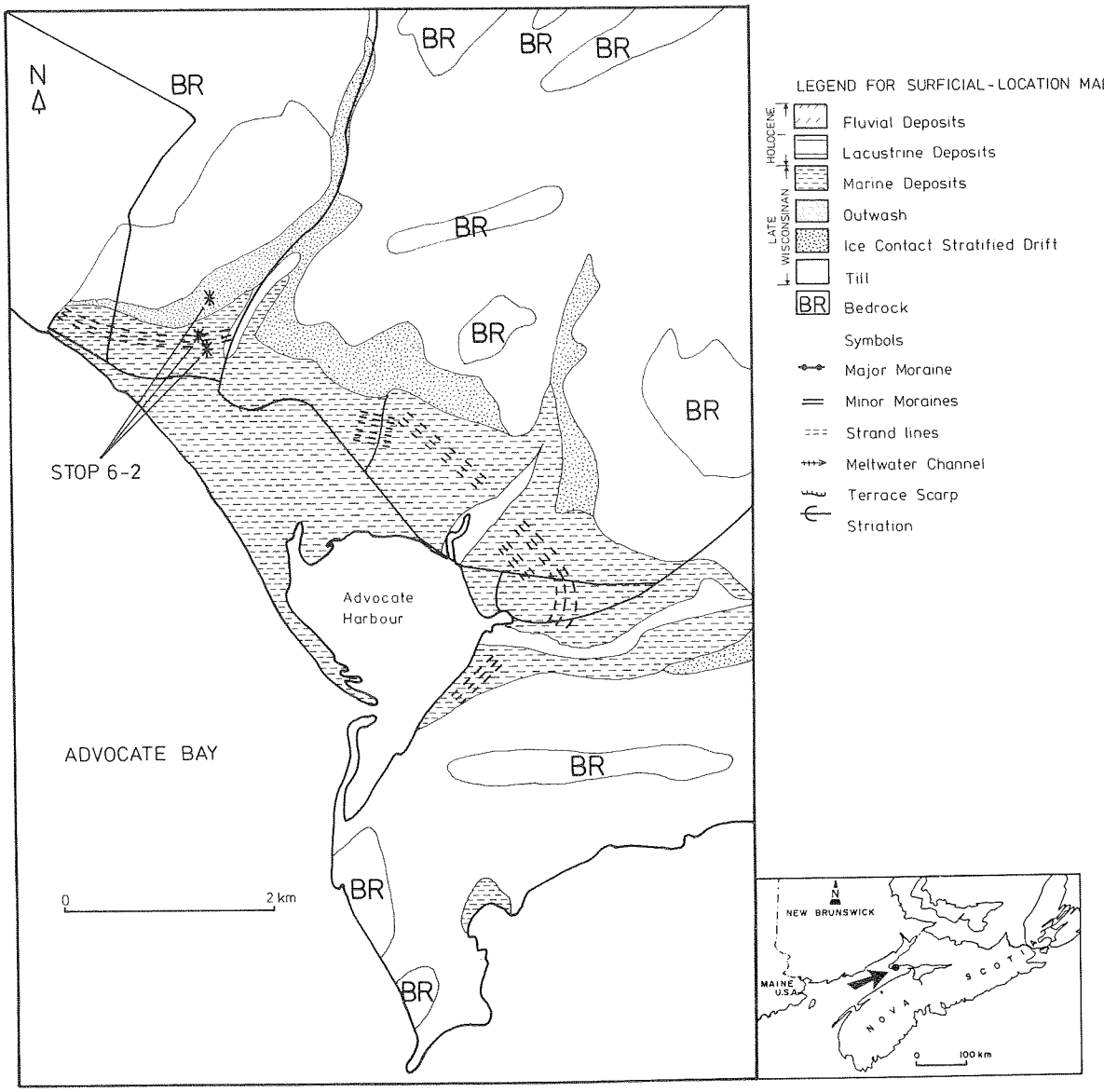


**Figure 47.** Location and surficial geology of Advocate Harbour at Stop 2 on Day 6

come to search for agate, amyethyst and zeolites found in the Triassic and Jurassic basaltic and sedimentary rocks outcropping along the shores (Fig. 3). A local amateur geologist, Eldon George, discovered fossilized footprints of Trithelodon (one of the early dinosaurs) in the red Triassic sandstones. Geologists from the United States have recently made a spectacular find of the bones of many dinosaurs of this period in the Parrsboro area, providing a possible link between early dinosaurs and early mammals.

Parrsboro is located on a large outwash plain and delta that has been dissected into a number of terraces (Fig. 50). Goldthwait (1924) originally interpreted these terraces as fluvial in origin, as they parallel the present course of the Parrsboro River. The first stop is a vantage point looking over the Parrsboro River. The second stop (time permitting) will be along one of three terrace scarps preserved in a meander loop of the Parrsboro River.

The downcutting of the Parrsboro outwash plain probably began during deglaciation. We noticed a terraced kettle hole along the route from Spencers Island. This implies that emergence began before blocks of ice, buried in the outwash, had melted. There is evidence of

terracing of ice contact stratified drift north of the delta at a level 18 m (59 ft) lower than the upper delta surface, indicating an 18 m (59 ft) drop in water height while meltwater was still flowing southward. The rate of emergence was probably rapid during and soon after deglaciation. The rate and uniformity of emergence after the initial uplift is uncertain. The lower two terrace levels have approximately the same soil development. The uppermost two terraces have 20 cm (7.9 in) more B-horizon soil development than in similar textured soils. This suggests that there may have been a hiatus or a waning in emergence followed by an another pulse of uplift during the downcutting process. Figure 7 is a diagrammatic representation of the stages in the formation and downcutting of the Parrsboro delta.

Site Description:

From the vantage point we can see three terrace scarps on the other side of the river and one behind us. The terrace scarps range 3-6 m (10-20 ft) in height. The first order terrace plain (Fig. 50) has more relief than the lower terrace levels. The seaward gradients of the terraces for the first and second order terraces are approximately the same.

The delta at Parrsboro is poorly exposed because the bulk of it is inland, not eroded at present by the sea. The topset beds are $\geq$ 5 m (16 ft) thick consisting of channel-fill sequences of gravelly sand and sand beds. The topset foreset contact was only briefly exposed in 1976 at a pit in the southern end of of the

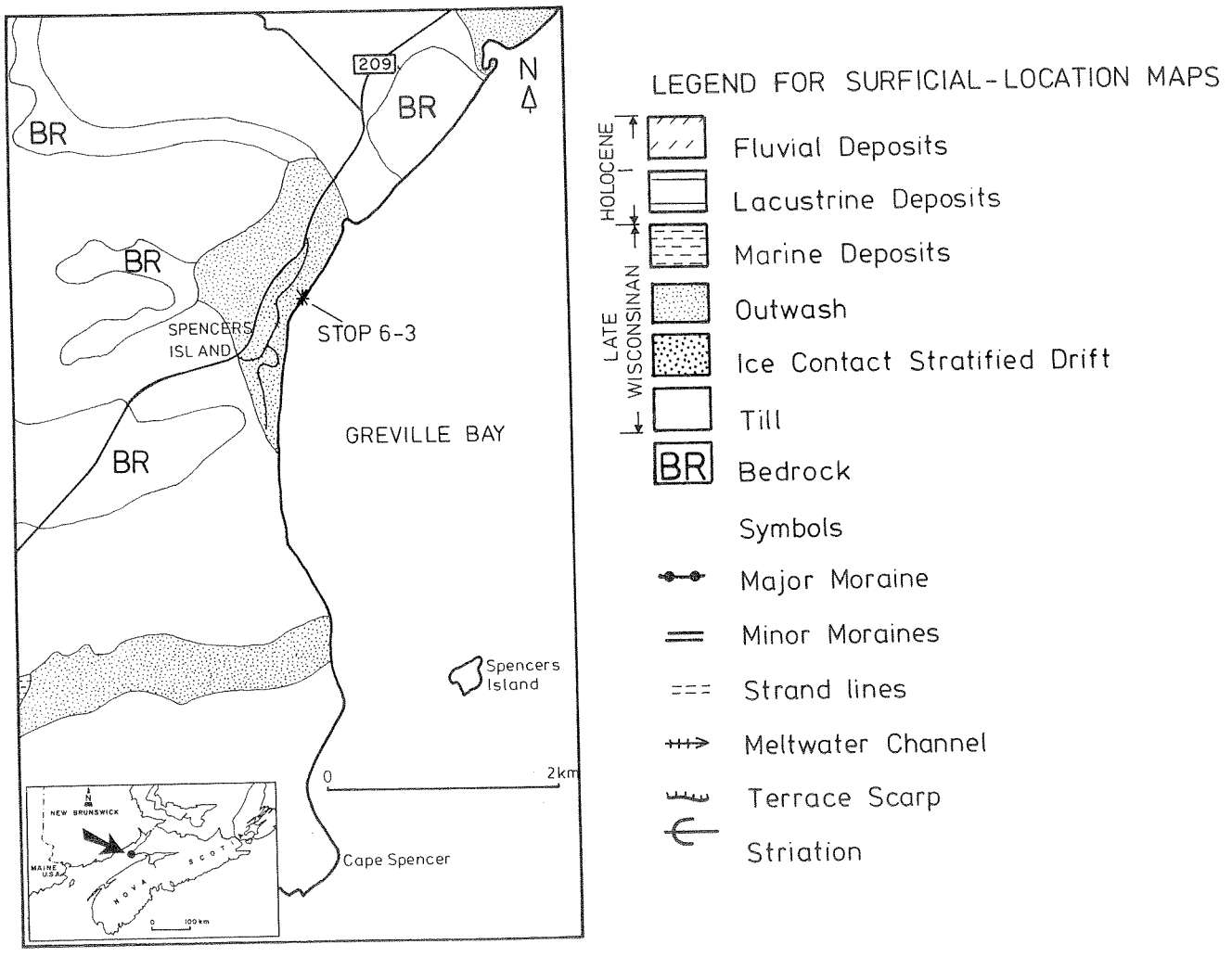


**Figure 48.** Location and surficial geology of Spencers Island at Stop 3 on Day 6



**Figure 49.** Photographs of the Spencers Island glaciomarine delta. A - stratigraphy (1 - diamicton, 2 - bottomset beds, 3 - foreset beds) B - close up of the bottomset rhythmites.

first terrace east of the Parrsboro River. These beds were finer grained than the topset beds and dipped 25°.

**Stop 6-5. Gilbert Lake Moraine**

Leaders: R. R. Stea, D. M. Wightman

Purpose: To observe a cross-valley moraine that represents a readvance of ice into the Parrsboro Gap

Route: Leave Parrsboro at 1530 hr and proceed northward along Highway 2 for 6 km (3.7 mi); arrive at 1545 hr.

Introduction:

The moraine at Gilbert Lake forms the drainage divide between the north-flowing Hebert River and the south-flowing Parrsboro River (Fig. 50). This moraine is interpreted as an end moraine of a readvance of an ice cap north of the Parrsboro Gap (Stea et al., 1986). This advance

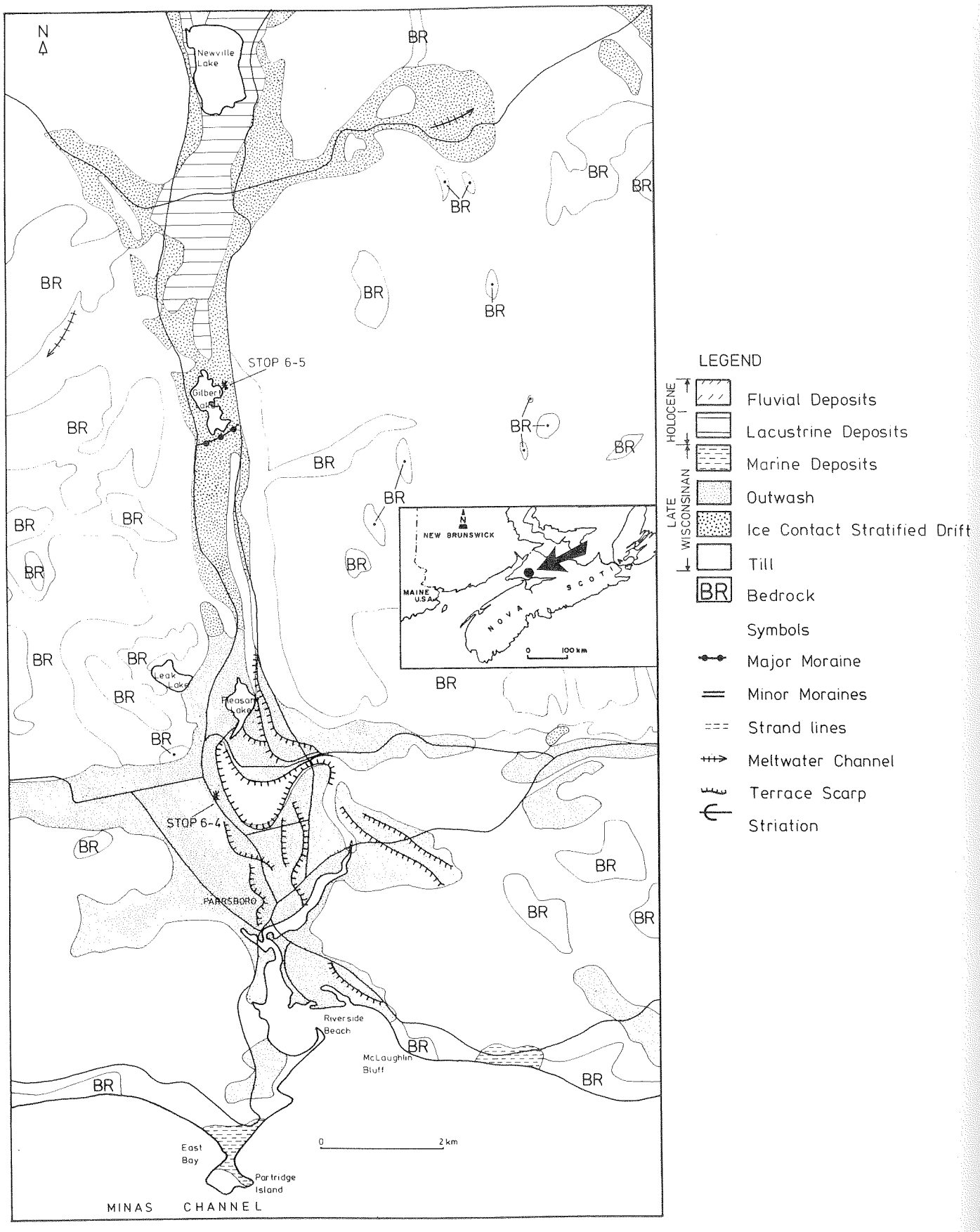


**Figure 50.** Location and surficial geology of the Parrsboro area at Stop 4 and 5 on Day 6

cut off the meltwater supply to the Parrsboro delta to the south. It also formed a widepread stony, till sheet called the Shulie Lake Till that terminates abruptly along a distinct line (Fig 6). Gilbert Lake is another lake that marks the edge of this glacier advance. This ice margin is north of the Cobequid Highlands (Ice Margin 2, Fig. 6) and is also marked by ice contact stratified drift in the Apple River area (Fig. 39). This margin corresponds roughly to the position that Grant (1977) considered to be the Late Wisconsinan maximum. The margin has not been dated directly as yet, but the age is estimated to be 12,500 - 11,500 yr B.P., before the major climatic amelioration in the region (Mott et al., 1986). A peat bed located north of the margin near Joggins formed 11,800 (GSC-3915) - 11,100 yr B.P. (GSC-3924). This peat overlies a diamicton formed during the last ice advance or retreat and is buried by < 1 m (3.3 ft) of sand of unknown origin. It is not certain whether all the ice was dissipated during the period of climatic warming. Remnants of the former ice mass may have persisted as late as 10,500 yr B.P. The pollen assemblage at the base of a cored bog within the limit of this ice mass indicates deposition after 10,000 yr B.P. (R. J. Mott, personal communication, 1984). Minimum dates from bogs and lakes in Nova Scotia are generally no older than 10,000 yr B.P. Till-like diamictons have been found truncating organic deposits dated at around 11,500 yr B.P. (Mott et al., 1986). Borns (1966) concluded that residual ice persisted during the occupation of the Debert paleo-Indian site at 10,600 yr B.P.

Site Description:

We will make a short stop in a gravel pit near the moraine. Spectacular kame deposits can be seen along the side of Highway 2 as we approach the moraine. The exposure we will see is composed largely of gravelly sand with occasional till inclusions. Folding of beds has been seen in fresh exposures. Gilbert Lake is a glacially scoured basin with water depths of > 20 m (66 ft) and additional sediment depths of > 10 m (33 ft).

**Stop 6-6. Lower Five Islands Delta**

Leaders: R. R. Stea, D. M. Wightman

Purpose: To examine the type locality for the Five Islands deltaic deposits

Route: Leave Gilbert Lake at 1630 hr; follow Highway 2 southward through Parrsboro then eastward for 30 km (18.6 mi); turn right on a dirt road just past the Moose River; arrive at 1700 hr.

Introduction:

This stop is at scenic Five Islands named after the five offshore islands - Moose, Diamond, Long, Egg and Pinnacle (Fig. 51). The Indians attribute the formation of the islands to Glooscap. In a fit of rage Glooscap threw giant handfuls of sod at Beaver, his nemesis, for mocking his magical powers. The sods which fell into the water became the islands.

The conventional interpretation of the formation of the Five Islands is that they represent eroded remnants of a cuesta formed by synclinal folding of a basalt-capped sedimentary sequence. Five Islands was displaced from the Cape Split part of the syncline by fault translation (Goldthwait, 1924).

Terraced gravel deposits are found at the mouths of major rivers that flow southward into the Minas Basin (Fig. 6). These deposits were correlated and mapped as one lithostratigraphic unit, The Five Islands Formation, by Swift and Borns (1967). They subdivided the formation into two members, an upper glaciofluvial ~~Sands~~ Saints Rest Member and a lower marine Advocate Harbour Member. This exposure at Lower Five Islands was designated as the type section for the Five Islands Formation (Swift and Borns, 1967).

Site description:

The upper surfaces of the deposit at Lower Five Islands, interpreted as a delta, slopes seaward approximately 6.5 m/km (33.6 ft/mi) (Fig. 51). The deposit at Lower Five Islands has a triparite structure with topset, foreset and bottomset beds similar to the Gilbert-type delta. The topset beds are about 3.5 m (11.5 ft) thick and divisible into 3 units. The uppermost unit (III) typically represents the Saints Rest Member. It is yellowish brown, coarse, predominantly sand unit and massive to crudely bedded with discontinuous lenses of unrippled

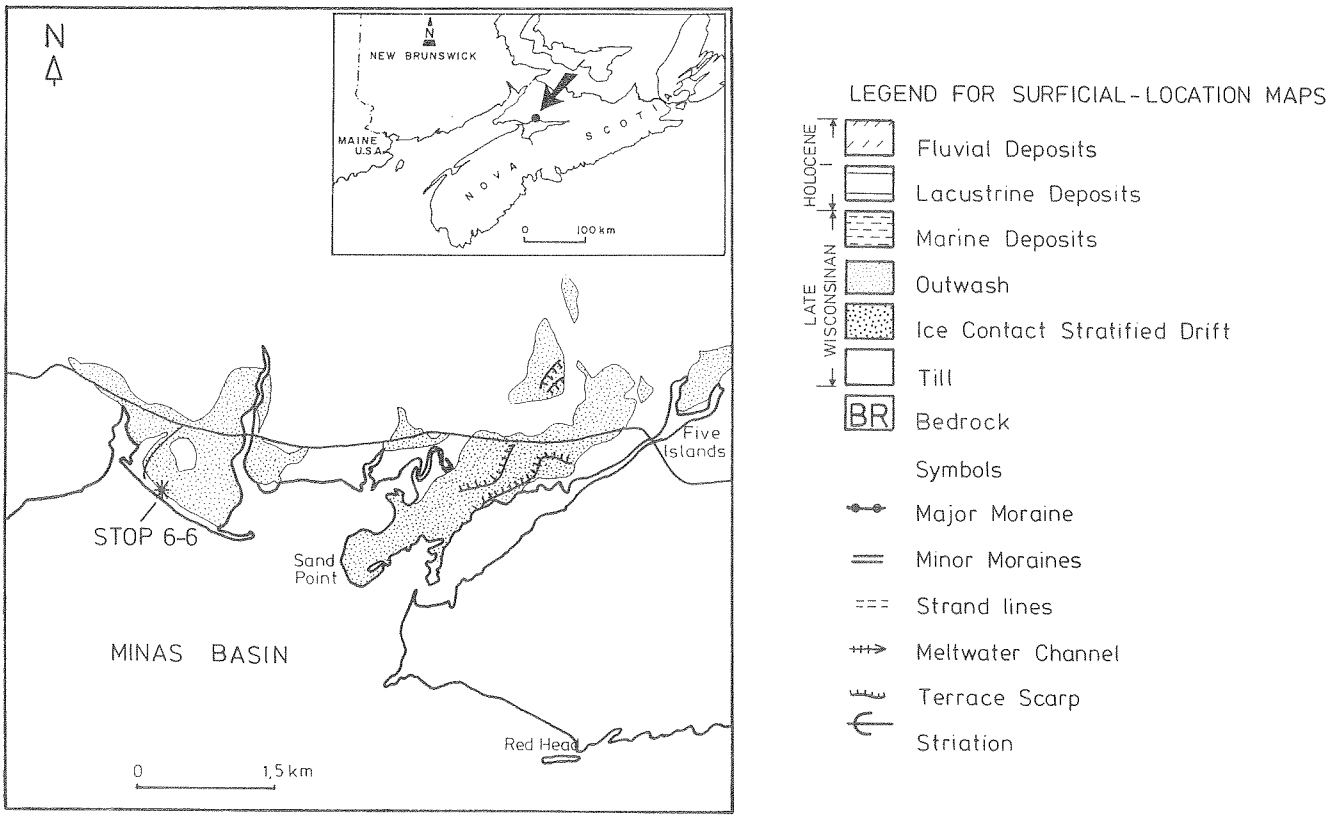


**Figure 51.** Location and surficial geology of the Five Islands area at Stop 6 on Day 6

sand. Cut and fill structures are common. It also contains abundant Cobequid Highland igneous and metamorphic erratics derived from the uplands to the north. Unit II is characterized by cobbles and boulders of red sandstone. Unit I is reddish, finer grained and has a high percentage of local sedimentary clasts.

The foreset beds dip 20-30° southeast at the distal point and are truncated by the topset beds in a planar angular unconformity (Fig. 52). They vary in texture proximally to distally from a gravelly sand to a medium- to coarse-grained sand, respectively. The contact with the topset beds is 15 m (49 ft) above MSL.

The bottomset beds meet the foreset beds in a tangential contact. They are composed of red clayey sand beds 1-2 cm (0.4-0.8 in) thick interbedded with sand beds 2-3 cm (0.8-1.2 in) thick.

The topset beds of the delta at Five Islands are interpreted to be subareal outwash on the basis of sedimentological characteristics. The foreset and bottomset beds are interpreted as the proximal and distal parts of a prograding glaciomarine delta. The relationships of ice contact stratified drift in the river valleys and the outwash deltas, especially at Parrsboro, suggest that an ice margin existed there and it receded northward (Fig. 6). Delta slopes and paleocurrent indictors suggest the meltwater was largely confined to the valleys and flowed southward. Recession of the ice margin across varying rock formations is responsible for the variations in the pebble lithology of the topset units (Fig. 53).

### Stop 6-7. Saints Rest Beach (optional)

Leaders: D. B. Scott, D. M. Wightman

Purpose: To observe a drowned foreset bed

Route: Leave Lower Five Islands at 1730 hr and follow Highway 2 for 23 km (14.3 mi); turn right to Saints Rest Beach; arrive at 1800 hr.

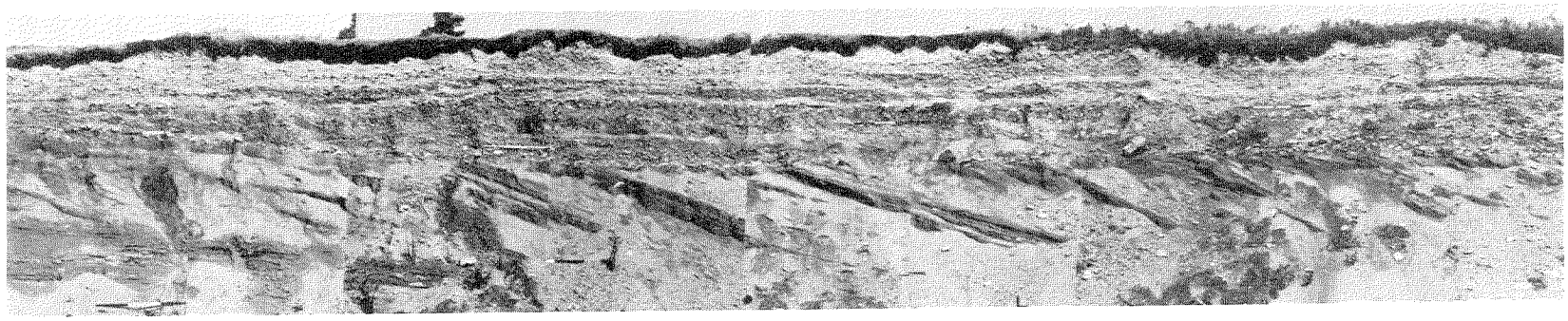


**Figure 52.** Photolog of proximal part of exposure, Lower Five Islands. Divisions on scales are 0.5 m. A - Topset beds units 1, 2 and 3, B - Foreset beds, C - Bottomset beds.

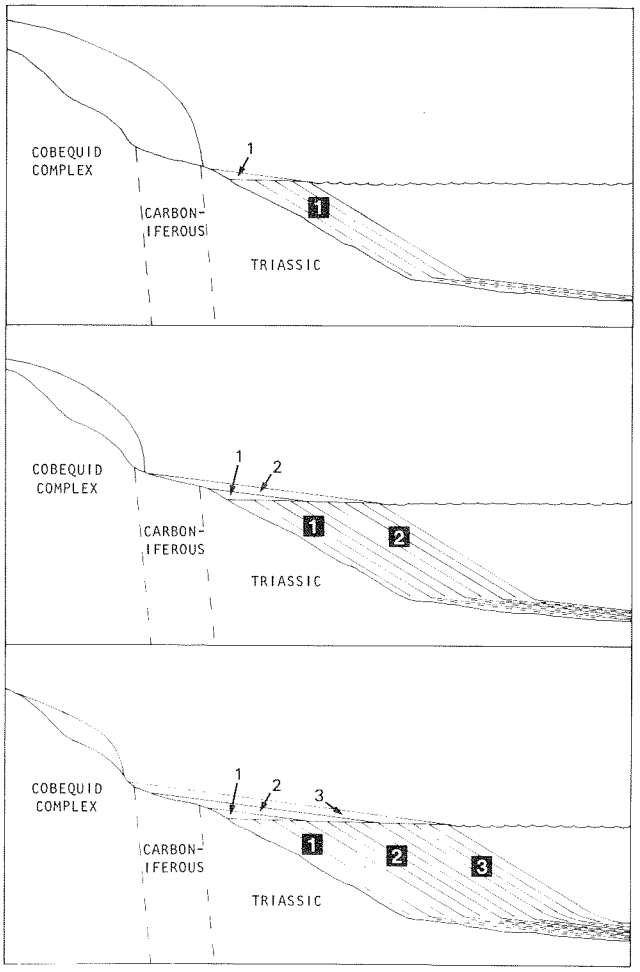


**Figure 53.** Schematic diagram showing deposition of Lower Five Islands delta. Top-margin of dissipating ice sits on Triassic bedrock as Unit 1 is deposited. Middle Unit 2 is deposited after ice front recedes on-to Carboniferous bedrock. Bottom last ice sits on the Cobequid Highlands and Unit 3 is deposited.

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This will be a short stop, depending on the position of the tide (Fig. 54). There are gigantic tree stumps exposed on the tidal flats at low tide. One of these was dated at 4,400 yr B.P. (Fig. 55; Grant 1970). These trees indicate that sea level was at least 12 m (39 ft) below present sea level at 4,000 yr B.P.

The contact of the topset and foreset facies of the Five Islands Formation may be exposed. This indicates that we are in the vicinity of the zero isobase - the zone of no emergence.

The erosion rates along this shore are so high that the house on the point has been moved several times in the past 50 years to prevent it from washing into the bay.

## DAY 7 - NORTHUMBERLAND STRAIT SHORE (JULY 26)

### INTRODUCTION

Twenty-four coastal sections were measured from Arisaig on the Northumberland Strait to MacIssacs Point on the coast of Georges Bay. Eleven representative sections are shown on Figure 56. Common to most of these sections is a sequence of statified, well sorted, sands and gravels (Unit 2) resting on an emerged abrasion platform believed to be a remnant of a Sangamon high sea level stand (Grant, 1980). The height of this rock bench varies within 4-6 m (13-20 ft) above MSL. This bench is developed on basaltic rock at Cape George Point. The surface of the bench, exhumed from under sand and till, is scalloped and smoothed.

A distinctive, bouldery to gravelly diamicton (Unit 3) lies above the stratified sands in most of the sections. The clasts are invariably angular and locally derived. This sediment varies in thickness within 4-20 m (13-66 ft). This material may be a product of mass wasting from adjacent rock slopes during peri-glacial conditions. It is also possible that it represents a supraglacial flowtill, deposited by advancing glaciers that deposited the overlying till.

Two till units distinguished primarily by their stone content lie stratigraphically above this diamicton. The lower till (Unit 4) is greyish red with a silty matrix. It is relatively stone-free. Robust fragments of Mercenaria sp. are commonly found near the base of this till unit. A date of > 37,000 yr B. P. was obtained on one of the fragments (GSC-4048, D. R. Grant, personal communication, 1984). Thick exposures of this till rested on bedrock surfaces with striations trending 90-130°. At the base of some sections with stoss and lee form, large elongate boulders with parallel surface striations were oriented parallel to the bedrock striations. This till sheet was probably emplaced by an ice sheet moving to the east and southeast.