

Bedford Institute of Oceanography
Institut océanographique de Bedford

Cruise Report 87042

CSS Dawson operations
on inner Scotian Shelf and
Sable Island Bank

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GENERAL INFORMATION

Cruise: CSS Dawson 87042

Dates: 2-10 November 1987

Area of Operations: inner Scotian Shelf and Sable Island Bank

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OBJECTIVES

1. Surficial sediment characteristics and bedform distribution.
2. Aggregate resource potential on the inner Scotian Shelf.
3. Quaternary stratigraphy of the inner Scotian Shelf and Sable Island Bank.
4. Holocene depositional environments and relative sea levels.
5. Equipment tests (scanning sonar, BRUTIV, UCON, vibracorer extension meter).

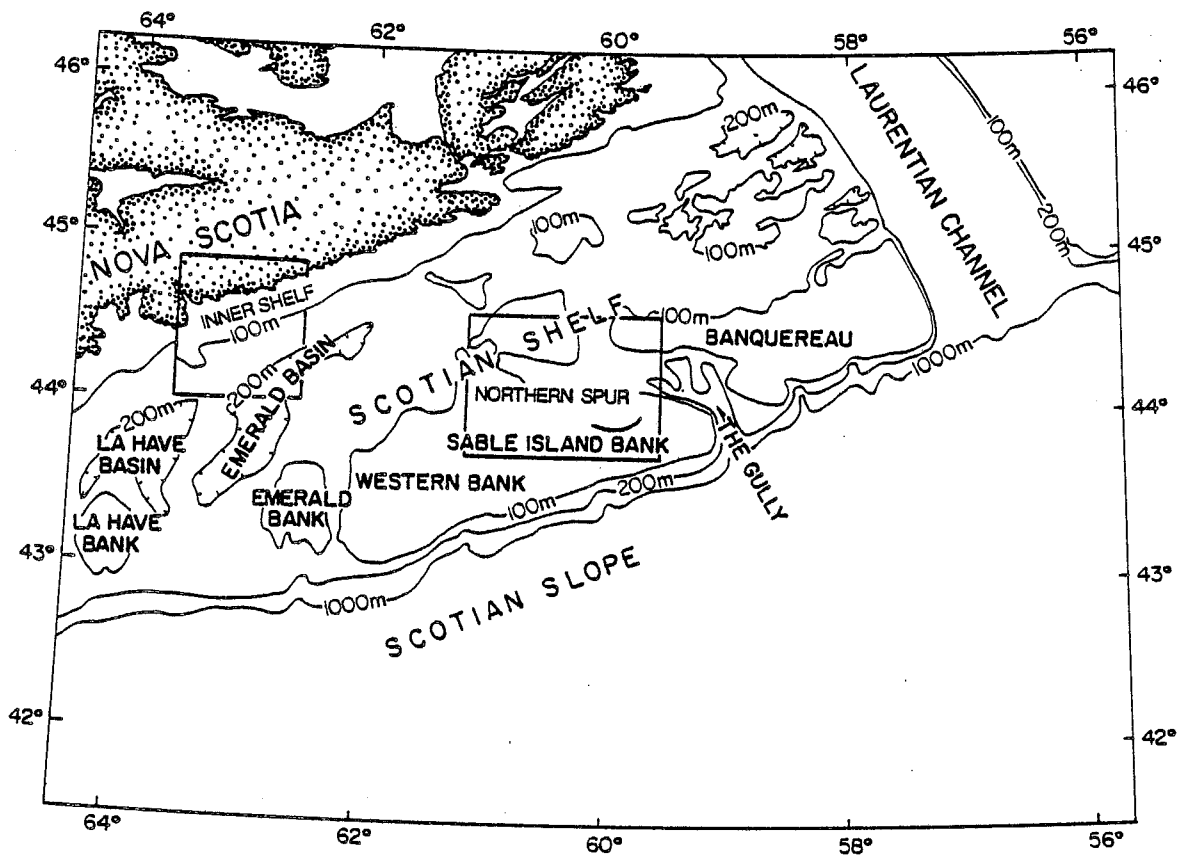


FIGURE 1.

Central and eastern Scotian Shelf, showing study areas on inner shelf (see Fig. 2) and on Sable Island Bank (Fig. 3).

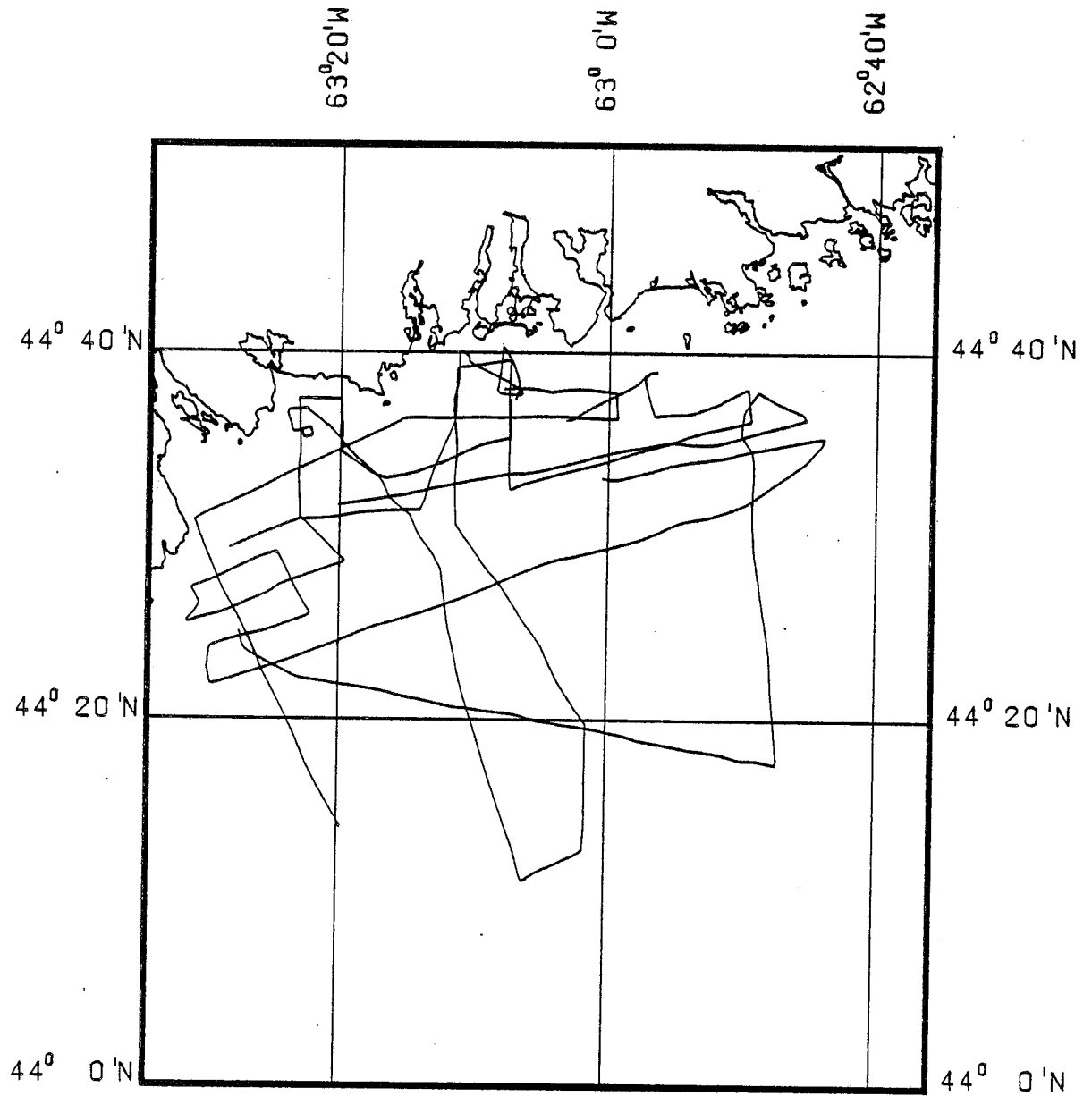


FIGURE 2a.

Inner Scotian Shelf study area: track lines.

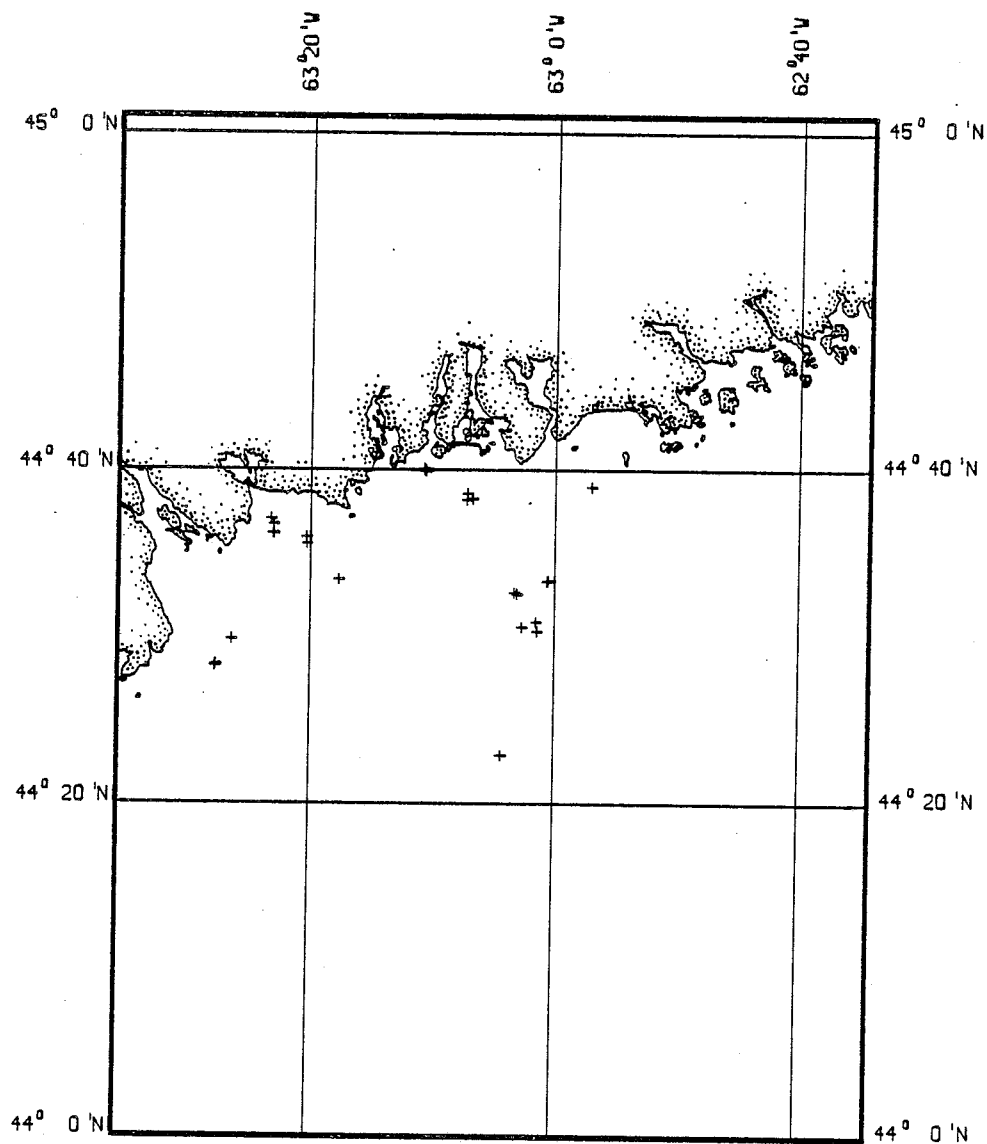


FIGURE 2b.

Inner Scotian Shelf study area:
sample locations [+].

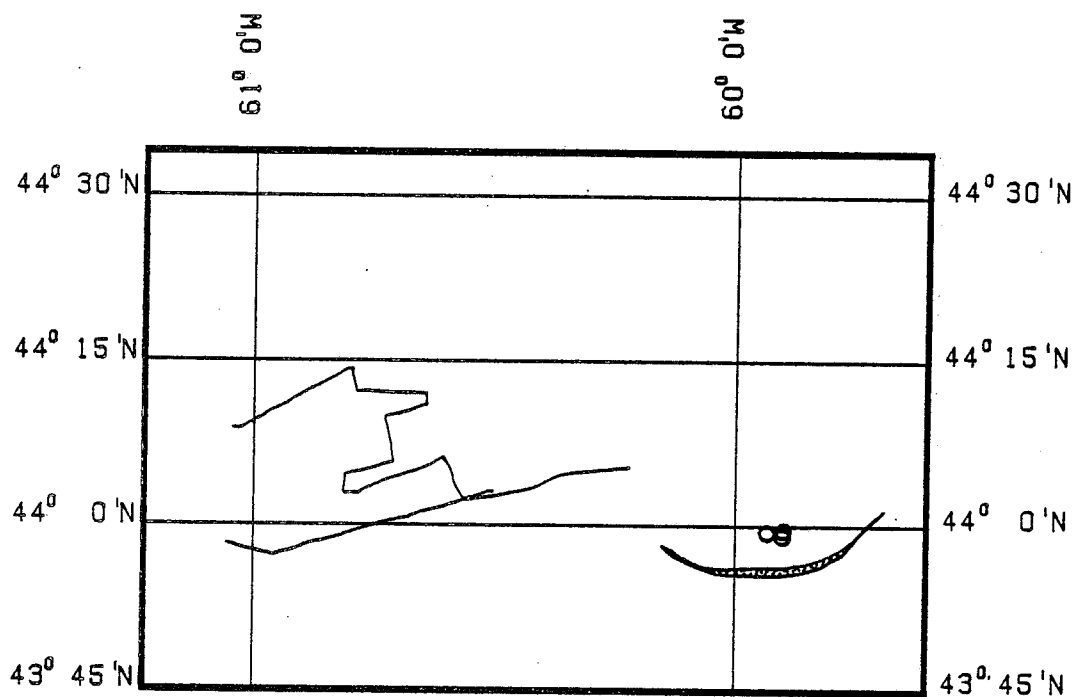


FIGURE 3.

Sable Island Bank study area:
track lines and sample locations [o].

SUMMARY OF ACCOMPLISHMENTS

A substantial proportion of the original cruise itinerary was completed, despite adverse weather conditions during part of the cruise and interruptions caused by equipment delivery delays, search and rescue, and medical emergency. The cruise yielded good acoustic and sample coverage over an area extending from the Nova Scotia coast across the inner shelf into the northern margin of Emerald Basin (Figure 1). It also produced some acoustic data on Sable Island Bank, particularly in the area of Northern Spur, and two vibracores from the shoreface off the north coast of Sable Island. The program was curtailed in the Sable Island area due to weather and none of the originally planned vibracore stations was occupied. An early return to port necessitated by a medical emergency at the end of the cruise resulted in the loss of four planned core stations and twelve hours of acoustic data, representing a significant part of the cruise objectives.

Approximately 750 line km of 100-kHz sidescan and 12-kHz echosounder data were collected (Figures 2 and 3), giving excellent results under relatively calm conditions and some useful information during rough weather. The surface-tow boomer was towed over 261 line km and produced good records, particularly in shallow water close to the coast; wave conditions limited the use that could be made of this system. The NSRFC deep-tow sparker system performed well, even under rough weather conditions, producing 580 line km of high-quality sub-bottom reflection data, some of which has led to new or improved understanding of the late-Quaternary stratigraphy of the inner shelf and of the occurrence and thickness of surficial sand and gravel deposits. BRUTIV was deployed 3 times with limited success; it provided roughly 39 km of bottom video and 48 still photographs, but could not be used after it collided with the bottom on the 4th night of the cruise.

Eleven cores were obtained using the AGC vibracorer with the 6.1-m barrel. The total length of these cores was 28.2 m, the longest being 5.65 m (apparent penetration 5.70 m). One 3.8-m gravity core was obtained (apparent penetration 9 m). Four more 9-m piston cores were planned, but had to be abandoned due to a medical emergency. The van-Veen grab sampler was dropped 27 times to obtain 19 samples. The IKU grab was dropped 8 times yielding 3 samples. These cores and grab samples have provided important ground truth for the interpretation of acoustic stratigraphy, key information on relative sea-level and other environmental changes over the past few thousand years, and valuable data on offshore aggregate and placer resources.

Further information on equipment types and performance can be found in later sections of this report. Inventories of cores, grabs, and acoustic records and tapes are provided in Tables 1 to 9. Additional information may be obtained from the cruise logs,

which are filed along with the original acoustic records at the Atlantic Geoscience Centre.

SCIENTIFIC RESULTS

Inner Scotian Shelf and Emerald Basin

The data collected on the inner Scotian Shelf have added substantially to the pool of information available before the cruise (King, 1970; Boyd and Penland, 1984; Hall and Boyd, 1984; Lapierre and Boyd, 1985; Hall, 1985; Piper, Mudie, Letson, Barnes and Iuliucci, 1986; Forbes and Boyd, 1987; Judge, Warner and Watanabe, 1987; Judge and Forbes, 1987). The cruise was planned to traverse the full width of the inner shelf in order to provide a link between existing stratigraphic models developed onshore and in deeper water (Grant and King, 1984; Stea and Fowler, 1979; King and Fader, 1986, 1988; Gipp and Piper, 1989). Palaeo-ecological data (Honig, 1988; Shaw, 1988) and radiocarbon dates (Table 10) from cores penetrating submerged estuarine deposits (Figures 4 and 5) have enabled us to extend the relative sea-level curve back to 9-10 ka at approximately -40 m (Fig. 6) and complemented studies of estuarine sedimentation in existing embayments along the coast (Scott, 1977; Miller, Mudie and Scott, 1982; Honig, 1987). Preliminary results from the cruise have been summarized by Boyd, Forbes and Shaw (1988). Detailed maps of small areas on the inner shelf in the vicinity of core stations 10 and 33 can be found in Forbes and Boyd (1989) and Forbes and Drapeau (1989), respectively.

Preliminary interpretation of the acoustic data indicates that the inner Scotian Shelf off the Eastern Shore of Nova Scotia can be subdivided into three distinct across-shelf zones (Figure 7). The inner part of the shelf (zone 1), extending to depths of about 60 m, is characterized by acoustic basement (interpreted as bedrock of the Paleozoic Meguma Group), either outcropping or overlain by unstratified deposits (acoustic facies B, interpreted as glacial diamict), typically 0 to 20 m thick, and stratified valley fill (acoustic facies C), rarely more than 20 m thick. These facies are overlain locally by stratified sediments (acoustic facies D) representing Holocene lacustrine and estuarine deposits sampled in a number of cores. Small-scale clinoform reflectors within facies D are considered to represent tidal inlet or flood delta deposits. The sidescan and sparker records, BRUTIV imagery, grab samples and cores show that a large proportion of the inner shelf is covered by a thin veneer of sand and gravel (facies E), generally less than 1 m thick. However, sea-floor exposures of facies D have been recognized and observed directly at two locations on the inner shelf in depths of about 30 m (Forbes, Judge, Boyd, Drapeau and Shaw, 1988; Forbes and

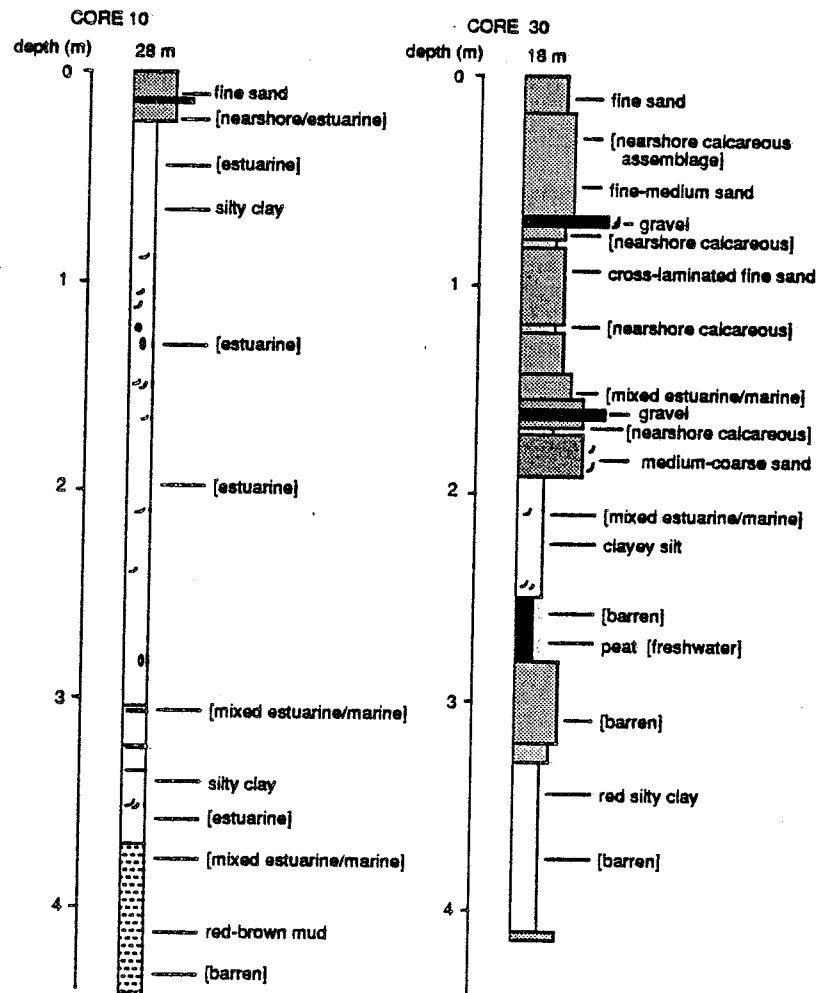


FIGURE 4a.

Simplified lithological logs, cores 10 and 30. Environmental interpretations [in brackets] are based on foraminiferal content (after Honig, 1988).

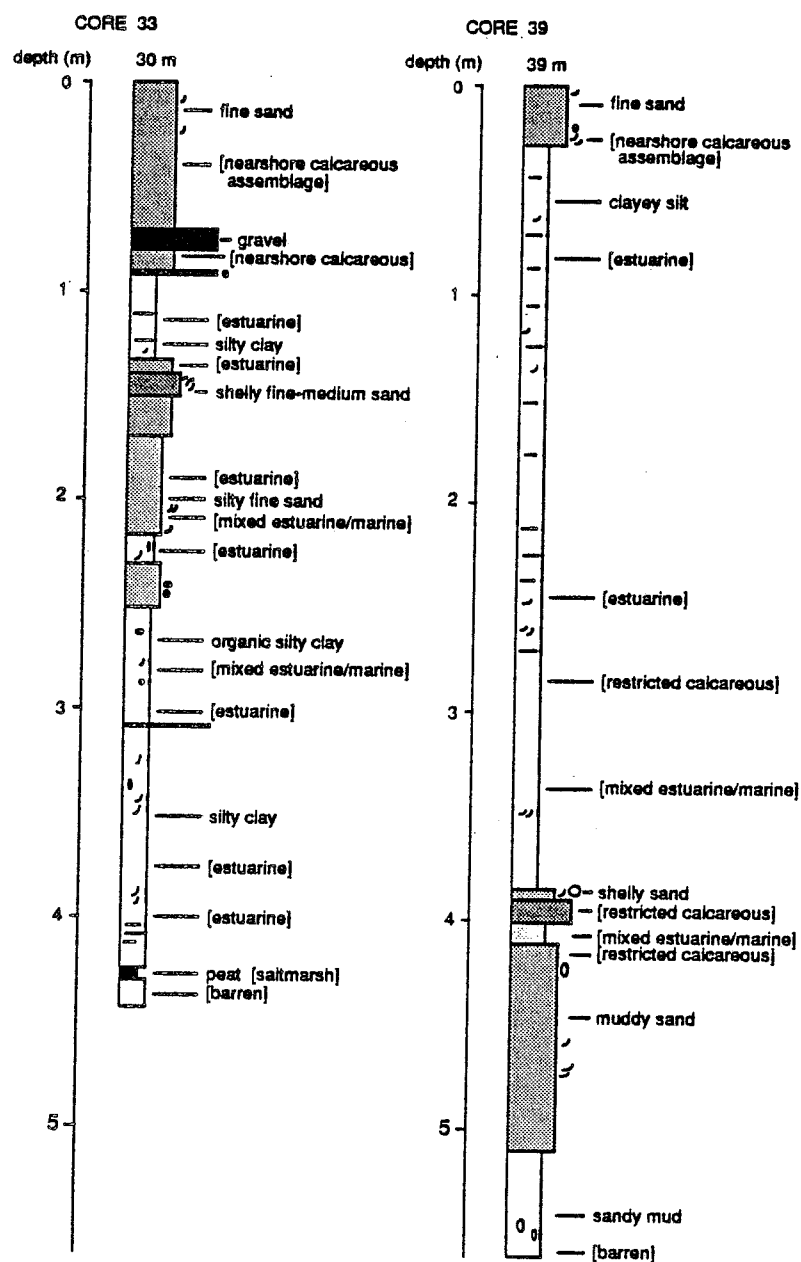


FIGURE 4b.

Simplified lithological logs, cores 33 and 39. Environmental interpretations [in brackets] are based on foraminiferal content (after Honig, 1988).

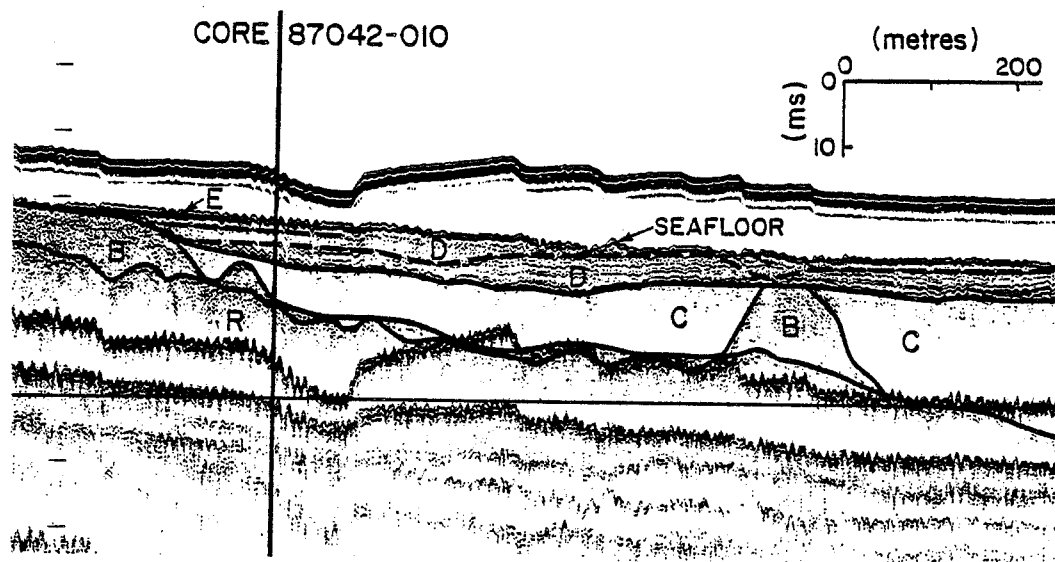


FIGURE 5a.

Representative deep-tow sparker profile and interpretation, vicinity of core 10, inner Scotian Shelf.

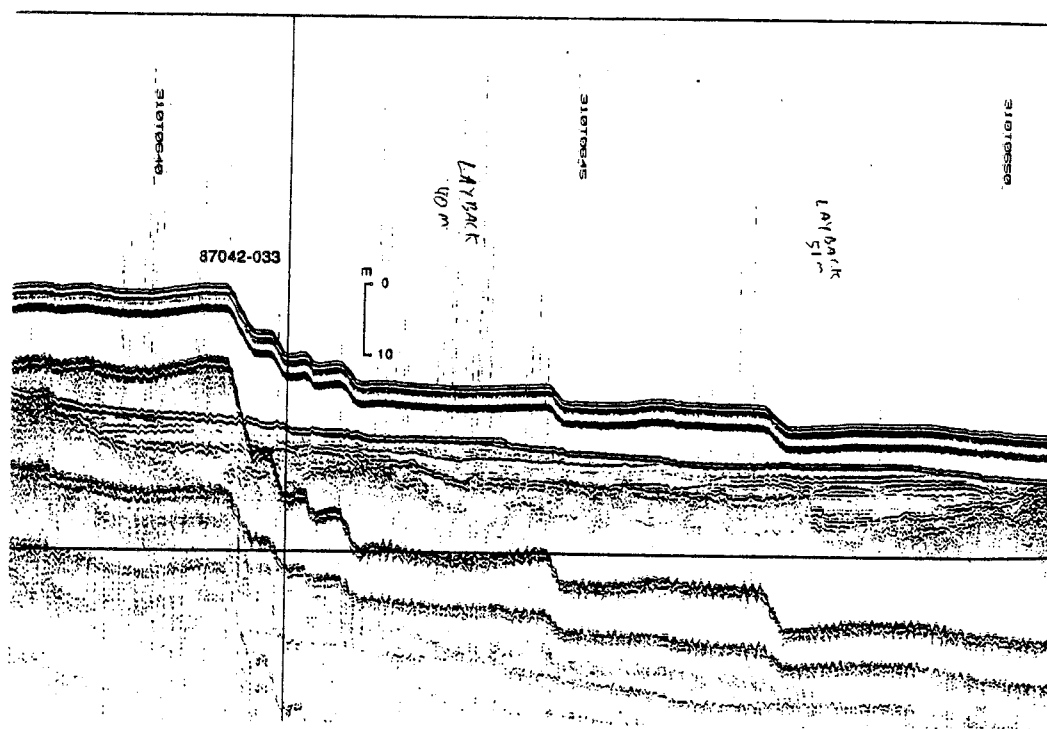


FIGURE 5b.

Representative deep-tow sparker profile, vicinity of core 33, inner Scotian Shelf.

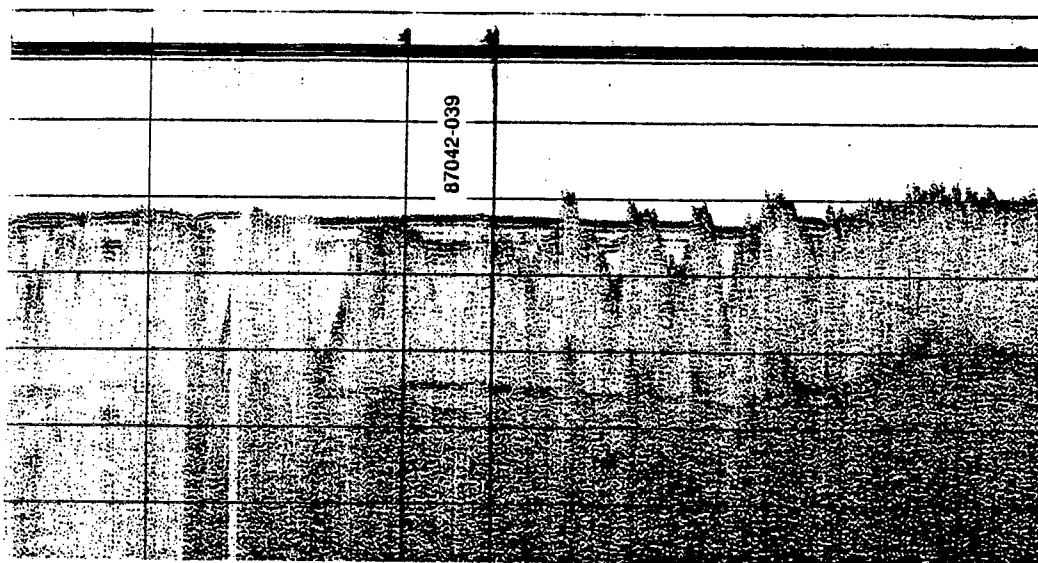


FIGURE 5c.

Representative surface-tow boomer profile, vicinity of core 39.

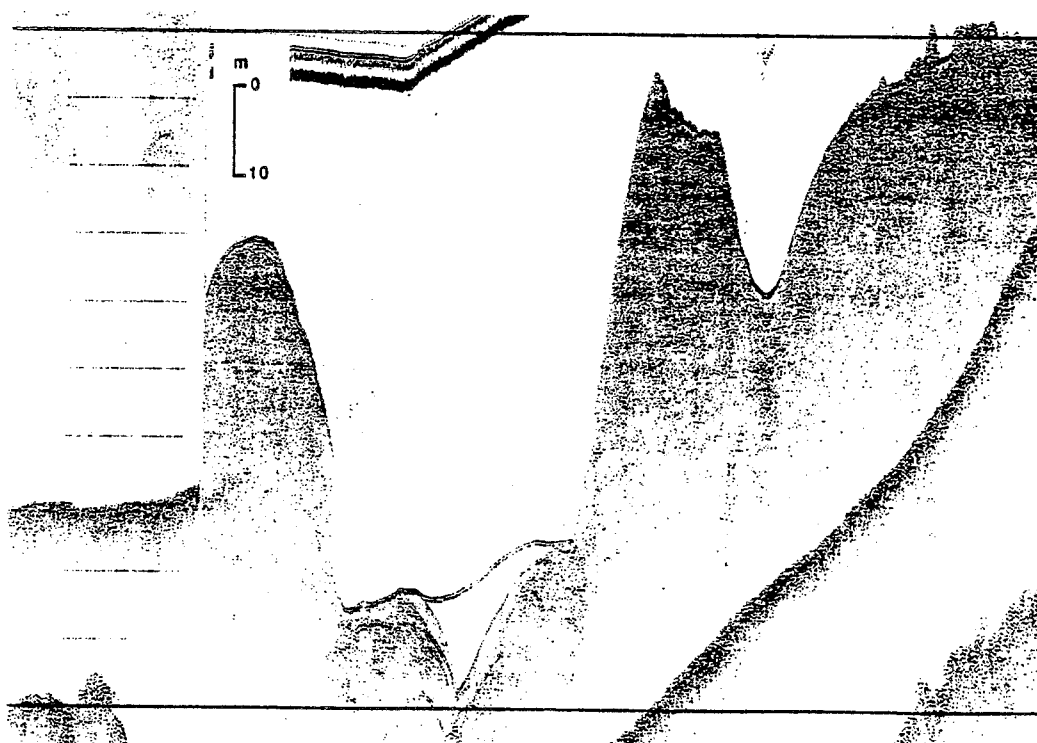


FIGURE 5d.

Representative deep-tow sparker profile, outer margin of inner shelf.

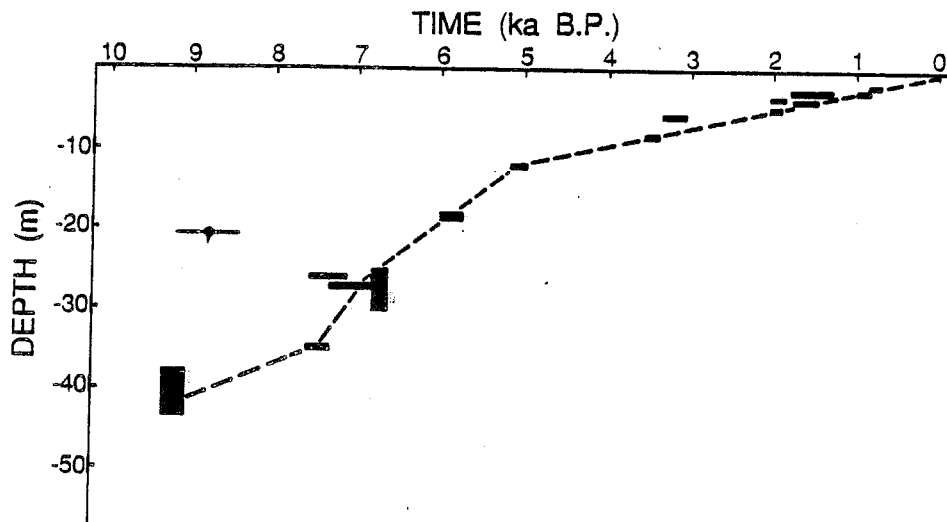


FIGURE 6.

Preliminary interpretation of relative sea-level history for the inner Scotian Shelf, based on previous data of Scott (1977), Miller et al. (1982), Hall (1985) and Honig (1988) and new dates obtained from cores collected on this cruise (see Tables 3 and 10).

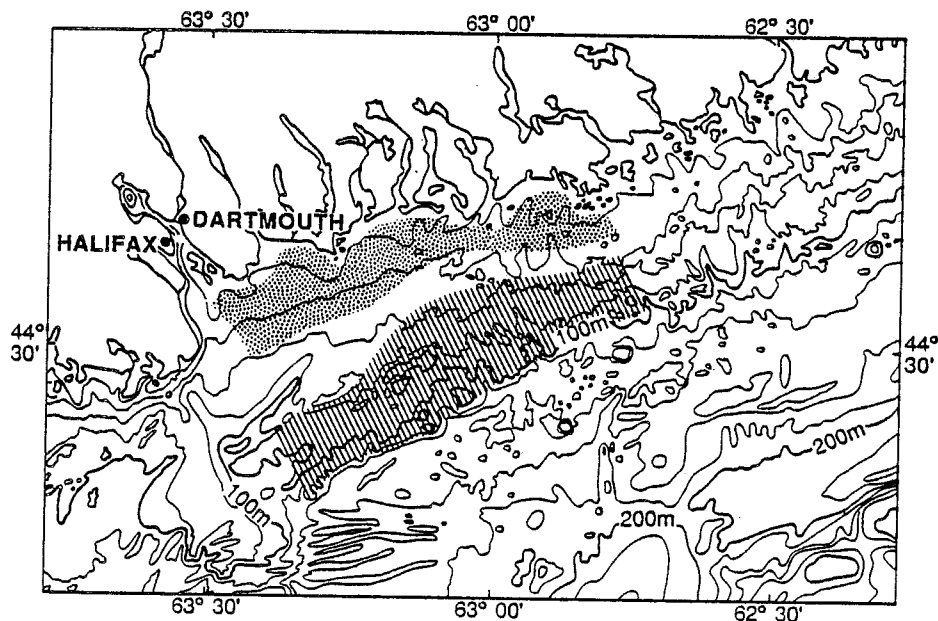


FIGURE 7.

Geological zonation of inner Scotian Shelf. Stippled area - zone 1 (inner [estuarine]); unpatterned area seaward of stipple - zone 2 (transitional); cross-hatched area - zone 3 (outer [outcrop]). Depth interval between isobaths 20 m.

Boyd, 1989). Further seaward (zone 2), the seafloor is interpreted as a transgressive erosional unconformity, which exposes thin units of acoustic facies B and C. The estuarine deposits (facies D) found in zone 1 appear to be absent. Occasional thin patches of transgressive lag deposits occur throughout the area. The outer part of the inner shelf (zone 3) is dominated by outcrop of acoustic basement, with very limited surficial sediment cover. This rugged outcrop zone occupies half or more of the inner-shelf width in much of the study area. Seaward of zone 3, a transitional zone between the inner shelf and Emerald Basin is characterized by extreme relief, with exposures of acoustic basement rising up to 60 m above intervening deep basins. The basins are partially filled by both stratified and transparent to poorly stratified deposits up to 40 m or more thick (equivalent to Emerald Silt and LaHave Clay of King and Fader, 1986). Seaward of this high-relief area is the Halifax Moraine (King, 1969, 1970), a thick sequence of ice-contact deposits, which pass basinward into, interfinger with, and are overlain by Emerald Silt.

Sable Island Bank

On Sable Island Bank, approximately 215 line km of deep-tow sparker data and two vibracores were collected to supplement existing seismic and borehole data (Scott, Medioli and Duffett, 1984; Scott, Boyd and Medioli, 1987; Boyd, Scott and Douma, 1988; among others). The seismic data generally confirmed the previously established acoustic stratigraphy (McLaren, 1988).

The base of the section beneath Northern Spur is demarcated by a series of channels up to 65 m deep, with apparent width between 2 and 3 km. Channel infill has an acoustic signature ranging from transparent to chaotic or stratified with high-amplitude reflectors. The channels are cut into acoustically amorphous and/or stratified sediments that grade laterally into each other. This lowermost sequence is interpreted to represent subglacial meltwater channels cutting into glacial and proglacial deposits. The bases of the channels are not resolved by the deep-tow sparker data, but similar channels north of Sable Island cut through a regional reflector dated between 12 and 30 ka, suggesting that the channel event occurred during the late Wisconsinan. The subglacial unit has variable relief, with a topographic high near the centre of Northern Spur, where the unit is exposed at the seabed.

In water depths less than 40 m over Northern Spur, the subglacial channel sequence is truncated by an unconformity marking the base of a unit acoustically defined by progradational foresets. In water depths greater than 40 m, the subglacial unit is overlain by a marine sand ridge field. The sand body with foresets represents a deltaic system, interpreted as a proglacial

marine delta because it directly overlies subglacial channels. The glaciomarine delta varies in thickness from 1-2 m on the west side of Northern Spur to 30 m on the east side, suggesting that deltaic depocentres are located toward the east. The polymodal orientation of internal foresets suggests that the deltaic sequence is multi-lobate with a source from the west. The seismic data collected on this cruise show that the proglacial deltaic sequence makes up most of Northern Spur. An unconformity separates the proglacial sequence from the uppermost unit, which is exposed at the seafloor. The unit is thickest where it overlies the deltaic sand body, suggesting that it was formed by reworking of the underlying unit as relative sea level rose. The surface unit thins laterally from the central area of Northern Spur, merging with sand ridges on the periphery. This unit is characterized by northward-dipping reflectors and small-scale channels up to 10 m deep and 100-200 m wide. Such features are thought to represent a reworked coastal sand body. The sand body may have originated as a barrier sequence or as a transgressive marine sand shoal. The occurrence of channels with a lenticular infill geometry, suggesting a migrating tidal-inlet origin, supports the submerged barrier island interpretation.

A line was run from the southeast flank of Northern Spur toward the southwest of Sable Island Bank to link the terrace area north of West Bar to the western extremity of the study area. This line shows that the subglacial channel sequence postdates regional reflectors R1 and R2 (Boyd, Scott and Douma, 1988). R1 cannot therefore be the Holocene/Pleistocene boundary as was previously thought, and must be between 11 and 30 ka in age. The proglacial deltaic unit described above is absent where the line crosses the southern part of Northern Spur. In this area, the subglacial sequence outcrops locally at the seafloor. It is overlain by marine sand ridges and shows significant reworking on the eastern flank of Northern Spur.

In summary, the seismic stratigraphy of Northern Spur consists of three depositional sequences separated by two erosional unconformities. These deposits are believed to represent a deglaciation sequence, with subglacial deposits and channels overlain by a proglacial marine sand body, which later provided sediments for an overlying barrier island complex. The resulting sand body is about 40 m thick and accounts for the positive relief of Northern Spur, which is interpreted as the site of an ice recessional depocentre during the late Wisconsinan.

The two vibracores collected north of Sable Island (Fig. 3; Table 3, cores 47 and 49) together show a marine sand sequence overlying peat and a lower sand body. The latter contains an oxidized soil profile and is barren of pollen except for fungal hyphae. The peat deposit contains spruce roots and passes upward from a freshwater peat with abundant pollen species (see McLaren,

1988), suggesting deposition close to a shallow pond, into an upper saltmarsh peat containing foraminifera and dinoflagellates. Radiocarbon dating of the fresh to salt transition in the peat (Table 10) places relative sea level 35.3 m below present around 8200 radiocarbon years BP. The peat is incised by an erosional unconformity interpreted as resulting from the Holocene transgression. Above this unconformity is a steeply-dipping cross-stratified marine sand containing bivalves and thin laminae of organic material derived from mixing of freshwater and saltmarsh peats.

SUMMARY OF OPERATIONS

Notes:

1. Sample numbers [given in square brackets, followed by sample lithology] omit cruise number prefix and leading zero (e.g. sample 87042-001 is reported as sample 01). Missing stations are Mesotech scanning sonar attempts. See Tables 1, 2, and 3 for complete sample listings.
2. Times are UT = GMT = AST+ 4 h.
3. Positions are as computed onboard from adjusted Loran-C. See section on navigation (below), navigation files, and Table 11 for more information.

Monday 2 November 1987 (day 306)

Completed lifeboat drill alongside and cast off from BIO wharf at 1330 UT. Departed Halifax Harbour and proceeded to Cole Harbour.

Anchored off Cole Harbour in 12 m water depth at position 44°37.15'N 63°23.50'W at 1550 UT. Deployed Mesotech sonar and vibracorer, collecting a 0.72-m core [01, thin sand over gravel]. Collected a van-Veen grab sample [03, sand]. Then let out two more shackles on anchor chain (90 feet each), to rest at position about 55 m southeast of first station, in 16 m of water. Took van-Veen grab [sample 05, sand] and a 0.73-m core [06, thin sand over gravel]. On completion of Navy firing practice circa 1800, moved south to anchor at position 44°36.15'N 63°23.15'W at 1905 in 27 m water depth. Took van-Veen grab [sample 08, sand] and a 4.63-m core [10, thin inner-shelf sand over estuarine mud and diamict]. Moved to position 44°36.18'N 63°23.02'W and anchored at 2020 UT in 22 m of water. Grab sampler came up empty twice, indicating gravel seafloor.

Weighed anchor at 2134 UT and proceeded north to deploy sidescan and boomer. Ran pattern of lines through preceding sample and core stations. Pattern completed at 2315, when

southeasterly course established for long overnight transect across inner shelf out to Emerald Basin. Deployed BRUTIV at 2330 and NSRFC deep-tow at 2415. Still camera on BRUTIV not functioning.

Tuesday 3 November 1987 (day 307)

Towed sidescan, deep-tow sparker, boomer, and BRUTIV through position 44°30.36'N 63°14.35'W. At this point, BRUTIV was recovered for adjustments at about 0145 UT. It was not redeployed because of damage to cable, which was caught in block at stern.

Resumed line at 0150 UT and continued southeast through position 44°27.96'N 63°12.43'W at 0210 to end of line in northern Emerald Basin at position 44°11.31'N 63°06.26'W, seaward of Halifax Moraine, at 0524 UT. Ran short line on northeasterly course parallel to moraine to position 44°12.78'N 63°01.79'W at 0609, before turning north to run back toward the coast through positions 44°19.73'N 63°01.51'W at 0730, 44°30.63'N 63°11.35'W at 1005, and 44°36.32'N 63°11.49'W, where the deep-tow was recovered at 1130. Deep-tow cable damaged as a result of being caught up in a line with an unmarked highflyer.

After recovery of deep-tow, continued north towing sidescan and boomer to position 44°40.02'N 63°11.23'W before making a long turn to starboard to run back southeast through proposed coring site at 44°39.54'N 63°10.48'W and a pattern through proposed sites off Martinique Beach at positions 44°40.33'N 63°07.88'W and 44°38.10'N 63°06.88'W, finishing at 44°37.57'N 63°06.88'W at 1440 UT, when all survey gear was brought aboard.

By this time the wind was picking up from the southwest, blowing about 25 knots. Anchored at position 44°38.27'N 63°06.82'W at 1515 UT, in 26 m water depth. Took van-Veen grab [14, fine sand] and attempted unsuccessfully to deploy vibracorer (too rough). Wind southwest at 30 knots. Weighed anchor at 1650 and proceeded to take van-Veen grab samples at the following locations:

44°32.65'N	63°03.34'W	depth 53 m	[16, no sample];
44°32.56'N	63°03.12'W	depth 59 m	[17, no sample];
44°30.59'N	63°02.71'W	depth 92 m	[18, sand];
44°30.90'N	63°01.53'W	depth 76 m	[19, gravel];
44°30.34'N	63°01.44'W	depth 74 m	[20, gravel];
44°33.32'N	63°00.67'W	depth 64 m	[21, no sample];
44°23.33'N	63°00.56'W	depth 64 m	[22, no sample].

With deteriorating sea-state making grab sampling hazardous by this time (1950 UT), it was decided to try towing sidescan in water deep enough to get partially below surface noise. Deployed

fish at position 44°43.21'N 63°00.38'W at 2040 UT and proceeded on an easterly course to position 44°35.39'N 62°44.18'W at 2300, then altered course to south-southwest and continued to 44°32.30'N 62°48.81'W at 0006 UT.

Wednesday 4 November 1987 (day 308)

Deployed deep-tow and continued through the night on the same course, roughly parallel to the coast, to position 44°21.90'N 63°29.37'W at 0558 UT, on the flank of Outer Bank off Sambro Ledges. From this position, ran a series of transects across approaches to Halifax Harbour (traffic lanes C and D), through positions

44°23.97'N 63°29.51'W at 0618,
44°25.67'N 63°22.26'W at 0715,
44°29.07'N 63°24.84'W at 0753,
44°27.31'N 63°30.47'W at 0845,
44°25.35'N 63°31.36'W at 0913,
44°28.15'N 63°21.33'W at 1030,
44°30.84'N 63°23.16'W at 1120,
44°29.47'N 63°27.75'W at 1200.

Recovered deep-tow and sidescan gear.

Proceeded into Halifax Harbour to pick up IKU grab sampler, anchoring off Georges Island, where Sigma-T came alongside. Took IKU aboard and departed Halifax Harbour in flat calm conditions at 1600 UT, en route to proposed core sites off Petpeswick Inlet.

Anchored at position 44°39.95'N 63°10.81'W off Petpeswick Head, in 17 m water depth, and collected van-Veen sample [23, sandy silt with shell fragments]. Search and Rescue call (for Sea-King helicopter ditched off Chebucto Head) intervened before coring could begin. Weighed anchor and proceeded at full speed toward scene of crash. Released from SAR duty at 1940 UT about 8 nautical miles from core station.

Set anchor again at position 44°40.02'N 63°10.76'W, in 17 m water depth off Petpeswick Head, at 2030 UT. Collected van-Veen sample [25, sand] and a 1.47-m core [26, sand]. At 2200 UT, moved ship to anchor in 19 m of water at position 44°39.91'N 63°10 67'W, 2 cables east of intended station. Collected van-Veen grab sample [27, sand with shells] and a 0.52-m core [28, pebbly sand over compact mud]. Moved ship and anchored at position 44°39.97'N 63°10.81'W at 2300 UT, in 18 m water depth. Collected van-Veen sample [29, fine sand] and a 4.28-m core [30, inner-shelf sand over estuarine and lacustrine mud and sand, with 0.2 m freshwater peat approximately 4.2 m down-core].

Thursday 5 November 1987 (day 309)

Anchored at position 44°38.58'N 63°07.25'W at 0037 UT, in a water depth of 30 m. Took a van-Veen grab sample [31, fine sand] and a 4.34-m core [33, inner-shelf sand over estuarine mud and sand, with saltmarsh peat including wood fragments at base].

On completion of coring, deployed BRUTIV at position 44°38.02'N 63°06.80'W at 0145 UT. Problems were detected with the cable almost immediately and some difficulty was encountered in recovery. BRUTIV appeared to be diving and could not be controlled. Therefore, abandoned BRUTIV plans and deployed sidescan and surface-tow boomer at position 44°38.01'N 63°07.81'W at 0212 UT. Ran lines as follows:

east to	44°37.82'N 62°59.49'W at 0342,
south to	44°36.57'N 62°59.39'W at 0400,
west to	44°36.39'N 63°15.32'W at 0630, and
southwest to	44°30.90'N 63°30.66'W at 0853.

At this point, off Chebucto Head, course was altered to southeast. The NSRFC deep-tow was deployed at 0858 UT and the line continued to position 44°14.24'N 63°19.89'W at 1300 UT, on the northern margin of Emerald Basin at the edge of the inner shelf.

At 1300 it was decided to terminate the line in order to take advantage of acceptable sea-state conditions for sampling. Proceeded to position 44°28.32'N 63°27.72'W and put out anchor at 1450 UT, in 51-55 m water depth. Collected van-Veen grab samples [34 and 35, gravel] and IKU grab [36, mud-sand-gravel including boulders, apparently a sample of diamict]. There being no hope of coring at this location, the ship was moved to position 44°29.83'N 63°26.43'W, depth 53 m. After some difficulty getting the anchor to hold, collected a second IKU grab sample [37, similar to sample 36].

BRUTIV, sidescan and deep-tow gear were streamed at position 44°30.80'N 63° 27.08'W, circa 2050 UT. At 2124 UT, BRUTIV hit the seafloor and had to be recovered. The run was then continued through a course change at 44°27.04'N 63°24.00'W at 2203 and a course change to north at 44°28.12'N 63°20.26'W at 2237 to run inshore toward Lawrencetown Beach.

Friday 6 November 1987 (day 310)

The sidescan and deep-tow run was continued, with the objective of passing over core sites 10, 30, and 33, as follows:

north to	44°37.34'N 63°19.96'W at 0039,
west to	44°37.47'N 63°23.08'W at 0112,

south to	44°30.98'N 63°22.95'W at 0239,
east to	44°31.45'N 63°14.28'W at 0409,
north to	44°39.10'N 63°11.38'W at 0554,
east to	44°39.58'N 63°07.59'W at 0629,
south to	44°32.66'N 63°07.43'W at 0752,
east to	44°35.17'N 62°55.16'W at 1000.

The deep-tow sparker was recovered at 1000 UT and the surface-tow boomer deployed in its place. The run was then continued, to explore potential coring sites identified in the area of Brig Shoal from Dawson 81006 records, as follows:

east to	44°36.39'N 62°49.40'W at 1100,
north to	44°38.03'N 62°49.82'W at 1122,
west to	44°36.63'N 62°56.00'W at 1222,
north to	44°38.72'N 62°57.32'W at 1253,

and then after a pattern involving a 270° turn to starboard in the vicinity of a proposed core site [39],

southwest to 44°36.65'N 63°02.19'W at 1402,

where the sidescan and surface-tow gear was recovered.

The ship then moved back to position 44°38.99'N 62°57.02'W and anchored at 1505 UT in 39 m water depth. Collected van-Veen grab sample [38, fine sand and shell fragments] and a 5.65-m core [39, inner-shelf sand over estuarine mud].

The next objective was to obtain a large (statistically adequate) sample of ripple-forming gravel from a site (S2) investigated by Judge, Watanabe, and Warner (1987) off Martinique Beach. The sidescan was streamed at 1710 UT at position 44°38.06'N 63°06.71'W, a few cables ahead of the site, in order to ensure that the site had appropriate material on the bottom. Except for one small ribbon, gravel ripples were not visible on the sidescan, either on this record or on the record from an orthogonal track the previous night (day/time 310/0645). The ship was anchored at 1744 UT at position 44°38.19'N 63°07.32'W, depth 28 m, and an IKU grab sample [40, mud, sand, pebbles, and cobbles] was obtained at this site. It contained much more fine material than expected, suggesting that the grab may have sampled an area of gravel lag over a more poorly sorted diamict or muddy gravel.

On completion of the sampling operation at 1840 UT, the ship was moved west to a proposed vibracore site (possible estuarine fill deposit in 49 m present water depth). Anchored at position 44°33.43'N 63°17.67'W at 2010. Unfortunately, in three attempts, the van-Veen sampler brought up only a few pebbles and cobbles [41 and 42], indicating that there would be no hope of the vibracorer punching through to the target deposits.

An alternative coring site was then selected on the basis of seismic stratigraphy suggesting a possible estuarine unit, and of sidescan evidence for a sandy bottom, in 23 m present water depth off Lawrencetown. Anchored on site at position 44°35.56'N 63°20.30'W, depth 23 m, at 2220 UT and collected nothing in three van-Veen casts, implying a rock bottom. From the sidescan data and after lengthy discussions about Loran-C navigation, it appeared sensible to move the ship a short distance to the northwest, where the anchor was set at 2340 UT, in 23-27 m depth, at position 44°35.96'N 63°20.38'N. Collected van-Veen grab sample [44, fine sand] and a 0.91-m core [45, fine sand over pebble gravel].

Saturday 7 November 1987 (day 311)

Proceeded to Halifax Traffic reporting point 2D and streamed sidescan and deep-tow sparker at 0144 UT. Ran line through the night, southwest across inner shelf into Emerald Basin, passing through 44°22.23'N 63°22.91'W at 0234 to position 44°17.60'N 62°47.37'W at 0741 UT. From this point, a line was run north onto and across the inner shelf to position 44°37.60'N 62°49.74'W, depth 33 m, at 1153 UT, when the deep-tow was pulled in. At this time, it was judged unsafe to proceed further landward to intended end-of-line.

Wind west-southwest at 40 knots gusting to 50. Too rough for any coring or sampling operations. While waiting for conditions to improve, continued running sidescan through position 44°35.91'N 62°48.02'W and thence westward along the inner shelf toward Chebucto Head. Recovered sidescan fish and ended survey line at 1730 UT in position 44°31.72'N 63°19.88'W. Turned and set a course for Sable Island, running with the sea.

Sunday 8 November 1987 (day 312)

Streamed sidescan and deep-tow gear at 0449 UT in position 44°08.90'N 61°02.88'W on Northern Spur. Ran lines through the following way-points:

44°08.93'N 61°01.51'W at 0503,
44°14.16'N 60°48.68'W at 0715,
44°14.25'N 60°47.94'W at 0722,
44°14.01'N 60°47.84'W at 0725,
44°12.16'N 60°47.21'W at 0747,
44°11.71'N 60°38.63'W at 0908,
44°10.98'N 60°38.92'W at 0918,
44°09.74'N 60°43.71'W at 1004,
44°05.81'N 60°42.92'W at 1055,
44°04.39'N 60°48.63'W at 1152,

44°02.93'N 60°48.34'W at 1215,
44°05.20'N 60°39.00'W at 1325,
44°06.12'N 60°36.90'W at 1345,
44°02.52'N 60°33.99'W at 1440,
44°05.30'N 60°13.59'W at 1700,

when the sidescan and deep-tow gear was recovered.

Weather prevented us from coring at sites originally targetted on Northern Spur. Alternative sites in relatively sheltered water in the lee of Sable Island were selected on the basis of data collected on earlier cruises. The anchor was dropped off the north shore of the island in position 43°59.32'N 59°53.84'W in 30 m water depth at 2210 UT. Collected van-Veen grab sample [46, sand and sand-dollars (*Echinarachnia parma*)] and a 2.10-m core [47, sand].

Monday 9 November 1987 (day 313)

Moved to second coring site off Sable Island and dropped anchor at 0010 UT in 33 m water depth at position 43°59.56'N 59°53.76'W. Collected van-Veen grab sample [48, sand and sand-dollars] and a 2.89-m core [49, shell-bearing massive sand over cross-stratified sand over 0.32 m peat (saltmarsh over freshwater, latter containing *Picea* sp. wood) over sand].

On completion of coring, moved to position 44°03.05'N 60°28.48'W and began streaming sidescan and deep-tow gear at 0316 UT. Ran lines through positions

44°03.14'N 60°30.93'W at 0336,
44°57.26'N 60°57.84'W at 0649,
43°58.24'N 61°03.03'W at 0730,

when the gear was recovered and a course set for proposed core site in northern Emerald Basin.

By means of a short echo-sounder traverse, we located the intended coring site in 140 m water depth at position 44°22.90'N 63°04.34'W, in northern Emerald Basin. Dropped 9-m gravity corer at 1511 UT, recovering a 3.8-m core [50, mud].

Plans to continue coring operations were interrupted by a medical emergency on board. Returned directly to Halifax Harbour, arriving alongside BIO at approximately 1800.

TECHNICAL SUMMARY

Navigation

Navigation was provided on a continuous basis by a Racal Decca Loran-C model 1028 receiver. Via an RS232 link with the receiver on the bridge, Loran data were logged once a minute to disk on the shipboard MicroVax-II. A hard copy printout was provided in the upper lab on a 300-baud Decwriter, also via an RS232 link with a deckhead distribution buffer box connected to the Loran-C receiver. The ASF corrections were applied directly into the Loran-C receiver. The Loran-C navigation data are included in the multiparameter data base file maintained at the Atlantic Geoscience Centre.

Radar fixes (Table 11) were noted when close to the coast as another check on the Loran-C accuracy. Fixes from satellite passes (Table 11) were received on a Magnavox MX5102 receiver and logged by the bridge officers in the scientific bridge log. These satellite fixes were plotted over the Loran data as a check and were logged (along with the radar fixes) on the MicroVax-II for future reference.

A MiniRanger system was also used and was originally intended as the primary means of navigation for inshore areas. Unfortunately the micro-based processing system for converting the ranges to latitude and longitude on a continuous basis did not function. At this time the cause of the failure is unknown. The MiniRanger ranges were logged by the watch-keepers at 15-minute intervals when running lines as well as at all sample locations. Positions at which shore transponders were deployed during the cruise are given in Table 12. The MiniRanger navigation data are recorded on a diskette filed with the cruise records at the Atlantic Geoscience Centre.

Bathymetry

Echo sounding was accomplished with a hull-mounted 12-kHz transducer, a Raytheon model PDD-200C transceiver, and a Raytheon model LSR1807M graphic recorder. Day/time annotations were added by the watch-keepers.

Deep-tow sparker

The high-resolution deep-tow sparker system was leased from NSRFC along with the operator, Jim Harris. NSRFC designed and built the electronics, including console, 9-element streamer, 30-tip sparker and pressure case. The sound source was a Teledyne model-253 500-J unit with the 30-tip sparker. Data were recorded on an EPC model-4603 recorder and on 1/4-inch tape on

channels 6 and 8 of a Hewlett-Packard tape recorder. The Geopulse data (see below) were recorded on the same tape on channels 1 and 2. The towed receiver was an Endeco V-fin, streamed and recovered using a Hawbolt winch with 700 m of armoured cable and a remote control.

The equipment was installed and operated in standard NSRFC operating configuration for Dawson (on the quarter deck through the A-frame). The equipment was fired at a standard rate of 250 ms at 200 J, triggered from the EPC recorder, and depth-compensated.

The tape channels contain the following information:

channel 1: Geopulse signal;
channel 2: Geopulse key;
channel 6: NSRFC key;
channel 8: NSRFC signal.

Surface-tow boomer

The AGC Geopulse system was used on this cruise, with a Hunttec surface-tow Sea-Otter as the sound source. The seismic information was collected with a 25-foot NSRFC hydrophone array. The signal was fed through a preamp and a Geopulse amplifier/filtering system.

Data were recorded for display on a EPC 1600-series recorder and stored on 1/4-inch magnetic tape on an 8-track Hewlett Packard tape recorder on channels 1 and 2 (see above).

Sidescan sonar

Sidescan information was collected with a Klein model-531T 3-channel system, using a 500-kHz fish with port and starboard transducers. Data were displayed on a Hydrosan model-531T wet-paper recorder.

The raw data were recorded on 1/4-inch magnetic tape on a Racal 4DS tape recorder. Information was stored on channels 1-4, as follows:

channel 1: FM port information;
channel 2: FM starboard information;
channel 3: DR reference;
channel 4: DR voice.

Scanning sonar

This cruise provided the first opportunity to test the Mesotech sonar in a hull-mounted configuration. The unit had recently been acquired at a good price from the ashes of Dobrocky Seatech and had been used successfully in a bottom-mounted configuration, using the old Ralph tripod, on a gravel-ripple patch at the mouth of Halifax Harbour.

The system consisted of the 971 controller, an RGB video monitor, and the sensor head. A crude camera housing and a hand-held 35-mm camera were used to photograph the video screen. An audio cassette recorder was used to record some voice comments and a Corona PC was used to send annotation to the screen. The head was mounted on a boom (the one built for the EM log) and the boom was attached to a plate welded to the hull on the starboard side forward of the hydrographic winch. The boom was raised each time the ship was underway. This part of the operation worked well.

The hope was that this unit would give an acoustic image of a 50- to 100-m area around each vibracore site in order to recognize such features as mud pits. Using the hull-mounted configuration, it does not appear that any bottom features can be unequivocally recognized. Returns from the ship's hull and propeller wash were the most prominent features seen in the sonar imagery. It seems that this system will only be effective if the sensor is mounted very close to the bottom and does not move during the scan cycle.

A software routine was written to send annotation (ship, cruise, date and time, ship's heading, sonar sector heading, film roll and frame number) to the bottom of the screen (see below). Some images were photographed, but it is not clear that these records will have any scientific value.

Dave Heffler wrote a Turbo-Basic program which adds annotation to the bottom of the video display screen. The program gives easy editing of the data, automatic date and time, and a permanent log on the disk. The following procedure is used to run the .EXE version.

- 1 -Connect the serial output of the computer to the serial input on the Mesotech. The Mesotech manual claims that it requires 9600 baud but the correct rate is 4800. Everything else is as the Mesotech manual says.
- 2 -Boot the computer and set the DOS date and time. Set the time to UT (GMT or Z) as required on the screen.
- 3 -Insert the Mesotech disk and type "A>meso file.dat". The file.dat is the name of the data file to which the data will be appended. The program can read this file (if it already exists) and initialize data with the last line from the file. The same file name could be used for an entire

cruise, with the data from each station being appended successively to the end of the file.

- 4 -Edit the data on the screen using arrow keys and typing letters or numbers where appropriate. F9 sends data to disk and F10 sends data to the Mesotech screen. The time is updated from the DOS clock on each display.
- 5 -The data format is as follows:
DAWSON 87-042 [day] [ship's heading] [sonar sector heading]
[film roll number and frame number] [time].

BRUTIV

The new Seastar BRUTIV (Bottom-Referencing Underwater Towed Instrument Vehicle) was used on this cruise. BRUTIV carried a low-light video camera, a 200-kHz echo sounder, a Lobsiger 35-mm still camera, and a 24-V DC sea battery. Lab equipment included surface controls, system console and a TV monitor. Some difficulties were encountered with deployment of BRUTIV from the foredeck, with cable running astern to a block on the quarterdeck crane. Although the vehicle was deployed successfully four times during the cruise, these aspects of operation from Dawson should be given some thought in future. BRUTIV towed well but there were problems with the cameras. In addition, a few minutes into the third deployment, the cable caught in the block at the stern and was damaged. BRUTIV was recovered with some difficulty as it seemed to fly down even when unpowered from the surface. The fourth deployment lasted about an hour. The flash wasn't working so again there were no pictures. The video worked but could see bottom only from about 4 feet. Bottom was going by too fast to see from this height. The bottom was rough and eventually a serious hit bent the port wing and caused the cable to be disconnected (and broken?).

UCON

This cruise provided a chance to test UCON, the Underwater CONtouring (high-frequency sonar) system developed for BRUTIV. It was installed for two of the four BRUTIV deployments. Graham Standen claimed that the vehicle didn't fly as well with UCON on board. This may have been because of interference between the two sounders. It could have been due to weight, drag, or imagination. Further controlled tests should be carried out.

Dave Heffler had written a crude but solid program to log data (no bells or whistles). This program seemed to work well in lab tests, but one test in Bedford Basin had suggested that there might be some data corruption. The program (\UCON\ ULOG.ASM) had two sections, one to log data and the other to dump it. Large portions of these were copied from Ralph programs. The logger used the Mesotech sounder to time the logging. It was

set to go at 20 samples per second and the program waited for replies. When it received a reply, it would check the real-time clock to see if the seconds had increased. If they had, it would save pressure, roll, pitch, and full altimeter reading (a D record). If a new minute, it would also save the time (a T record). Otherwise, the lower two BCD digits of the altimeter would be saved as one byte, 19 of them making an X record. It appeared that the Mesotech speed and the real-time clock speed were not quite in agreement and sometimes there would be 18 X readings, sometimes 19. These were always padded to 19 before a T or D record was taken, in order to keep the format constant. To facilitate testing, a breakpoint vector was needed in the bottom of each memory bank, so data were started at location 0040 of each bank. If the memory overflowed, it was set to cycle in the last bank. The 512-K memory was sufficient for about 5 hours of logging. The playback routine was almost a direct copy from SUDL (in Ralph). It asked for the start and end blocks (inclusive) and then sent the data in X-modem protocol. This seemed to work flawlessly. The logging program began at 8000 and the dump program at 9000. The monitor was used to load the hex file and start whichever program was desired.

The UCON data from both deployments were dumped successfully and examined by writing Turbo-Basic programs on the Compaq PC. The data were corrupted a little (perhaps 1% of the bytes). This corruption involved substitution of a garbage byte. There were absolutely no lost or added bytes: the format was perfect in several hundred kilobytes of memory. A big program was written to decode the data and display in three ways: numbers printed on the screen, a graph on the screen, or a strip chart on the Thinkjet printer. The sensors worked well in spite of the data corruption.

One battery pack (20 C-cells and 10 D-cells) was installed for almost two days, with the sounder on for about 4 hours. The sounder supply dropped from 30.9 to 28.5 V and the CPU from 16.0 to 12.8 V. This suggests that one pack will easily last a drop. It would be worthwhile making a low-power hibernate mode and giving the CPU control of the sounder supply. It would also be great to have the A/D sample and display battery voltages. If the hibernate power is low enough, an external switch is not necessary.

What needs to be done?

- 1 -We have to establish whether UCON's sounder interferes with BRUTIV's. A program could be written to turn the sounder on and off every 5 or 10 minutes. We could then fly BRUTIV (in Bedford Basin) to see if the performance changes.
- 2 -We should upgrade the sounder to higher resolution and (if needed, based on the above-mentioned test), use a different frequency.
- 3 -Heffler will decode the X records.

- 4 -Heffler will clean up the program sometime and make the above-mentioned battery changes.

Sampling equipment and handling

Grab samples were obtained using a small van-Veen grab as well as the new large IKU grab. The latter proved to be quite successful, despite some handling difficulties and occasional failure to trip. A 30-foot gravity core was attempted once, prior to the early termination of the cruise, with reasonable success. Full penetration into soft mud resulted in a 3.8-m core. The AGC vibracorer with the 20-foot barrel was the primary sampling tool for this cruise. The vibracore operations were very successful, except for some minor problems with the retraction winch and difficulty in extraction of the core liners from the barrel after recovery. Despite concerns about the handling of unwieldy sampling gear at the beginning of the cruise, the crew displayed exemplary skill in deploying this equipment. The ship's anchor was dropped for all vibracoring operations, an innovation that undoubtedly contributed to the success of the program and reduced the risk of bending the core barrel.

Vibracorer extension meter

The extension meter consists of an optical shaft encoder in a small pressure case mounted on the top of the frame. A wire, wound on a spring-loaded pulley, is connected to the core head. This pulley is geared to the shaft encoder. When the core head goes down it pulls the wire and turns the shaft of the encoder, which sends its absolute angular position up the cable about 10 times per second.

The position signal is transmitted serial as 3 ASCII decimal digits (followed by CR LF) at 1200 baud. This signal is sensed by a simple single-board computer mounted inside a dumb terminal in the lab. The computer corrects for the zero position, keeps track of complete turns of the encoder, and displays the extension in centimetres about once a second. The only complexity is that the encoder makes several complete rotations for full extension of the corer. The computer must track these rollovers. The shaft encoder has 8-bit resolution, so the angular position can range from 0 to 255. The pulley size and gearing have been chosen to give one step for each centimetre of extension. A full turn is 2.56 m, so 4 turns are possible. On retraction, the counts go in the other direction so the program must be able to detect rollovers in either direction. If the corer moves very quickly, the computer will not follow the rollovers properly and will introduce an error amounting to integer multiples of 256 cm. This quick motion could result from (a) the core barrel falling quickly through very soft mud, (b) a

sudden retraction if the core is retracted by the lifting cable and not by the retraction winch, or (c) the extension meter cable breaking or coming off the pulley.

The objectives on this cruise were (1) to observe the mechanical operation of the pulley system; (2) to log all the serial data to check for error signals; and (3) to give some thought to a better display.

Experience and conclusions:

- 1- The mechanical operation was reasonable. Several failures occurred. On one occasion the cable broke at the point of attachment on the core head. An eye-bolt should be provided and a better termination on the end of the sensor wire is needed. In another case, the wire jumped the pulley. The spring should be pre-tensioned a little.
- 2- The complete signal was logged for 8 minutes during collection of one 1.5-m core. There were about 10 readings per second but the old computer only looked at the data about once a second. The data were logged using XTALK on a Corona PC and copied to floppy disk. The data were plotted using a simple Turbo-Basic program. There were about 4000 readings with only one noise spike. A program could easily be written to filter noise glitches and plot in real time, either on a Thinkjet printer or on the computer screen. This program, because it would read all the data, would be much better at detecting rollovers.
- 3- It appears most reasonable to buy a PC-type computer (possibly a lap-top) to act as the display. The data could be logged and, with a little experience, we could say something about the properties of the sediments on the basis of core penetration rate. At the very least, real-time information on extension and retraction (while the corer is operating) can yield cores more quickly and with less disturbance. If the penetration rate diminishes to zero, the operator can stop vibrating and retract the barrel to minimize disturbance of the sample. An A/D board could be added and the roll and pitch logged as well, but this is less necessary.

Processing and inventory of samples and records

Core samples were cut into 1.5-m lengths, labelled, capped, taped, measured, and then stored securely in a vertical position outside aft. Labels consisted of cruise number, sample number and arrows indicating the top of the section. The sections were lettered according to AGC standards, with the lowermost 1.5-m section designated A/B, the next higher section B/C, and so on. Core lengths were measured top to bottom (0 m at the surface). The longer vibracores [10, 30, 33, 39, 47, 49] were subsequently split, photographed, and logged in the laboratory ashore.

Subsamples were taken for analyses of foraminifera, pollen, carbon, and grain size, and for ^{14}C dating.

Sidescan and seismic analogue records were annotated with day and time every 15 minutes using the TSS model 312B annotator. Bathymetric analogue records were annotated by the watch-keepers. Tape records were voice annotated every 15 minutes.

Throughout the cruise, a general-purpose logbook was maintained in the lab, in addition to separate logs for seismics, sidescan, and bathymetry. A scientific log was also maintained on the bridge by the ship's officers. This contained information on sampling locations, the time any piece of equipment went over the side or reached the bottom, etc.

Using a Corona PC and the data base management package dBase-III, an inventory of records, tapes, and samples collected was maintained on files updated daily throughout the cruise. The listings in this report were generated directly from these files with the report writing features of dBase-III.

Computers

Several micros were utilized on this cruise for functions such as data logging, word processing, development, and data processing.

A MicroVax-II minicomputer was used for Loran-C navigation data processing, plotting and data storage. The MicroVax was configured with 4 Mb of RAM, three 72-Mb hard disks, one TK50 tape cartridge and two VT terminals. One VT terminal was dedicated to running the Loran-C data-logging routine 'LOGLORAN'.

The logging and plotting routines were adapted from the SHIPAK geophysical data processing system and were first used on Dawson in the spring of 1987. A number of modifications must be made to this system to improve the plotting capabilities as well as the data viewing and logging routines. The system performed well.

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APPENDIX

Tables

TABLE 1

SAMPLE INVENTORY 87042

station number	sample type	day/time (UT)	latitude	longitude	depth (m)	geographic location
001	CORE	3061706	44 36.73N	63 23.05W	12.5	INNER SCOTIAN SHELF
003	GRAB	3061739	44 36.73N	63 23.05W	12.5	INNER SCOTIAN SHELF
005	GRAB	3061740	44 37.05N	63 23.28W	16.6	INNER SCOTIAN SHELF
006	CORE	3061801	44 37.05N	63 23.28W	16.6	INNER SCOTIAN SHELF
008	GRAB	3061911	44 36.19N	63 23.10W	26.0	INNER SCOTIAN SHELF
010	CORE	3061928	44 36.19N	63 23.10W	27.8	INNER SCOTIAN SHELF
011	GRAB	3062020	44 36.18N	63 23.01W	22.0	INNER SCOTIAN SHELF
012	GRAB	3062028	44 36.18N	63 23.01W	22.0	INNER SCOTIAN SHELF
014	GRAB	3071518	44 38.27N	63 06.82W	26.0	INNER SCOTIAN SHELF
016	GRAB	3071802	44 32.65N	63 03.34W	53.0	INNER SCOTIAN SHELF
017	GRAB	3071810	44 32.56N	63 03.12W	59.0	INNER SCOTIAN SHELF
018	GRAB	3071841	44 30.59N	63 02.71W	92.0	INNER SCOTIAN SHELF
019	GRAB	3071910	44 30.90N	63 01.53W	76.0	INNER SCOTIAN SHELF
020	GRAB	3071918	44 30.34N	63 01.44W	74.0	INNER SCOTIAN SHELF
021	GRAB	3071951	44 33.32N	63 00.67W	64.0	INNER SCOTIAN SHELF
022	GRAB	3071950	44 23.33N	63 00.56W	64.0	INNER SCOTIAN SHELF
023	GRAB	3081855	44 39.95N	63 10.81W	17.0	INNER SCOTIAN SHELF
025	GRAB	3082035	44 40.02N	63 10.76W	16.8	INNER SCOTIAN SHELF
026	CORE	3082112	44 40.07N	63 10.82W	16.8	INNER SCOTIAN SHELF
027	GRAB	3082213	44 39.91N	63 10.67W	19.5	INNER SCOTIAN SHELF
028	CORE	3082220	44 39.92N	63 10.65W	19.0	INNER SCOTIAN SHELF
029	GRAB	3082302	44 39.97N	63 10.81W	18.0	INNER SCOTIAN SHELF
030	CORE	3082309	44 39.97N	63 10.82W	18.0	INNER SCOTIAN SHELF
031	GRAB	3090038	44 38.58N	63 07.25W	30.0	INNER SCOTIAN SHELF
033	CORE	3090047	44 38.58N	63 07.25W	30.0	INNER SCOTIAN SHELF
034	GRAB	3091453	44 28.32N	63 27.72W	51.0	INNER SCOTIAN SHELF
035	GRAB	3091530	44 28.23N	63 27.82W	55.0	INNER SCOTIAN SHELF
036	GRAB	3091645	44 28.23N	63 27.80W	55.0	INNER SCOTIAN SHELF
037	GRAB	3091855	44 29.83N	63 26.43W	53.0	INNER SCOTIAN SHELF
038	GRAB	3101506	44 38.99N	62 57.02W	39.5	INNER SCOTIAN SHELF
039	CORE	3101520	44 38.99N	62 57.03W	39.5	INNER SCOTIAN SHELF
040	GRAB	3101803	44 38.19N	63 07.72W	28.0	INNER SCOTIAN SHELF
041	GRAB	3102015	44 33.43N	63 17.67W	49.0	INNER SCOTIAN SHELF
042	GRAB	3102019	44 33.43N	63 17.68W	49.0	INNER SCOTIAN SHELF
043	GRAB	3102221	44 35.56N	63 20.30W	27.8	INNER SCOTIAN SHELF
044	GRAB	3102344	44 35.96N	63 20.30W	27.0	INNER SCOTIAN SHELF
045	CORE	3102359	44 35.96N	63 20.33W	23.0	INNER SCOTIAN SHELF
046	GRAB	3122216	43 59.32N	59 53.84W	30.5	SABLE ISLAND BANK
047	CORE	3122256	43 59.30N	59 53.84W	30.5	SABLE ISLAND BANK
048	GRAB	3130018	44 59.56N	59 53.76W	33.0	SABLE ISLAND BANK
049	CORE	3130024	43 59.60N	59 53.75W	33.0	SABLE ISLAND BANK
050	CORE	3131511	44 22.90N	63 04.34W	140.0	NORTHERN EMERALD BASIN

TABLE 2

GRAB SAMPLES 87042

sample number	tool	day/time (UT)	latitude longitude	depth (m)	number attempts	notes
003	vanVeen	3061739	44 36.73N 63 23.05W	12.5	1	grey fine sand with shell and shell fragments
005	vanVeen	3061740	44 37.05N 63 23.28W	16.6	1	grey sand with shell fragments
008	vanVeen	3061911	44 36.19N 63 23.10W	26.0	1	sand with shell fragments
011	vanVeen	3062020	44 36.18N 63 23.01W	22.0	1	no sample (kelp in jaws)
012	vanVeen	3062028	44 36.18N 63 23.01W	22.0	1	no sample (kelp in jaws)
014	vanVeen	3071518	44 38.27N 63 06.82W	26.0	1	fine sand with pebble and shell fragments
016	vanVeen	3071802	44 32.65N 63 03.34W	53.0	1	no sample (did not trip)
017	vanVeen	3071810	44 32.56N 63 03.12W	59.0	1	no sample (did not trip)
018	vanVeen	3071841	44 30.59N 63 02.71W	92.0	1	fine sand with worm tubes and starfish
019	vanVeen	3071910	44 30.90N 63 01.53W	76.0	1	poor sample (cobble [saved] in jaws)
020	vanVeen	3071918	44 30.34N 63 01.44W	74.0	1	gravel (jaws part open)
021	vanVeen	3071951	44 33.32N 63 00.67W	64.0	1	no sample (jaws closed)
022	vanVeen	3071950	44 23.33N 63 00.56W	64.0	1	no sample
023	vanVeen	3081855	44 39.95N 63 10.81W	17.0	1	sandy silt with shell fragments
025	vanVeen	3082035	44 40.02N 63 10.76W	16.8	1	sand
025	vanVeen	3082045	44 40.02N 63 10.76W	16.8	1	sand

TABLE 2

GRAB SAMPLES 87042

sample number	tool	day/time (UT)	latitude longitude	depth (m)	number attempts	notes
027	vanVeen	3082213	44 39.91N 63 10.67W	19.5	1	sand with fine shells
029	vanVeen	3082302	44 39.97N 63 10.81W	18.0	1	fine sand with sand-dollar and fragments
031	vanVeen	3090038	44 38.58N 63 07.25W	30.0	1	fine sand with shell fragments
034	vanVeen	3091453	44 28.32N 63 27.72W	51.0	1	cobbles
035	vanVeen	3091530	44 28.23N 63 27.82W	55.0	1	gravel
036	IKU	3091645	44 28.23N 63 27.80W	55.0	2	mud-sand-gravel with 2 boulders and worm tube
037	IKU	3091855	44 29.83N 63 26.43W	53.0	5	sand-gravel-boulders with brittle-stars & shells
038	vanVeen	3101506	44 38.99N 62 57.02W	39.5	1	fine sand with shell fragments
040	IKU	3101803	44 38.19N 63 07.72W	28.0	1	mud-sand-gravel with shells and shell fragments
041	vanVeen	3102015	44 33.43N 63 17.67W	49.0	1	cobble
042	vanVeen	3102019	44 33.43N 63 17.68W	49.0	2	pebble-cobble gravel
043	vanVeen	3102221	44 35.56N 63 20.30W	27.8	3	no sample
044	vanVeen	3102344	44 35.96N 63 20.38W	27.0	1	sand
046	vanVeen	3122216	43 59.32N 59 53.84W	30.5	1	sand and sand-dollars
048	vanVeen	3130018	44 59.56N 59 53.76W	33.0	1	sand and sand-dollars

TABLE 3

CORE SAMPLES 87042

core number	type of core	day/time (UT)	latitude longitude	water depth (m)	corer length (cm)	app. penn. (cm)	core length (cm)	no. of sect.	seismic day/time (UT)	notes
001	VIBRACORE	3061706	44 36.73N 63 23.05W	12.5	610	130	072	1	3100120	Inner shelf off Cole Harbour.
006	VIBRACORE	3061801	44 37.05N 63 23.28W	16.6	610	133	073	1	3100115	Inner shelf off Cole Harbour. Depth checked with lead line.
010	VIBRACORE	3061928	44 36.19N 63 23.10W	27.0	610	533	463	3	3100130	Inner shelf off Cole Harbour.
026	VIBRACORE	3082112	44 40.07N 63 10.82W	16.8	610	183	147	1	3071219	Inner shelf off Petpeswick Inlet. Sand. Sand in catcher. Winch malfunction on retraction. Barrel not fully retracted.
028	VIBRACORE	3082220	44 39.92N 63 10.65W	19.0	610	101	52	1	3071222	Inner shelf off Petpeswick Inlet. Stiff mud in cutter. Problems with winch on retraction.
030	VIBRACORE	3082309	44 39.97N 63 10.82W	18.0	610	437	428	3	3071220	Inner shelf off Petpeswick Inlet. Sand at bottom of core. Trouble again with retraction.
033	VIBRACORE	3090047	44 38.58N 63 07.25W	30.0	610	464	434	3	3100638	Inner shelf off Martinique Beach. Wood and plant fragments in cutter.
039	VIBRACORE	3101520	44 38.99N 62 57.03W	39.5	610	570	565	4	3101305	Inner shelf off Clam Bay. Grey mud. Silt-sand in catcher. Retraction problem. Stuck in mud for few minutes before released.
045	VIBRACORE	3102359	44 35.96N 63 20.33W	23.0	610	172	091	1	3100026	Inner shelf off Lawrencetown Beach. Appears some sample left in hole.
047	VIBRACORE	3122256	43 59.30N 59 53.84W	30.5	610	234	210	1	*	Off Sable Island (north side). Material washed out of catcher. Liner very difficult to extract. * No seismic coverage this cruise.
049	VIBRACORE	3130024	43 59.60N 59 53.75W	33.0	610	284	289	2	*	Off Sable Island (north side). Peat 2.30-2.67 m. Organic medium sand in catcher. * No seismic coverage this cruise.
050	GRAVITY	3131511	44 22.90N 63 04.34W	140.0	915	915	380	2	3070812	Emerald Basin. Section 0.8 m long from top of C placed in small section of liner and stored in bucket. Small piece

TABLE 4

PARAMETER RECORDING PERIODS 87042

data type	start day/time (JD) (UT)	stop day/time (JD) (UT)
12-kHz bathymetry	3062134	3071440
12-kHz bathymetry	3072042	3081200
12-kHz bathymetry	3090138	3091300
12-kHz bathymetry	3092100	3101411
12-kHz bathymetry	3110147	3111730
12-kHz bathymetry	3120500	3121700
12-kHz bathymetry	3130316	3130730
Klein sidescan	3062215	3071440
Klein sidescan	3072045	3081200
Klein sidescan	3090212	3091300
Klein sidescan	3092100	3101411
Klein sidescan	3110147	3111730
Klein sidescan	3120500	3121649
Klein sidescan	3130316	3130730
NSRFC deep-tow	3070004	3070117
NSRFC deep-tow	3070150	3071122
NSRFC deep-tow	3080006	3080618
NSRFC deep-tow	3080631	3081200
NSRFC deep-tow	3090915	3091300
NSRFC deep-tow	3092100	3100830
NSRFC deep-tow	3100845	3101000
NSRFC deep-tow	3110147	3111153
NSRFC deep-tow	3120500	3121700
NSRFC deep-tow	3130316	3130730
Geopulse surface-tow	3062208	3071440
Geopulse surface-tow	3090247	3091300
Geopulse surface-tow	3101030	3101411
BRUTIV camera sled	3062345	3070131
BRUTIV	3090138	3090145
BRUTIV	3092048	3092130

TABLE 5
SEISMIC TAPES 87042

tape number	start day/time	stop day/time	geographic location	channels
001	3062215	3070120	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
002	3070120	3070434	SHELF- EMERALD BASIN	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
003	3070437	3070751	EMERALD BASIN	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
004	3070753	3071105	EMERALD BASIN- SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
005	3071109	3071424	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
006	3080000	3080320	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
007	3080320	3080632	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
008	3080634	3080948	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
009	3080951	3090352	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
010	3090352	3090706	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL

TABLE 5
SEISMIC TAPES 87042

tape number	start day/time	stop day/time	geographic location	channels
011	3090708	3091020	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KYE 8= NSRFC SIGNAL
012	3091022	3092115	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
013	3092126	3100040	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
014	3100040	3100354	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
015	3100357	3100708	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
016	3100710	3101024	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
017	3101025	3101343	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
018	3101345	3110437	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
019	3110452	3110805	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
020	3110808	3111123	INNER SCOTIAN SHELF	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL

TABLE 5
SEISMIC TAPES 87042

tape number	start day/time	stop day/time	geographic location	channels
021	3111127	3120827	INNER SHELF- SABLE	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
022	3120832	3121145	SABLE ISLAND BANK	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
023	3121150	3121505	SABLE ISLAND BANK	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 3= NSRFC KEY 4= NSRFC SIGNAL
024	3121507	3130441	SABLE ISLAND BANK	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL
025	3130444	3130730	SABLE ISLAND BANK	1= GEOPULSE SIGNAL 2= GEOPULSE KEY 6= NSRFC KEY 8= NSRFC SIGNAL

TABLE 6

SHALLOW SEISMIC RECORDS 87042

roll	data type	start day/time	stop day/time	geographic location	recorder	hydrophone
001	NSRFC deep-tow	3070020	3071123	INNER SHELF & BASIN	EPC 4603	V-FIN
002	NSRFC deep-tow	3072350	3081200	INNER SCOTIAN SHELF	EPC 4603	V-FIN
003	NSRFC deep-tow	3090905	3091300	INNER SCOTIAN SHELF	EPC 4603	V-FIN
004	NSRFC deep-tow	3092103	3100505	INNER SCOTIAN SHELF	EPC 4603	V-FIN
005	NSRFC deep-tow	3100512	3101000	INNER SCOTIAN SHELF	EPC 4603	V-FIN
006	NSRFC deep-tow	3110150	3110910	INNER SCOTIAN SHELF	EPC 4603	V-FIN
007	NSRFC deep-tow	3110911	3111150	INNER SCOTIAN SHELF	EPC 4603	V-FIN
008	NSRFC deep-tow	3120450	3121655	SABLE ISLAND	EPC 4603	V-FIN
009	NSRFC deep-tow	3130330	3130730	SABLE ISLAND BANK	EPC 4603	V-FIN
001	Geopulse surface-tow	3062158	3071437	INNER SCOTIAN SHELF	EPC 1600	EEL
002	Geopulse surface-tow	3090250	3101411	INNER SCOTIAN SHELF	EPC 1600	EEL

TABLE 7

SIDESCAN TAPES 87042

tape number	start day/time	stop day/time	geographic location	channels
001	3062215	3070113	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
002	3070115	3070424	SHELF- EMERALD BASIN	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
003	3070427	3070739	EMERALD BASIN	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
004	3070800	3071056	EMERALD BASIN- SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
005	3071058	3071413	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
006	3071413	3072320	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
007	3072322	3080220	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
008	3080230	3080530	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
009	3080546	3080900	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
010	3080903	3081200	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE

TABLE 7

SIDESCAN TAPES 87042

tape number	start day/time	stop day/time	geographic location	channels
011	3090209	3090510	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
012	3090520	3090830	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
013	3090835	3091309	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
014	3091148	3092252	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
015	3092253	3100210	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
016	3100210	3100520	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
017	3100523	3100835	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
018	3100837	3101147	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
019	3101150	3110238	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
020	3110239	3110548	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE

TABLE 7

SIDESCAN TAPES 87042

tape number	start day/time	stop day/time	geographic location	channels
-----	-----	-----	-----	-----
021	3110552	3110901	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
022	3110904	3111215	INNER SCOTIAN SHELF	1=FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
023	3111219	3111526	INNER SCOTIAN SHELF	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
024	3111530	3120550	INNER SHELF- SABLE	1=FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
025	3120552	3120902	SABLE ISLAND BANK	1=FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
026	3120904	3121214	SABLE ISLAND BANK	1=FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
027	3121217	3121526	SABLE ISLAND BANK	1=FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
028	3121530	3130457	SABLE ISLAND BANK	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE
029	3130459	3130730	SABLE ISLAND BANK	1= FM LEFT 2= FM RIGHT 3= DR REF 4= DR VOICE

TABLE 8

SIDESCAN RECORDS 87042

roll	start day/time	stop day/time	geographic location	recorder
001	3062215	3070417	INNER SCOTIAN SHELF	HYDROSCAN
002	3070420	3071425	INNER SHELF & BASIN	HYDROSCAN
003	3072005	3080515	INNER SCOTIAN SHELF	HYDROSCAN
004	3080519	3081200	INNER SCOTIAN SHELF	HYDROSCAN
005	3090215	3091155	INNER SCOTIAN SHELF	HYDROSCAN
006	3091157	3091300	INNER SCOTIAN SHELF	HYDROSCAN
007	3092100	3100449	INNER SCOTIAN SHELF	HYDROSCAN
008	3100451	3101411	INNER SCOTIAN SHELF	HYDROSCAN
009	3110148	3110200	INNER SCOTIAN SHELF	HYDROSCAN
010	3111030	3111734	INNER SCOTIAN SHELF	HYDROSCAN
011	3120500	3121340	SABLE ISLAND BANK	HYDROSCAN
012	3121345	3121704	SABLE ISLAND BANK	HYDROSCAN
013	3130330	3130740	SABLE ISLAND BANK	HYDROSCAN

TABLE 9

12-kHz BATHYMETRIC RECORDS

roll	start day/time	stop day/time	geographic location	recorder
001	3061500	3070420	INNER SCOTIAN SHELF	RAY (UGR)
002	3070130	3081100	INNER SHELF & BASIN	RAY (UGR)
003	3081115	3101200	INNER SCOTIAN SHELF	RAY (UGR)
004	3101205	3121345	INNER SHELF- SABLE	RAY (UGR)
005	3121355	3131555	SABLE- INNER SHELF	RAY (UGR)

TABLE 10

Radiocarbon dates

core	depth (cm)	material	lab. no. ¹	age ² (years BP)
----	-----	-----	-----	-----
10	131	<u>Portlandia</u> sp. shell	RIDDL-1077	6130 ± 110
30	170	seaweed	RIDDL-1078	4240 ± 130
30	272	freshwater peat	GX-13973	8800 ± 390
33	224	<u>Mytilus edulis</u> shell	RIDDL-1079	7190 ± 120
33	338	<u>Macoma balthica</u> shell	RIDDL-1080	7280 ± 100
33	430 ³	saltmarsh peat	GX-13972	7500 ± 120
39	259	<u>Macoma balthica</u> shell	RIDDL-1081	7680 ± 130
39	384	<u>Polinices heros</u> shell	GX-13974	9240 ± 130
39	544	<u>Spisula polynyma</u> shell	RIDDL-1082	10980 ± 120
49	202	organic-rich sand	GX-13969	8465 ± 330
49	230	unidentified bivalve	RIDDL-1083	7130 ± 120
49	234	saltmarsh peat	GX-13970	8100 ± 235
49	257	freshwater peat	GX-13971	8445 ± 125

¹RIDDL: Radio-Isotope Direct Detection Laboratory, Simon Fraser University, Burnaby, B.C.

GX: Geochron Laboratories, Krueger Enterprises Inc., Cambridge, Massachusetts.

²Ages in radiocarbon years BP, assuming ¹⁴C half-life of 5568 years. RIDDL dates are AMS, corrected for $\delta^{13}\text{C}$ according to and follow conventions of Stuiver and Polach (1977). GX dates are from conventional ¹⁴C analyses, corrected for $\delta^{13}\text{C}$, following standard procedures of Geochron Laboratories.

³Catcher sample (87042-033-CATA).

TABLE 11

Radar fixes

<u>day</u>	<u>time</u>	<u>latitude</u>	<u>longitude</u>
306	1656	44°37.12N	62°23.45W
306	2222	44°35.75N	63°23.00W
306	2227	44°35.87N	63°22.23W
306	2233	44°36.31N	63°22.41W
306	2245	44°36.09N	63°23.87W
306	2300	44°37.05N	63°24.07W
306	2313	44°37.23N	63°22.90W
307	0000	44°35.80N	63°20.42W
307	1118	44°36.50N	63°11.70W
307	1130	44°37.25N	63°11.75W
307	1200	44°38.80N	63°11.45W
307	1230	44°40.30N	63°10.80W
307	1300	44°38.80N	63°07.50W
307	1330	44°38.40N	63°08.40W
307	1400	44°40.05N	63°08.00W
307	1430	44°38.90N	63°07.40W
307	1530	44°38.70N	63°06.70W
307	1600	44°38.60N	63°07.05W
308	0500	44°23.95N	63°22.50W
308	0530	44°22.92N	63°26.10W
308	0558	44°22.10N	63°29.33W
308	0600	44°23.05N	63°29.84W
308	0608	44°23.96N	63°29.68W
308	0630	44°24.60N	63°28.00W
308	0700	44°25.40N	63°24.35W
308	0715	44°25.95N	63°22.55W
308	0751	44°29.13N	63°24.80W
308	0800	44°29.08N	63°25.95W
308	0830	44°27.89N	63°29.12W
308	0848	44°27.22N	63°31.09W
308	0859	44°26.35N	63°30.65W
308	0913	44°25.45N	63°31.40W
308	0930	44°25.90N	63°29.26W
308	1130	44°30.62N	63°24.38W
308	1850	44°40.00N	63°10.75W
308	2030	44°40.00N	63°10.80W
308	2110	44°40.10N	63°10.82W
308	2214	44°39.91N	63°10.60W
308	2302	44°39.91N	63°10.75W
309	0030	44°38.60N	63°07.40W
309	0230	44°38.30N	63°06.70W
309	0430	44°36.53N	63°02.22W
309	0500	44°36.53N	63°05.35W
309	0530	44°36.52N	63°08.47W
309	0600	44°36.50N	63°11.63W
309	0730	44°34.10N	63°21.75W
309	0800	44°32.90N	63°25.32W

Satellite fixes

<u>day</u>	<u>time</u>	<u>latitude</u>	<u>longitude</u>
307	0124	44°31.56N	63°14.64W
307	0348	44°19.66N	63°09.98W
307	0402	44°18.50N	63°09.51W
307	0549	44°12.58N	63°03.88W
307	0635	44°15.39N	63°01.79W
307	0822	44°23.99N	63°04.80W
307	1011	44°31.28N	63°11.55W
307	1023	44°32.23N	63°11.53W
307	1050	44°34.32N	63°11.49W
307	1321	44°38.11N	63°07.69W
307	1908	44°30.72N	63°01.35W
307	2057	44°33.23N	62°58.98W
307	2156	44°33.82N	62°50.99W
307	2319	44°34.26N	62°44.85W
308	0016	44°31.85N	62°49.75W
308	0204	44°29.13N	63°01.51W
308	0325	44°26.66N	63°10.96W
308	0514	44°23.22N	63°23.93W
308	0759	44°28.96N	63°25.76W
308	0859	44°26.35N	63°30.41W
308	2030	44°40.00N	63°10.80W
308	2332	44°40.00N	63°10.73W
309	0115	44°38.61N	63°07.19W
309	0230	44°38.30N	63°06.70W
309	0450	44°36.56N	63°04.44W
309	0627	44°36.48N	63°15.09W
309	0736	44°33.79N	63°22.38W
309	0810	44°32.39N	63°26.25W
309	0915	44°29.46N	63°29.94W
309	0956	44°26.66N	63°28.44W
309	1042	44°23.57N	63°26.16W
309	1115	44°21.23N	63°24.61W
309	2159	44°27.20N	63°24.23W
309	2234	44°28.14N	63°21.06W
309	2251	44°29.25N	63°19.72W
309	2343	44°33.29N	63°19.78W
310	0403	44°31.43N	63°14.67W
310	0429	44°32.87N	63°13.39W
310	0551	44°38.86N	63°11.37W
310	0714	44°35.85N	63°07.43W
310	0902	44°33.98N	63°01.09W
310	0951	44°35.02N	62°56.08W
310	1007	44°35.31N	62°54.60W
310	1052	44°36.21N	62°50.19W
310	1136	44°37.57N	62°51.34W
310	1401	44°36.69N	63°02.22W
311	0328	44°21.54N	63°16.61W

TABLE 11 (continued)

Radar fixes

<u>day</u>	<u>time</u>	<u>latitude</u>	<u>longitude</u>
309	0830	44°31.70N	63°28.62W
309	0853	44°30.82N	63°30.90W
309	0900	44°30.34N	63°30.70W
309	0930	44°28.50N	63°29.60W
309	1000	44°26.45N	63°28.24W
309	1600	44°28.30N	63°27.00W
309	2330	44°32.17N	63°19.80W
310	0030	44°36.50N	63°20.00W
310	0100	44°36.40N	63°21.75W
310	0130	44°36.19N	63°23.10W
310	0200	44°34.30N	63°23.00W
310	0230	44°31.80N	63°22.90W
310	0300	44°30.90N	63°21.20W
310	0330	44°31.30N	63°17.90W
310	0400	44°31.30N	63°15.40W
310	0412	44°31.49N	63°13.88W
310	0500	44°35.34N	63°12.14W
310	0518	44°36.50N	63°11.90W
310	0530	44°37.41N	63°11.42W
310	0554	44°39.17N	63°11.38W
310	0629	44°39.62N	63°07.62W
310	0641	44°38.63N	63°07.39W
310	0700	44°37.05N	63°07.50W
310	0830	44°33.42N	63°03.90W
310	0900	44°33.92N	63°01.10W
310	0930	44°34.59N	62°58.42W
310	1000	44°35.30N	62°55.30W
310	1030	44°35.82N	62°52.72W
310	1100	44°36.78N	62°48.05W
310	1130	44°37.90N	62°50.70W
310	1200	44°37.00N	62°53.45W
310	1230	44°37.95N	62°58.90W
310	1400	44°36.80N	63°01.80W
310	1500	44°39.10N	62°57.20W
310	1800	44°38.18N	63°07.37W
310	2217	44°35.50N	63°20.45W
311	1130	44°36.35N	62°50.20W
311	1200	44°37.80N	62°47.00W
311	1230	44°36.45N	62°45.50W
311	1300	44°35.90N	62°48.20W
311	1430	44°34.90N	62°57.50W
311	1500	44°34.28N	63°01.38W
311	1530	44°33.50N	63°06.00W
311	1600	44°33.20N	63°07.60W
311	1630	44°32.66N	63°12.71W
311	1700	44°32.10N	63°16.35W

Satellite fixes

<u>day</u>	<u>time</u>	<u>latitude</u>	<u>longitude</u>
311	0406	44°20.82N	63°12.13W
311	0515	44°19.78N	63°03.91W
311	0651	44°18.24N	62°52.94W
311	1213	44°37.13N	62°47.02N
311	1247	44°36.03N	62°46.97W
311	1338	44°35.02N	62°52.58W
312	0440	44°09.44N	61°04.44W
312	0628	44°12.82N	60°53.83W
312	0729	44°14.21N	60°48.27W

TABLE 12

MiniRanger transponder positions

		latitude	longitude

<u>day 306/1400 UT - day 306/2030 UT</u>			
station	1	44°13.222'N	63°25.338'W
	2	44°38.267'N	63°19.090'W
	3	44°37.750"N	63°17.000'W
	4	44°41.174'N	63°08.914'W
 day 306/2100 UT - day 311/1730 UT			
station	1	44°36.775'N	63°25.590'W
	2	44°40.525'N	63°12.475'W
	3	44°37.750'N	63°17.000'W
	4	44°41.174'N	63°08.914'W