Report on Cruise 2004-099
CCGS *Frederick G. Creed*
Surveys in the Bras d'Or Lakes, Nova Scotia, 2004

Geological Survey of Canada Open File Report 5061

J. Shaw and M. Lamplugh

Geological Survey of Canada (Atlantic) and Canadian Hydrographic Service

2006

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GEOLOGICAL SURVEY OF CANADA

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CRUISE INFORMATION

Vessel	CCGS *Frederick G. Creed*
Dates	
Areas of operation	Bras d'Or lakes, Cape Breton, Nova Scotia
Personnel	John Shaw (GSC) M. Lamplugh (CHS) A. Robertson (GSC)
Ship's personnel	
14th -15th June	Elie Bureau (Captain) Stephane Tessier (Chief Officer) Richard Boisvert (Chief Engineer) Maurice Jean (Chef)
16th – 25th June	Jean-Jacques Simard (Captain) Daniel Marcotte (Chief Officer) Clarence Russell (Chief Engineer) Emile Sioch (Chef)

OBJECTIVE

Collect multibeam bathymetry data in Bras d'Or Lakes, Cape Breton, Nova Scotia. This is a continuation of bathymetric mapping in the region as part of Project X-29 in the Geoscience for Ocean management Program.

SUMMARY OF OPERATIONS

Operations are in Atlantic Daylight Saving Time (Z - 3 hours.

Day 164 Saturday 12 June 2004
Creed leaves BIO en route to Cape Breton.

Day 165 Sunday 13 June 2004
Creed arrives at St. Peters and ties up at the south end of the canal locks at about 18:00. Shaw and Lamplugh leave BIO at about 16:00 and arrive about 20:00. The day is warm and sunny on the mainland. At St. Peters the evening is sunny but very cool.

Day 166 Monday 14 June 2004
The day dawns sunny (scattered high altocumulus cloud) and cool. Shaw and Lamplugh go to Radio Shack in St. Peters to collect some items. *Creed* is through the locks of the St. Peters Canal by 08:40. Shaw and Lamplugh go aboard and the vessel continues to the survey area. At 10:05 we slow down for the first svp cast. It fails due to 'finger error'. A second cast is completed in the deep area northwest of Kelly Shoals (depth 115-120 m) at 10:25 (SVP_JD166.002). The profile exhibits a uniform layer down to 15 m then a strong gradient down to about 40 m depth, and no gradient below that depth. This is followed by familiarization and a fire drill. At 11:00 *Creed* proceeds towards the start of lines. Moderate to strong southwest winds prevail during a sunny day with scattered to broken high and middle cloud. The vessel conducts surveys in the vicinity of George Island and Cameron Island. We run lines close to shore and around shoals, in order to delineate the shallowest areas and fill in the deeps at higher speed. By 16:45 we have collected and processed lines 2000 to 2013. However, several problems have been encountered. First, the chart is somewhat misaligned, so that navigation has to proceed very cautiously. Second, the logging stops six times and the sounder stops once. For example at 16:07 the operator gets the message "logging process is broken down. Mermaid will terminate."

At 16:50 we resume line running after the system is rebooted, and redundant files removed. We pass Clark Cove at 16:55 and observe tailings at the coast, and a former open pit mine behind. After running south of Green Island, we head for home but keep the sounder running. It is very rough at this point, due to a strong southerly wind: the seas are short and steep. L. 2019 is a very long line along the coast. A concentration of fishing gear is observed off MacRaes Point. By 19:00 there it is overcast with milky cirrus, with scattered altocumulus below. The final line is L. 2020. *Creed* ties up at the canal at 19:55. Near dusk it is nearly overcast with high, broken altocumulus. We do some repairs to the cell phone (broken power connections) and have to reboot the Sony CD/DVD burner in order to make it work. The day's raw data and HDCS data are backed up. In the evening terminators on the BMC lines of the Mermaid system are changed, and the computers are vacuumed to remove dust.

Day 167 Tuesday 15 June 2004
By daylight it is overcast with light rain and low stratus cloud. There is a strong southwesterly wind. We are under way by 06:30. By 07:20 we start logging just north of Cape St. George, on a line parallel to yesterday's return line (L. 2020). We start doing SVPs at 07:35 in about 60 m depth, but the first attempt fails (a problem with the configuration file). Data from the second try are used: SVP-JD167.002g. Lines 2021-2023 are connector lines. L. 2023 turns north and

becomes part of the main grid being run yesterday. Line running proceeds smoothly, without any of the breakdowns of the previous day. We 'fill in' the area between the coast at Marble Mountain and the nearby islands. In the morning we attach the DGPS feed to Shaw's lap top – previously the laptop has been receiving navigation for the Garmin GPS mounted just outside the laboratory. On starting up the laptop the mouse becomes impossible to use – it moves erratically when we try to point it. The problem is that the computer thinks the port with the navigation input is a mouse. The solution is to start up without the navigation feed in com 1, then connect the navigation when the computer is running.

The 'filling in' process ends about 18:20 near Green Island, as we end L. 2063. L. 2064 is a long line run as we return to St. Peters. The day is overcast and misty at times. The wind is mostly moderate to strong southwesterly, although it dies in the mid afternoon and the sun tries to make an appearance. The wind picks up in the late afternoon, and the overcast becomes continuous. Stratus ceiling is several hundred feet by 19:00 as we pass MacRaes Point. We terminate L. 2066 at about 19:20 and tie up at St. Peters Canal at 20:00. It is overcast with fog and drizzle.

Day 168 Wednesday 16 June 2004

Daybreak brings light winds and dense fog, but before 08:00 it is clearing. This is crew change, so no surveys are planned. At 08:15 Shaw and Lamplugh leave for Iona in bright sunshine. The day becomes warm, with scattered to broken cumulus humulus, and a stiff westerly breeze. We take some photographs at Marble Mountain, in the area of the previous days' surveys. We note the large amount of vegetated tailings at the water's edge. We reach the Iona tide gauge at 10:30. Unfortunately, the laptop does not have procom installed. Lamplugh downloads the data onto his Compaq iPAQ personal digital assistant (PDA). We measure the water level at the staff (0.32 m) and note the level at the gauge (0.303 m at 13:49.). We depart for Sydney at 11:30, have lunch in a Subway outlet, and drive to Canadian Tire for some supplies. We return to St. Peters by the south road – a shorter route and completely paved, unlike the western route via Marble Mountain. We return to *Creed* at 14:45, by which time the day has become quite warm. Later we stroll across to the nearby Bras d'Or Lakes Inn to pick up a CD and a memory stick posted in separate Priority Post packages from BIO. The new crew has arrived. Emile (le chef) has gone to Port Hawkesbury for groceries.

Day 169 Thursday 17 June

Creed is underway shortly after 06:30. The morning begins calm, and quite cold, with a clear sky except for some scattered high altocumulus. We collect data en route, then collect an SVP (SVP_JD169.002). Conditions are calm initially, with light to moderate breezes at times during the day. It is mostly sunny and warm, with patches of scattered to broken high stratocumulus. We survey in areas that adjoin the previous surveys, filling in holes and mapping shoals. The day passes without incident. By 19:40 we are passing MacRaes Point en route for St. Peters. We arrive at 20:40. The sky is nine tenths covered with angry looking stratocumulus/cumulus, and the wind is calm. In the evening Mike Lamplugh imports the HDCS data from the 2003 *Creed* cruise in the area and grids it.

Day 170 Friday 18 June 2004

Another beautiful morning arrives, with some scattered high stratocumulus far to the east, cool temperatures, and bright sunshine. *Creed* leaves the canal wharf at 06:30. We run lines filling in holes on the 2003 data, and then adding onto the 2003 coverage just to the southeast. The wind becomes quite strong by noon, reaching an estimated 25 to 30 knots at times, producing a

short choppy sea. However, this has little effect on *Creed* operations. The MVSVP is done at 07:30. A new directory was started on Mermaid for the raw data, so that it would not be overloaded. There were some problems with the POSMV at 14:30 on L. 2160. The survey was underway again by 14:45. At 18:25 we finish the homeward survey line off Dock Point, and are tied up at St. Peters by 19:00. The day's data are cleaned by this time, and backup is commenced.

Day 171 Saturday 19 June 2004

Creed departs St. Peters at 06:30. It is sunny and comparatively warm, with broken high altocumulus. As usual, line running begins where the channel widens. However, the first line – L. 2176 – cannot be converted. Later we discover that it can be converted but only without sidescan. After an SVP the *Creed* continues west, surveying a line close to the coast, and avoiding lobster pots on the shoals that extend off from the south coast of the lake. Thereafter most of the day is spent filling the large hole remaining from the previous day. The cloud progressively increases, and about 15:00 there is occasional light rain, though there is no low cloud, only about 8 tenths altocumulus –thickening into nimbostratus in places – and one tenth cirrus. The wind remains light. When the hole is filled in shortly before 15:00 (L. 2220) *Creed* runs south to Pringle Shoal, then east, surveying shoals. This is followed by more 'hole filling', which ends at 18:45 as the vessel turns for home, running a line en route. By now the cloud ceiling has lowered, the wind is light southeasterly, and there are a few spots of rain from time to time. *Creed* is tied up at St. Peters at 19:45. The cloud ceiling progressively lowers and rain begins after nightfall. Logging and processing are without incident, except that the first line of the day – L. 2156 – will not convert, but did so when we convert without sidescan.

Day 172 Sunday 20 June 2004

Departure is just after 06:30. The morning has begun overcast with fog and drizzle and light winds. We survey near Cape St. George, mapping the southeastward extension of the deep water channel (The Drain), then continue west, hugging the previous coverage and mapping shoals as we go. After finishing a hole left over from yesterday, we proceed west, surveying shoals, and begin a long line down the centre of West Bay – L. 2257. Then we run up one side and down the other for the rest of the day. The wind pick up suddenly from the WSW at 10:30, and blows strongly for most of the day. The overcast breaks in the late morning, and there are sunny spells and broken stratocumulus, with generally thicker cloud banks to the west over land. It is very cool. We finish running the West Bay grid with L. 22 75, at about 18:30 and head home, mapping coastal shoals en route. Logging and processing is uneventful, except as yesterday a line (L. 2269) has to be converted without sidescan. The last L. is L. 2278. As *Creed* heads down the channel into St. Peters it is a beautiful evening, the wind having died, the sun is shining low down in the western sky, with broken high stratocumulus, virga in places, and a few scraps of stratus fractus. The landscape is glowing. *Creed* ties up at St. Peters at 20:30.

Day 173 Monday 21 June 2004

Midsummer's Day, although it does not feel like it. Sunrise brings pleasant conditions at St. Peters: scattered high stratocumulus, cool temperatures, and light winds. We get under way at 06:30 and begin logging where the channel widens (l. 2279). This first line cannot be converted with sidescan. We collect an SVP as usual in the deep area north of MacRaes Point (SVP_JD173.001) and continue, operating in the areas between the shoals off MacRaes Point and Morrison Harbour. There is a very strong (25+ knots) westerly wind, and scattered cumulus. We observe numerous lobster pots on the shoals near the marker buoys, but no pots on the

landward continuation of the shoals, possibly because these comprise beach deposits, whereas the shoals – remnants of drumlins – are bouldery. We finish this coastal grid at 11:30 and go west, turn north at Ross Shoal, and conduct a detailed survey over the mysterious circle on the sea floor just west of Unknown Shoal. We finish this detailed grid at 15:55 and proceed to infill a large area between last year's survey and the coast, in MacKenzie Cove. The afternoon becomes cloudy, and there are a few spots of rain by 16:00. The wind drops completely, and there is a brief shower at about 18:00. A band of showers has passed to the east by 18:45. We break off surveys at MacKenzie Cove at 19:00 and head home. The final line is L. 2322. As we are nearing St. Peters, a rain shower brings with it a magnificent double rainbow. We tie up at 20:30.

Day 174 Tuesday 22 June 2004

It is midsummer and it does not feel like it. The morning is cool and dull, with broken altocumulus, including some altocumulus castellanus. The wind is light. We depart at 06:30 and carry out the same routine: start logging where the channel widens, stop for an SVP in the 61 m deep hole, then continue a long line to the northeast to rejoin yesterday's grid. The middle level cloud clears top the east and the day is fine, with scattered to broken cumulus, and lots of sunshine. Winds are light WSW, but moderate at times near the south end of West Bay. We run lines near MacKenzie Cove to infill a hole remaining from yesterday (most of the time is spent on one shoal). Then we break off to move south. At the east end of Green Island we almost snag a lobster pot. Fortunately is passes right between the two hulls and emerges at the other end. The system stops pinging at 12:31 and has to be stopped entirely, and started from scratch, including rebooting the BDU. At 13:05 we start on the main West Bay grid once more. At 14:40 we do a second cast of the MVSVP. At 17:45 we finish running the grid and turn for home, hugging the shoals along the coast. The final line is L. 2362. On our return the cirriform component of a band of frontal cloud that had been hovering on the SW horizon in the late afternoon comes overhead, possibly a herald for a change in the weather.

Day 175 Wednesday 23 June 2004

Indeed the weather has changed! At nightfall the sky had cleared somewhat, the altocumulus patches giving a fine red sunset. The old adage did not work, however, and this morning is overcast with rain and light winds at St. Peters as we depart, as usual, at 06:30. After running a line out we do a test SVP (to dry the drum) followed by a deeper one (SVP_JD175.002). The we do a grid in the deep water north of St. Peters. This shows that the long escarpment in deep water on older data is an artifact! At 09:00 we finish this grid and travel west. The day is overcast with rain at times and a light (5-10 knots) NE wind. We survey a few lines in west bay then run a boundary line near Calf and Cow Islands, then travel south to Floda Island, reaching there at 18:30. We run home, surveying as we go, ending surveys at 19:50 and tying up at St. Peters at 20:30. The rain has stopped, and a high overcast of stratocumulus remains. Angus Robertson arrives shortly after *Creed* ties up.

Day 176 Thursday 24 June 2004

Depart wharf at 06:30, Lamplugh having left. Sunny and calm. We proceed to the west and complete an SVP by 08:37. We begin surveys with L. 2419 at 08:37. The work proceeds normally until 16:10 when the system stops pinging. We use the 'stopped pinging' procedure: 1) stop logging; 2) turn off power on OPU/BDU; 3) turn off Simrad in hold –leave 20 s then turn on again; 4) load floppies and power up OPU/BDU; 5) turn on sounder; 6) increment line; 7) start

logging; 8) check speed of sound at transducer. The work ends with the end of L. 2441 and we return to St. Peters.

Day 177 Friday 25 June 2004
Creed departs as usual at 06:30. The morning is pleasant with light WSW winds (10-15 knots) and broken cirrus. When trying to run the MVSVP we get no signal. We commence surveys using the previous day's SVP. The POSMV fails at 14:25. L. 2464 is bad, but is not deleted from the data-logging system on the bridge. We shut down the POSMV and restart. Accuracy is sufficient to survey at 15:10. We start on L. 2465. At 17:00 we finish the grid and move east to fill a hole near Pringle Shoal. Surveys end at 17:45. Shaw and Robertson do backups then demobilize the system. The vessel transits the St. Peters Canal and the equipment is offloaded at the south end. They drive home in the government vehicle, returning home to Dartmouth at about 11:30.

TECHNICAL OPERATIONS

Summary
The intention was to extend the coverage obtained in 2003 in West Bay, Bras d' Or Lake. The survey equipment was a Simrad EM-1000 multibeam bathymetry system. Data were transmitted to the HIPS running on a workstation in the lab. Raw and processed data were stored on CDs and DVDs. The ship's tracks are shown in Figure 1, and the multibeam bathymetry in Figure 2.

The vessel
The ship is a twin-hulled vessel of the SWATH type (Small Waterplane Area Twin Hull) with a length of 20.42 m and accommodation for up to five crew and four scientific staff. The draft is commonly about 10.5 feet. Two staff were aboard during the survey, and four crew. Typical survey speed was 10-11 knots. Slower speeds were used when surveying shoals.

Digital baththymetry system
The vessel was equipped with a hull-mounted Simrad EM-1000 swath bathymetric system. Two required inputs each day were the transducer depth and the sound velocity profile. The transducer depth was input into the INSTALLATION menu in the EM-1000 TRANSDUCER sub menu. It was calculated by obtaining the ship's draft fore and aft (immediately before departure), calculating a mean, converting the mean to metres, and subtracting 0.27 m.

Before each day's surveys a sound velocity profile was collected using the Moving Vessel Sound Velocity Profiler (MVSVP), manufactured by Brook Ocean Technology Ltd. The system comprised a pc display in the lab and the profiler itself, positioned on the stern. The display allows the operator to assign a filename. It shows the position of the instrument (blue line), the sea surface (blue line), and the sea bed (Red line). A yellow line marks the assigned safety zone, usually 10 m above the sea bed. The instrument is deployed with the vessel moving fast enough to keep the instrument at about transducer depth (i.e., about 2-2.5 m). It is released and plunges downward until it reaches the assigned depth above bottom, and then automatically recovers. The data were entered into the Simrad system using the navigation computer on the bridge.

The array transducers mounted in the starboard pod fed 60 soundings per ping (over a range of 120 degrees) into the EM-1000. Files were stopped and started and file numbers allocated at the Simrad operators' console on the bridge. All turns were logged – (normal GSCA practice has been to cut off turns during cleaning).

The screens watched by the bridge operator were (from left to right): 1) The MERMAID console, showing whether or not logging was proceeding; 2) A console showing coverage; 3) the Simrad console, showing the cross-track and along-track pings as staves; 4) The navigation console, showing the lines as a REGULUS grid, overlying the chart. This information was displayed on the steersman's console; and 5) The POSMV console, indicating navigation information.

Navigation

A Magnavox Global Positioning System (GPS) receiver located on the bridge received differentially corrected signals from Canadian Coastguard stations. The differentially corrected signal was fed into the POSMV system that used its motion sensor - a gyro accelerometer package -to provide sub-metre accuracy positions to the Simrad sounder.

Data Management

Bathymetry and navigation data from the EM-1000 system fed to the HIPS (Hydrographic Information Processing System) computer, where the data were cleaned, and tide files added. Every evening raw data and processed (HDCS) data were backed up on CDROM or DVD tapes. The detailed process was as follows:

The data-cleaning operator retrieved data from the Mermaid system using SmartFTP. The data source was **142.2.4.1 (Neptune)/ data1/raw/West_Bay**. The data were moved to the pc in the lab, specifically into **hips on 'Creedpc2' (W:)/Preprocess/Brasdor_2004**. In this location a series of folders was made up, on for each day, e.g., **JD166_2004** etc. The screen capture below shows this process.

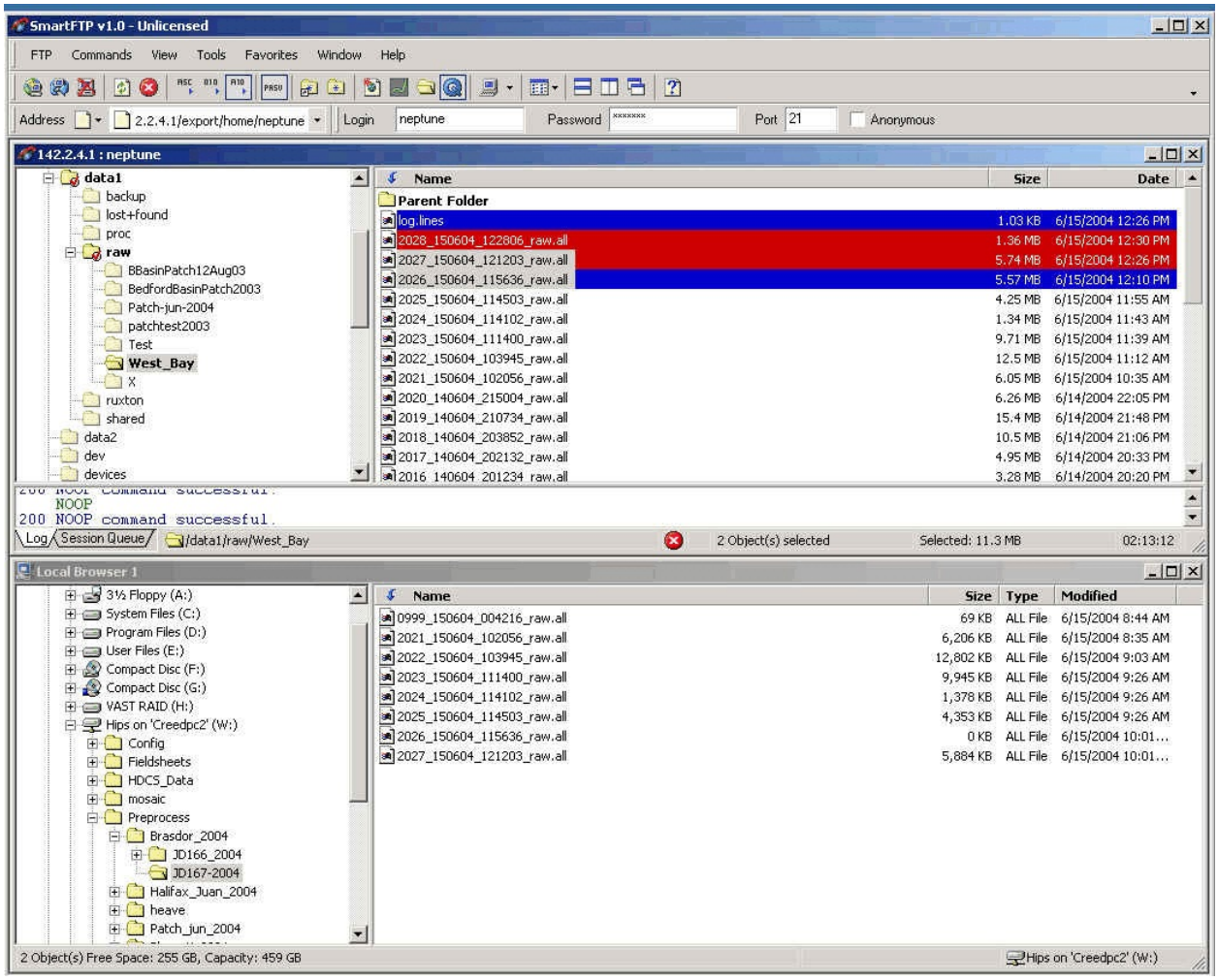


Fig. 1: Screen grab showing an example of the ftp screen during an operation to transfer raw data to the cleaning pc.

The structure of the Hips data-cleaning pc is shown below:

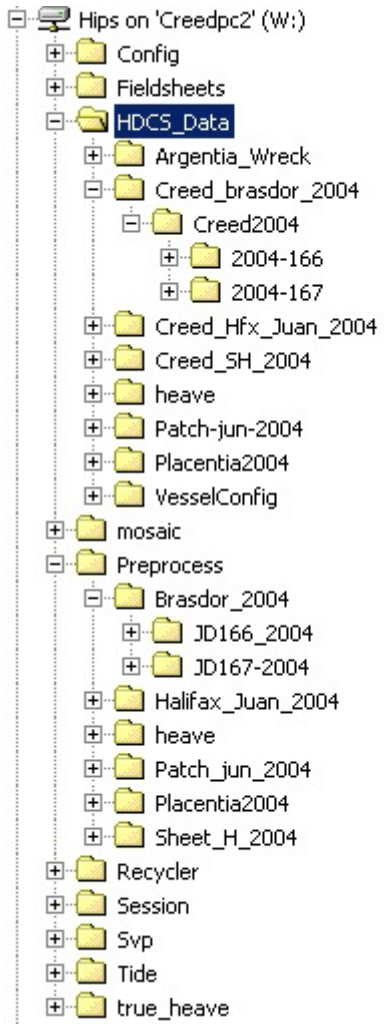


Fig. 2: Screen grab showing the file structure on the pc running hips. Raw data are stored in the 'Preprocess' folder, and cleaned data in the file 'HDCS_Data.'

The next stages in cleaning were as follows:

1) The project '*Creed*_brasdor_2004' was opened.
2) The conversion wizard was used to convert the lines.
3) The navigation was cleaned with the navigation editor. Compared with a few years ago, navigation is very clean, and errors are seldom encountered.
4) The soundings were cleaned in Swathedit.
5) Tides were added.
6) Data were merged.

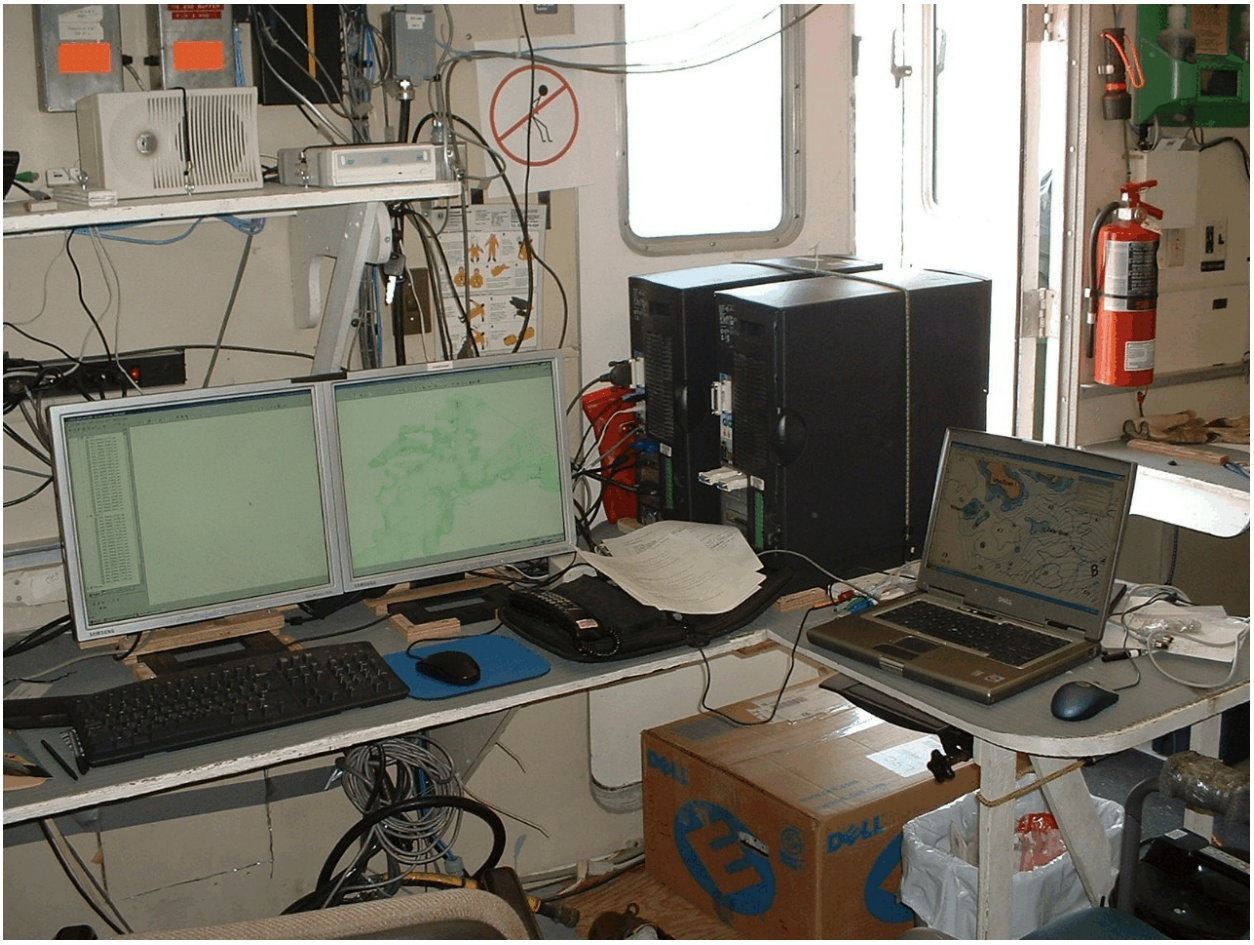


Fig. 3: The main laboratory on CCGS *Creed*. At left-of the image - is the 'vastraid' computer. On the desk are the twin screens and keyboard for the HIPS data cleaning system. To the right are two pcs. In the right foreground is a laptop used to write the cruise report. IT is using FUGAWI software to display a chart of the region. This program is receiving real-time navigation which is displayed on top of the chart.

Fig. 4: Another view of the laboratory, this time showing the MVSVP pc computer.

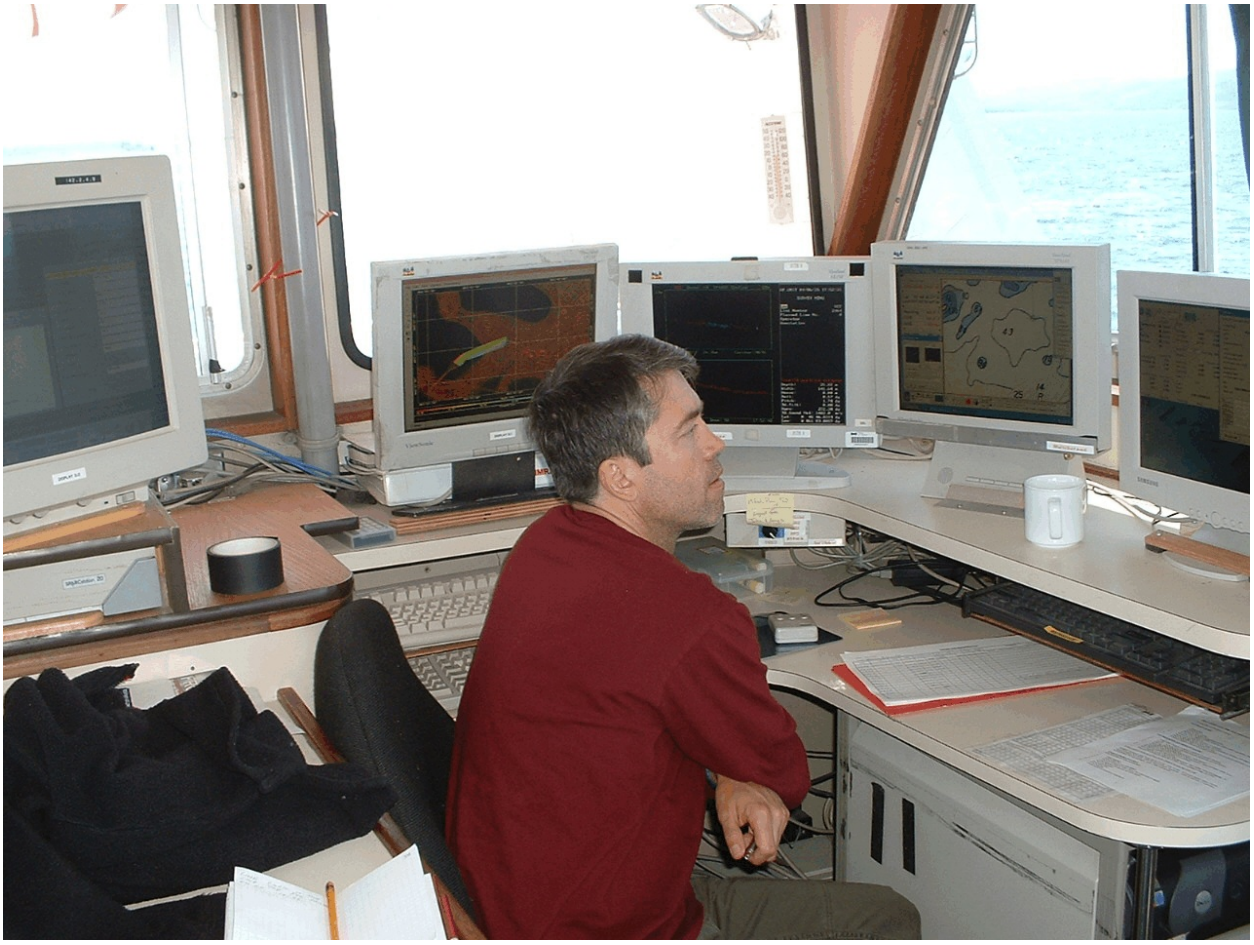


Figure 5: Setup on the bridge. At left is the MERMAID computer and screen. Next is the screen for MERLIN, then the display for the SIMRAD system. Next is the REGULUS navigation display and at the right is the PSOMV screen. Angus Robertson is seated.

Laptop procedures

The SVP data were collected from the MVSVP computer each day and stored on the lap top computer. Apart from being used to maintain the cruise report, the lap top computer was also used to run the Fugawi chart-plotting software. Early in the cruise navigation was fed into the program from a (hand-held) Garmin GPS receiver hung just outside the laboratory, into com port 1. However, this meant that we were unable to plug in the power cord for the Motorola cell phone. A solution was to feed in the DGPS navigation from the bridge, using the POSMV GPS data buffer box in the laboratory. A problem encountered (and also by Ned King on the previous *Creed* cruise) was that if the computer was started with the com port 1 connected, the mouse became erratic and useless. The solution was to start up the computer with the data link disabled. Once the lap top was running, the connection could be made safely.

SCIENTIFIC SUMMARY

This part of Bras d'Or Lake is dominated by the presence of fields of drumlins oriented northeast-southwest. The drumlins have been modified during the Holocene transgression, so that coastal landforms of various types are present. In the 2003 *Creed* data, a bedrock structural grain running about 300 degrees is apparent. The evidence is a series of short, parallel bedrock ridges that emerge from beneath the till cover between drumlins.

The evidence of former coastlines consists of several types. On the larger, shallower drumlin hills – e.g., Paddle Shoal – there appears to be a notch cut at -24 m with an offshore platform with a break of slope at -25 m. Similar notches occur on smaller drumlins farther north. A series of stranded tombola beaches links the former drumlin islands. Between Paddle Shoal and the un-named shoal to its southeast they lie at -21m; they were stranded at this depth because with rising sea level in the mid-late Holocene they were unable to migrate anywhere else. Other deeper drumlins have crests that have been modified, but coastal deposits have been strongly modified by wave action so as to be un-recognizable as beaches, spits etc.

The other aspect of the 2003 survey area that is noteworthy is the presence of sub-glacial channels. These run from northwest to southeast, across the grain of the drumlin terrain, and are located immediately east of Paddle Shoal. The principal channel is at depths of -35 to -45 m, and rises and falls as it crosses the terrain.

Essentially in the adjacent areas surveyed in 2004 the story is the same, except for sub-glacial channels. Well-developed coastal platforms are present, consisting of terraces that slope from -23 m to -24.5 m. These partly erosional/partly constructional features indicate a lake level just below -23 m. This supports the idea, developed from data from elsewhere, including the 2003 survey near MacKinnons Shoal, that the water level in the southern part of the lakes was slightly higher than the northern part, because of the shallow sill at Cod Shoals. Short rivers probably drained the slightly higher southern lake system into the northern. Close inspection of the data reveals numerous small submerged coastal landforms, chiefly tombolas and fringing barrier beaches. There are also what appear to be linear lobes of material on the seafloor, on the southwest edges of drumlins shoals; these may be the remains of overstepped coastal deposits.

On Sunday 20th June, as we examine data from previous days, some further ideas are developed. When sea level was lower, the northern Bras d'Or lakes had a level of ~-25 m. South of the narrows, the level was similar, but south of Cod Shoals – which formed an arcuate isthmus – the lake level was perhaps slightly higher -23 to -24 m. This level continues southwest into West Bay, but the arrangement of drumlins islands was such that the large lake in West Bay was almost separated from the main lake, except for several narrow channels. Between the two channels was a small lake. In the middle of this is Unknown Shoal. Just west of Unknown Shoal is a deeper flat-topped shoal (-23 to -24 m) upon which is a circular ridge. Elevation is about 0.5 m, outer diameter about 100 m, and width of the ridge about 28 m. The ridge has high backscatter compared with the surrounding shoal.

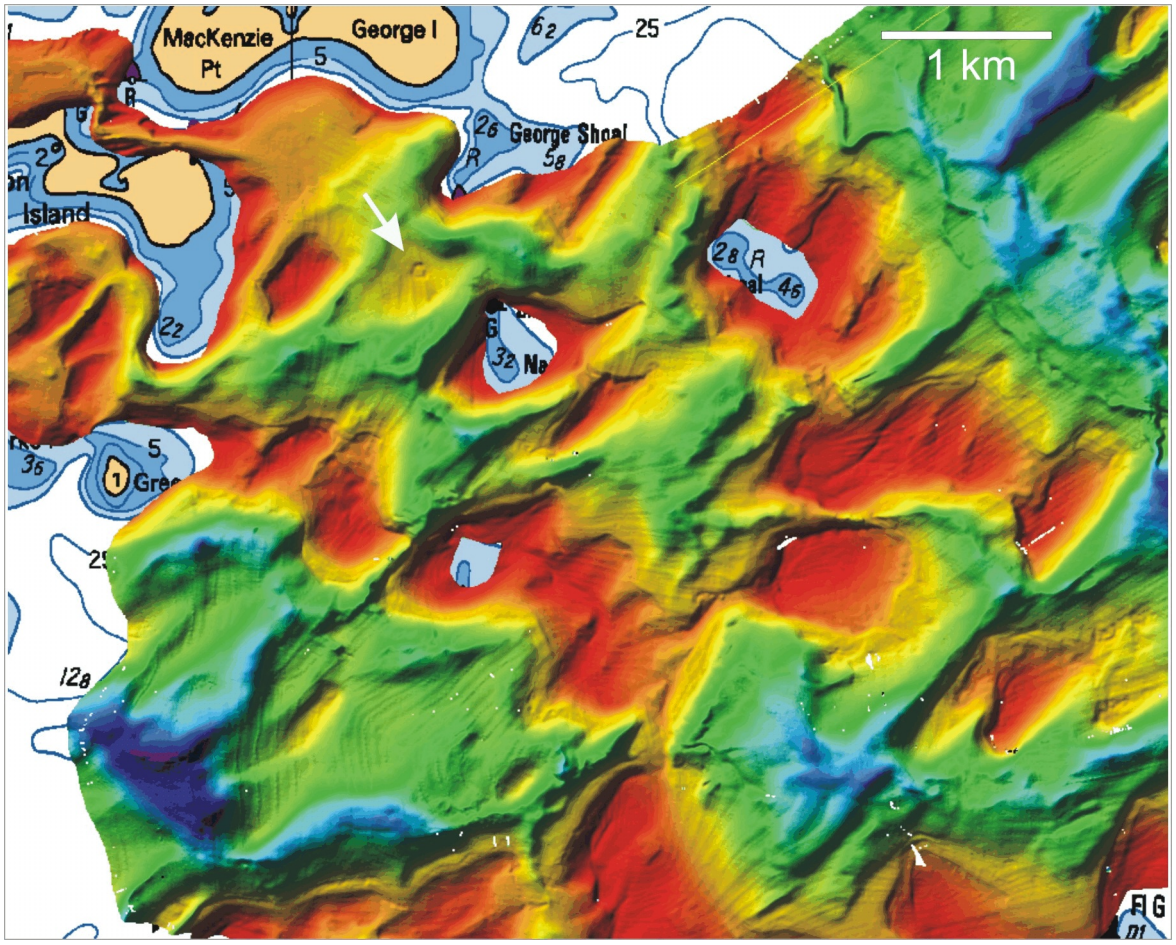


Figure 6: Bathymetry of part of West Bay, with the circular ridge arrowed.

There are several hypotheses that might explain the ridge:

1) *Pockmark.* No. Pockmarks develop in thick Holocene mud.
2) *Sinkhole.* No. Sinkholes have steep sides, are usually deep, and have no raised rim.
3) *Meteorite impact crater.* Unlikely. This would be deeper and might have a mound in the centre.
4) *Dredge spoil.* Dredge spoil commonly forms ring shapes, but only when impacting on a soft bottom. Any mud on this plateau is probably thin.
5) *Remains of a coastal landform.* Coastal processes form ovate looped barriers that might, in some situations, be almost completely enclosed. However, this feature is nearly circular, rather than ovate.
6) *Ancient fish trap.* This is a highly speculative concept. In the early- to mid-Holocene Nameless Shoal was an island in a body of water that connected via a narrow channel to the lake in West Bay, and also via a second channel to the main lake farther north. In addition several streams drained directly into this part of the lake from the east. It is possible that ancient peoples camped on the island. Across a narrow stretch of deep water the second shoal lay 0.5 m to 1.0 m below water level. If it was boulder strewn – very likely since it was a drumlin ridge – then perhaps boulders were collected and arranged to form a circular holding area into which salmon were herded. Salmon

traveling to all the watershed to the southwest, southeast, and south of here would have to pass through here. If this hypothesis is correct, the ancient peoples trapped salmon in a period before 5.5 ka. Arguing against this hypothesis is the fact that the boulder ring – if indeed it is composed of boulders – is nearly 20 m wide in places. Also, fish traps tend to have structures that channel the fish into the trap – lines of rocks that support wooden poles.

7) *Explosion crater.* The feature is perhaps a crater resulting from an underwater explosion, probably of a depth charge. Unlike most bombs, that are designed to explode upon impact, depth charges are triggered by pressure, and hence depth. Possible a depth charge was exploded here during World War II. Escort vessels were stationed at nearby Sydney. The perfect circular nature of the inner part of the feature accords with this idea. On the other hand, the size of the feature would require an extremely massive explosion. Note that the Halifax explosion did not make a crater (although the vessel that exploded was afloat at the time). An explosion is an unlikely cause.

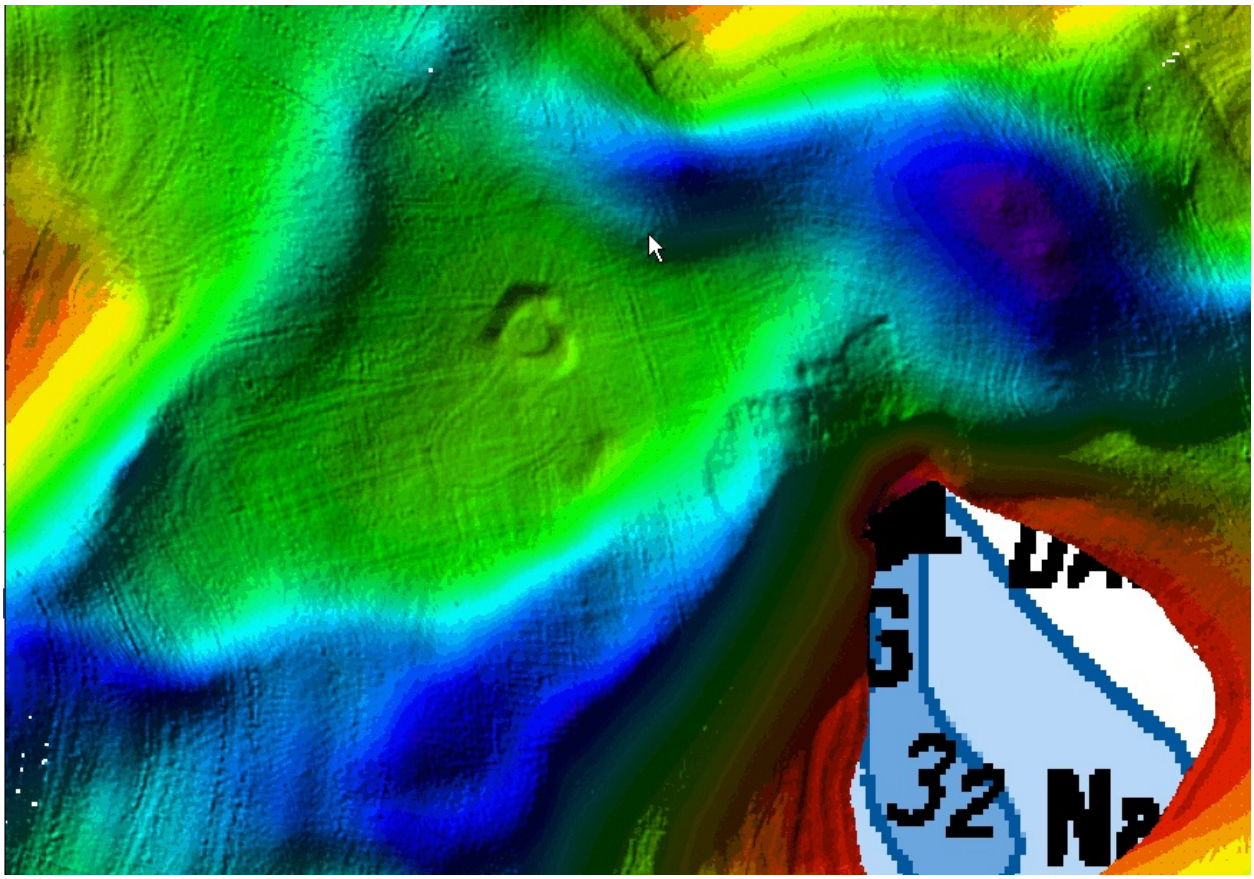


Figure 7: Circular structure on the floor of West bay. The diameter of the outer ring is 100 m.

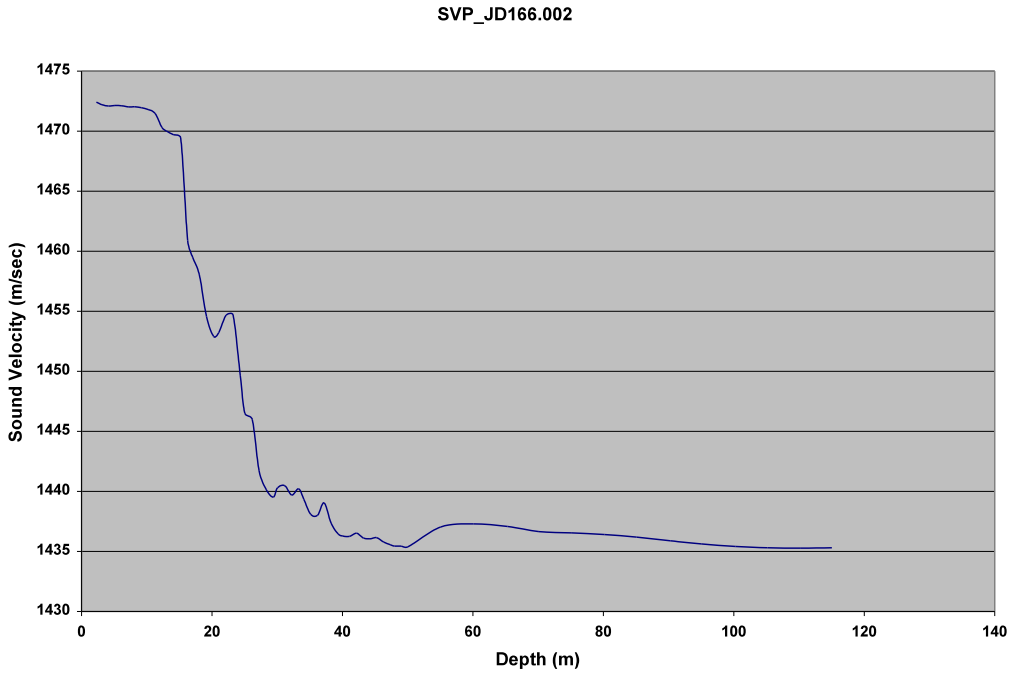
On 21st June examination of the recently collected data showed that the lake in West Bay was reasonably sheltered, and contains well developed submerged shore platforms, usually at about -23 m. Farther northeast, most of the submerged drumlins have a tail pointing landwards. These are the remnants of beach deposits trapped by the transgression. As we survey West Bay it is

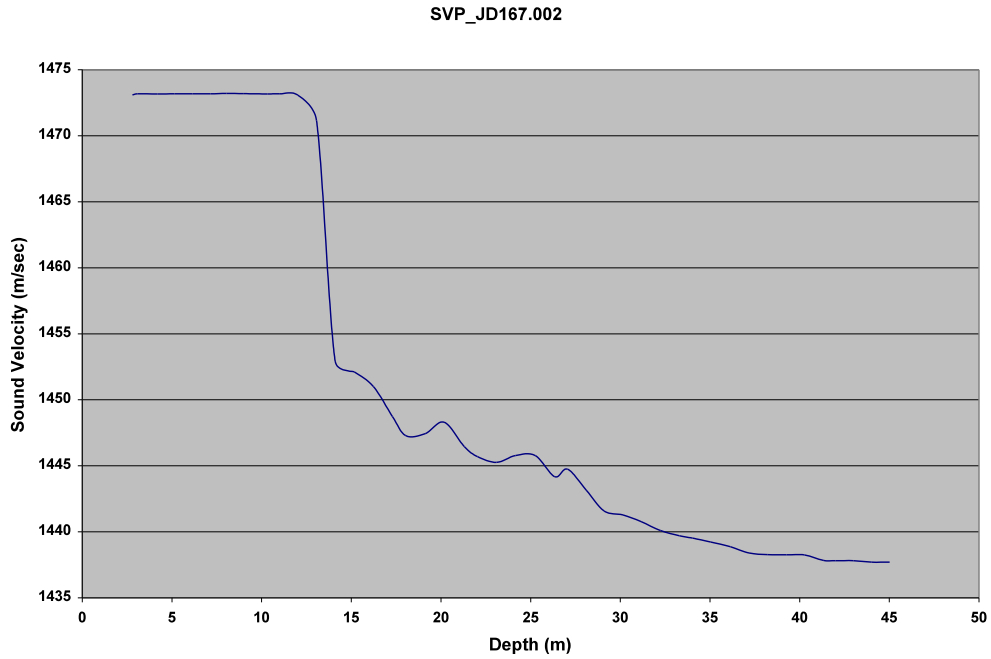
also realized that the drumlins towards the head of the bay are less organized spatially – they are chaotic and do not have the NW-SW orientation of those farther north.

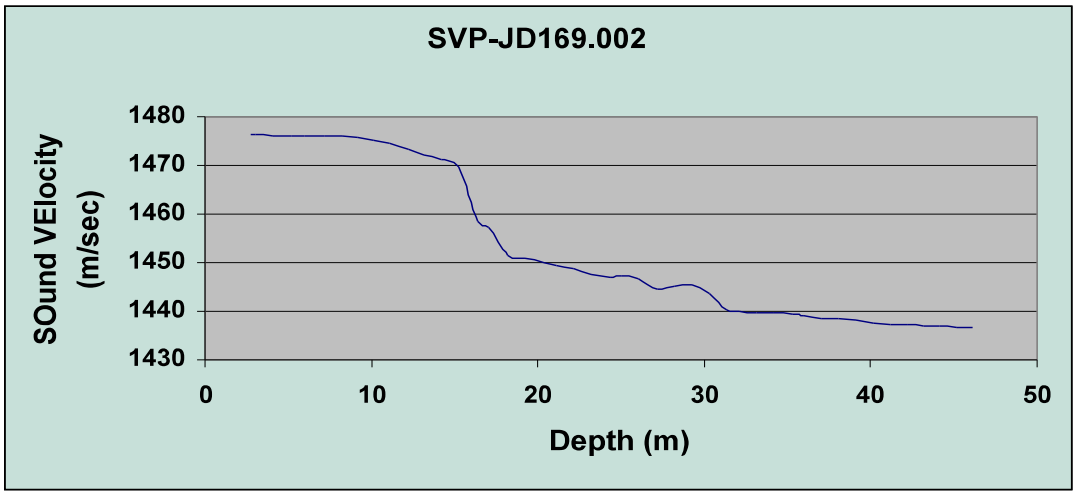
ACKNOWLEDGEMENTS

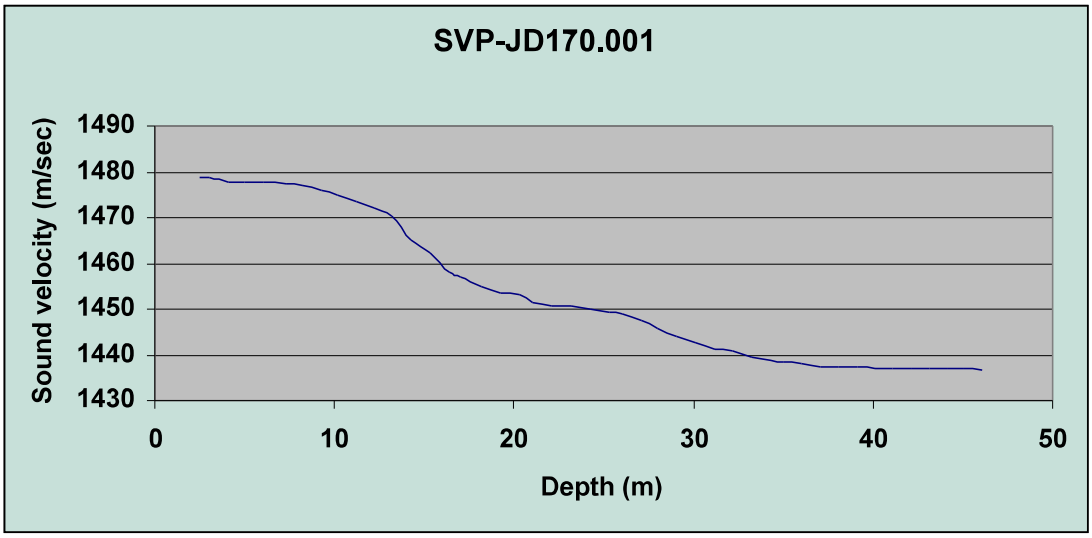
We thank the captains and crews of the CCGS Frederick G. *Creed* for their efforts to ensure the success of the surveys.

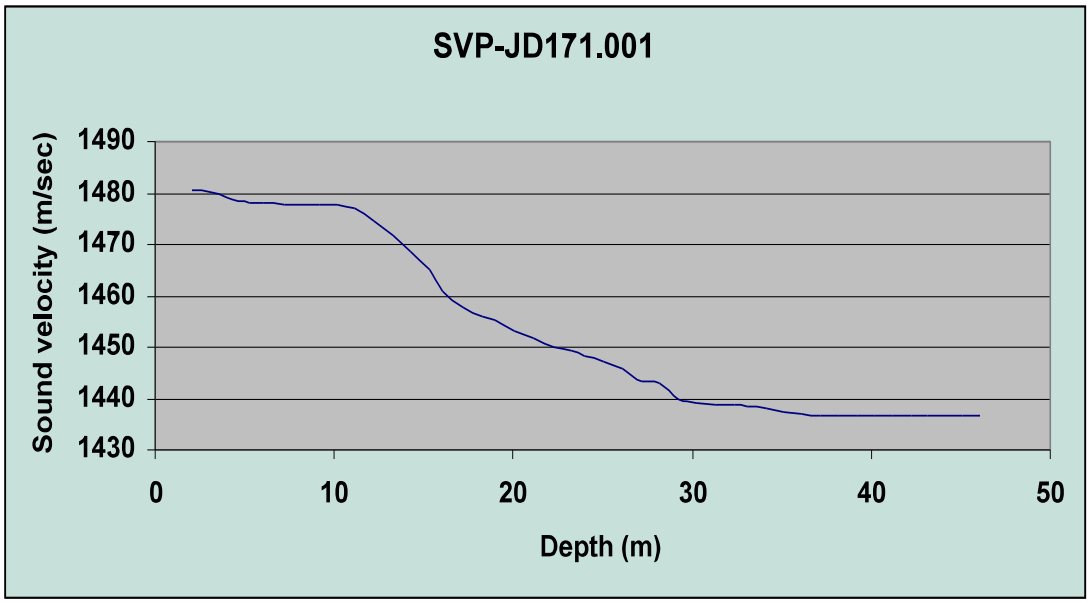
APPENDIX 1 SVP Data

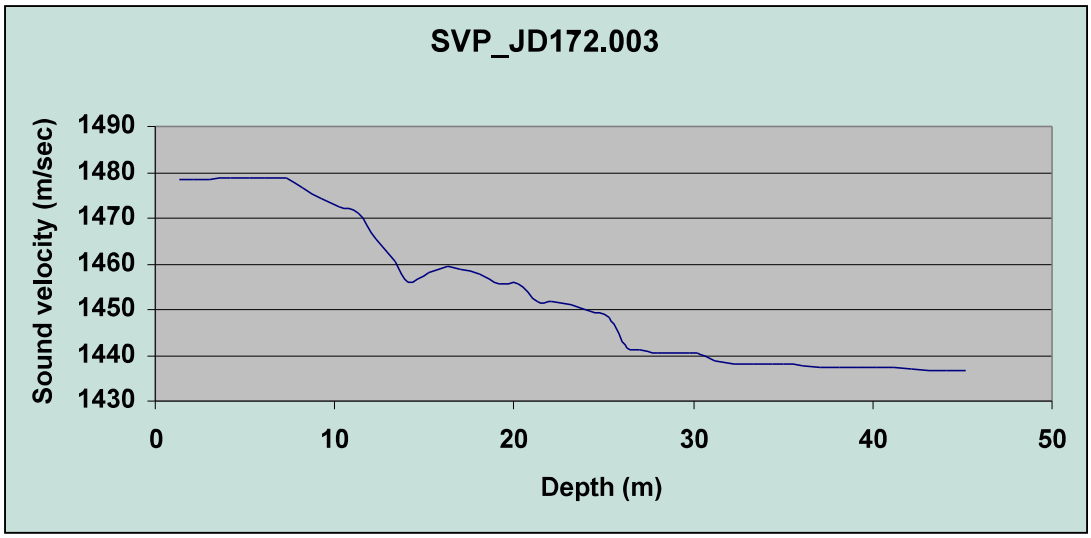





SVP-JD169.002
SOund VElocity (m/sec)
1480
1470
1460
1450
1440
1430
0
10
20
30
40
50
Depth (m)


SVP-JD170.001
Sound velocity (m/sec)
1490
1480
1470
1460
1450
1440
1430
0
10
20
30
40
50
Depth (m)


SVP-JD171.001
Sound velocity (m/sec)
1490
1480
1470
1460
1450
1440
1430
0
10
20
30
40
50
Depth (m)


SVP_JD172.003
Sound velocity (m/sec)
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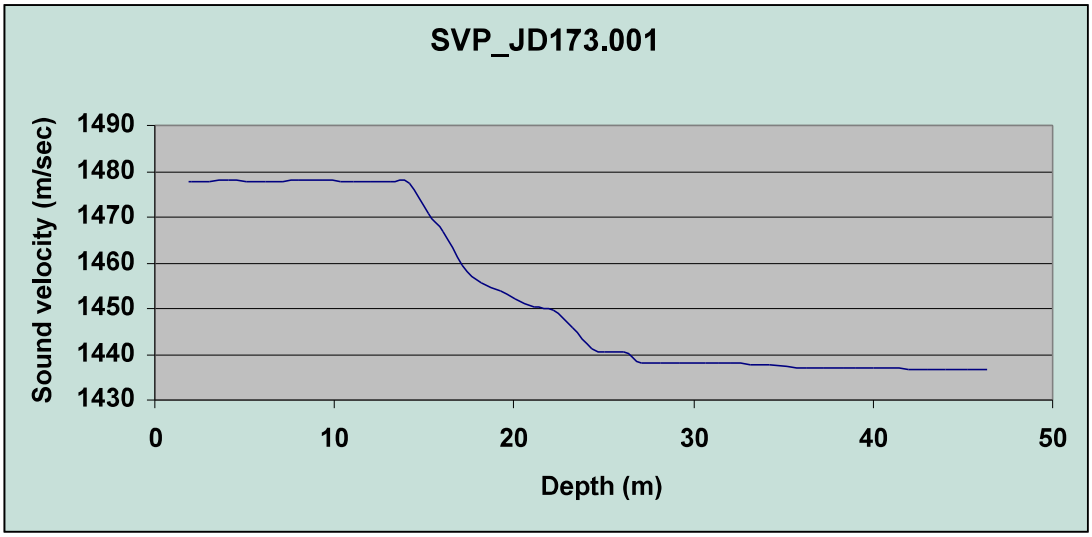
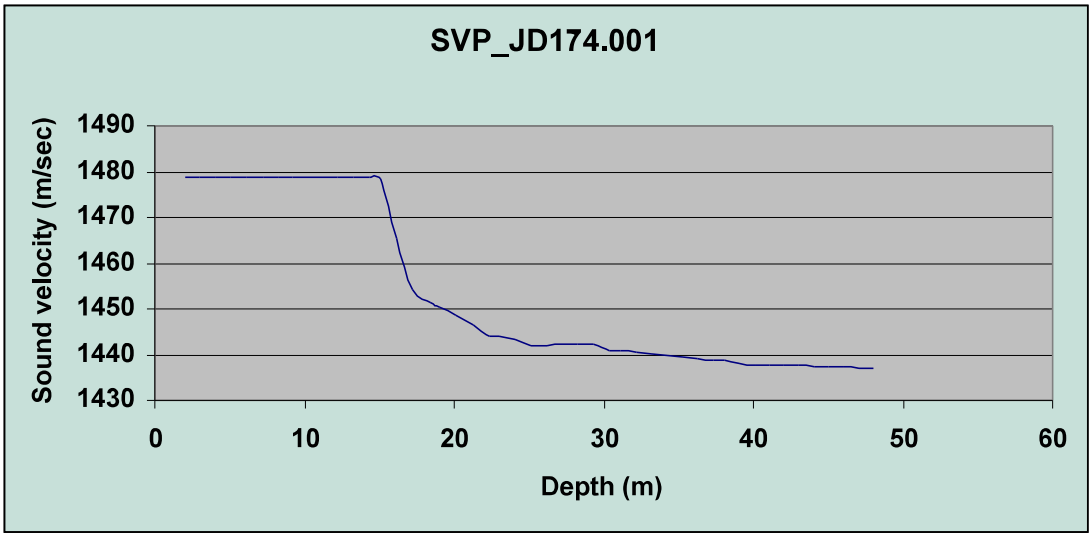
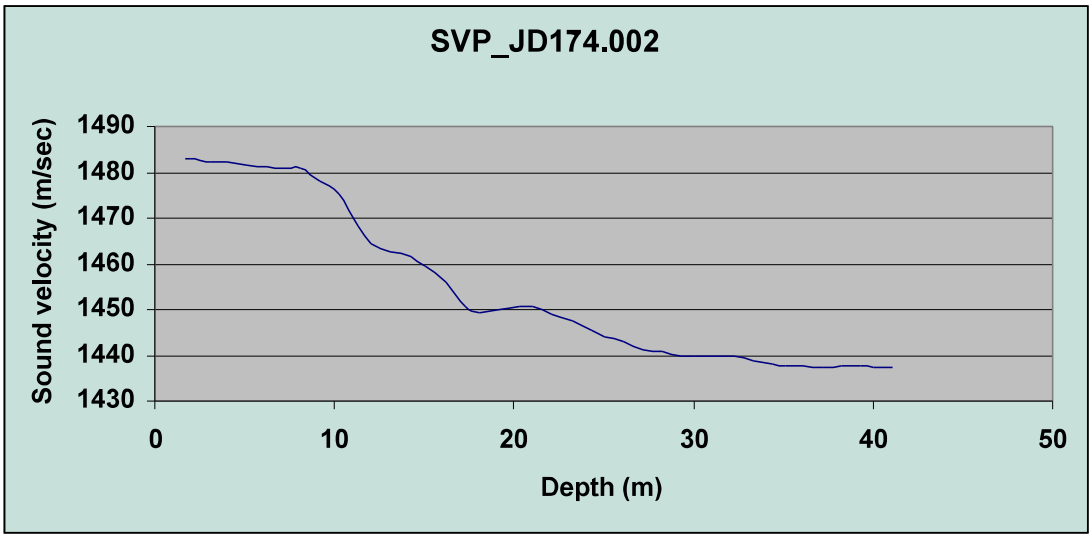
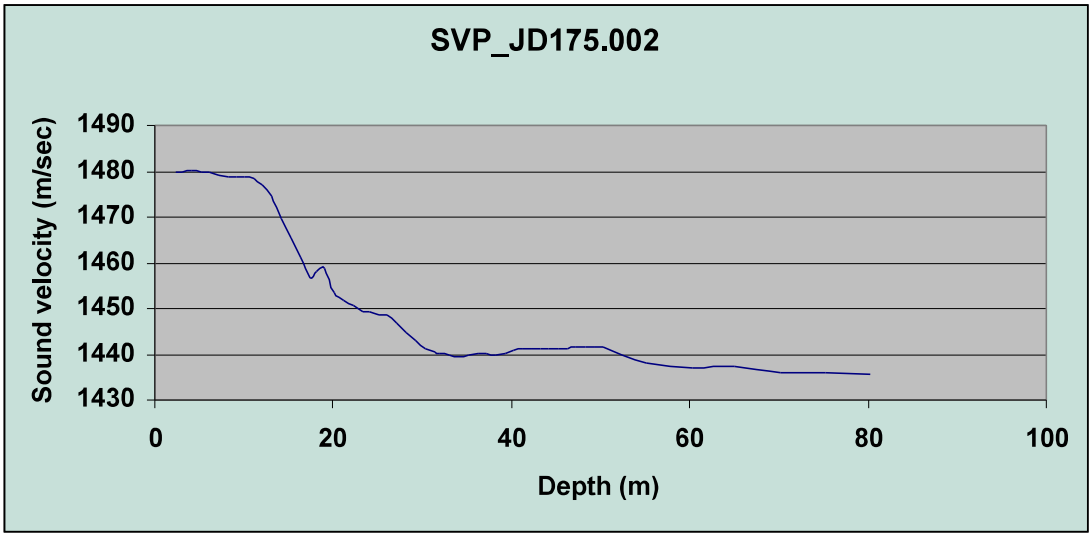
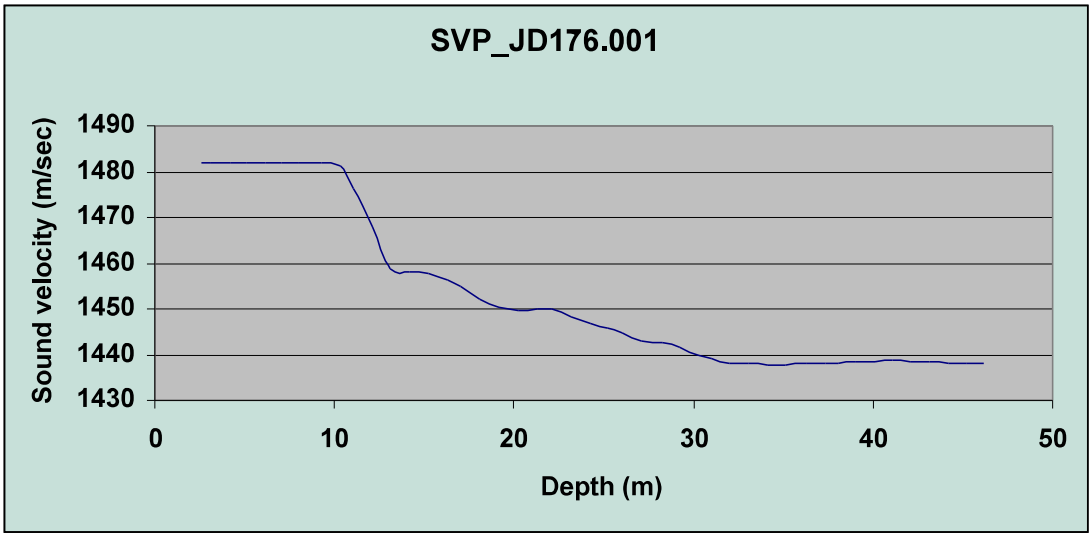
1470
1460
1450
1440
1430
0
10
20
30
40
50
Depth (m)


SVP_JD173.001
Sound velocity (m/sec)
1490
1480
1470
1460
1450
1440
1430
0
10
20
30
40
50
Depth (m)


SVP_JD174.001
Sound velocity (m/sec)
1490
1480
1470
1460
1450
1440
1430
0
10
20
30
40
50
60
Depth (m)


SVP_JD174.002
Sound velocity (m/sec)
1490
1480
1470
1460
1450
1440
1430
0
10
20
30
40
50
Depth (m)


SVP_JD175.002
Sound velocity (m/sec)
1490
1480
1470
1460
1450
1440
1430
0
20
40
60
80
100
Depth (m)


SVP_JD176.001
Sound velocity (m/sec)
1490
1480
1470
1460
1450
1440
1430
0
10
20
30
40
50
Depth (m)

Appendix 2: Data backup

Disk #	Type	Date	Description
1	CD	166	Raw data JD 166 *No!-wrong data backed up!* HDCS data JD 166 *No! -wrong data backed up!* HDCS data Argentia wreck
2	CD	167	HDCS data JD 166, 167
3	CD	167	Raw data JD 166,167
4	DVD	169	Raw data JD 166,167, 169 (folder Brasdor_2004) HDCS data JD 166, 167, 169 (folder *Creed*_brasdor_2004) Vessel configuration files (various dates)
5	DVD	170	Raw data JD 166,167, 169, 170 (folder Brasdor_2004) HDCS data JD 166, 167, 169, 170 (folder *Creed*_brasdor_2004) Vessel configuration files (various dates)
6	DVD	171	Raw data JD 166,167, 169, 170, 171 (folder Brasdor_2004) HDCS data JD 166, 167, 169, 170, 171 (folder *Creed*_brasdor_2004) Vessel configuration files (various dates)
7	DVD	172	Raw data JD 166,167, 169, 170, 171,172 (folder Brasdor_2004) HDCS data JD 166, 167, 169, 170, 171,172 (folder *Creed*_brasdor_2004) Vessel configuration files (various dates)
8	DVD	173	Raw data only: JD,166,167,169,170,171,172,173
9	CD	174	Raw data JD 174, HDCS data JD 174
10	DVD	175	Raw data JD 166,167,169,170,171,172,173,174,175
11	CD	175	HDCS data JD 173
12	CD	175	HDCS data JD 175
13	DVD	175	Raw data JD 166,167,169,170,171,172,173,174,175
14	DVD	176	Raw data JD 166-176; HDCS JD 176; vessel configuration files
15	DVD	177	Raw data JD 166-177; vessel configuration files
16	DVD	177	All HDCS data except day 166,167 (i.e., JD 169 -177)

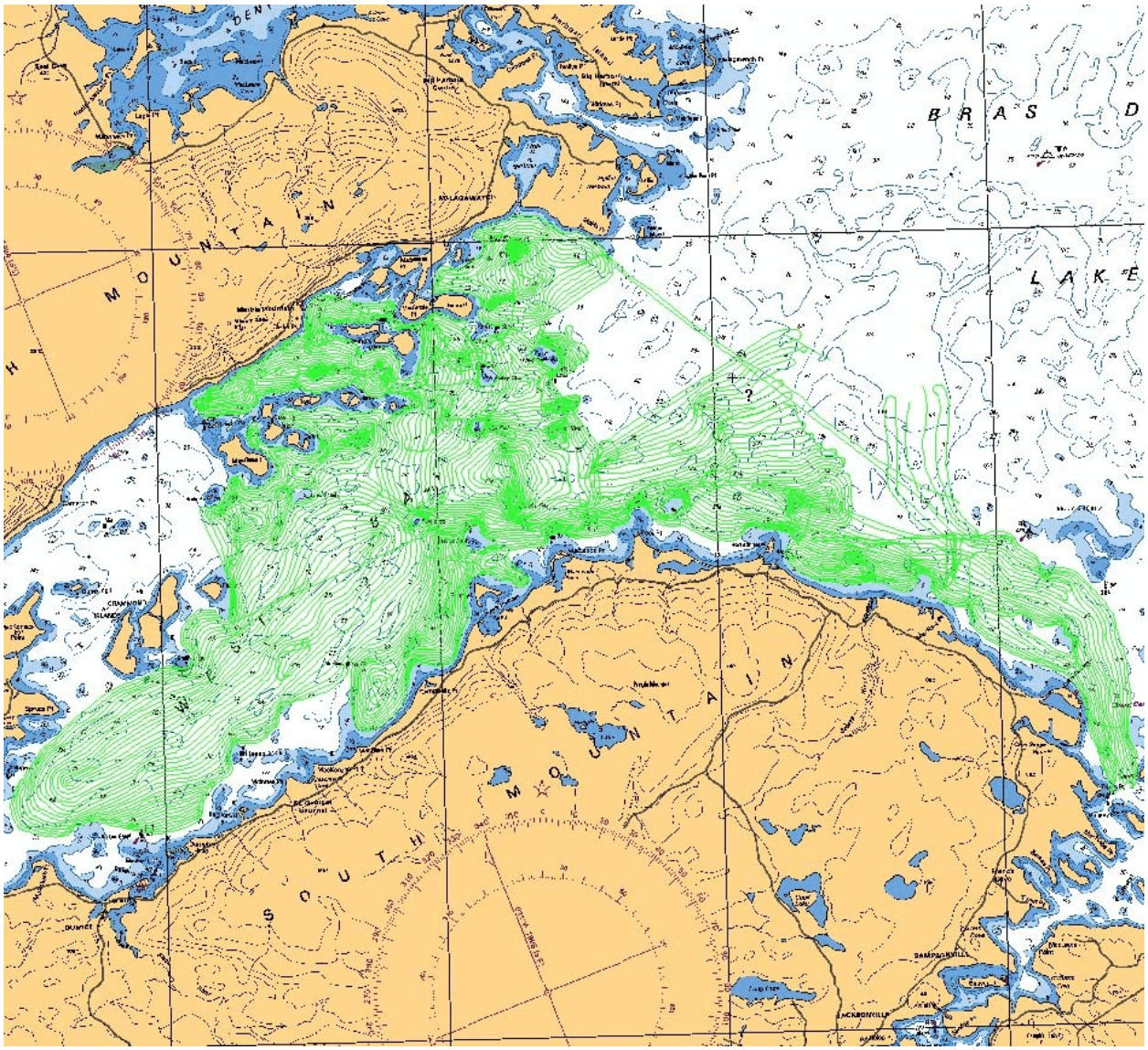
Appendix 3: Photographs

This is a record of photographs taken during the survey, primarily as an aid to coastal geomorphology research by R.B. Taylor (GSC).

*Creed*2004-099-001	Mike Lamplugh and Eli on bridge of *Creed* in West Bay – perhaps Green Island? 14 June 2004
*Creed*2004-099-002	West Bay – possibly Green Island. 15 June 2004
*Creed*2004-099-003	West Bay – possibly Green Island. 15 June 2004
*Creed*2004-099-004	Lighthouse-east tip Cameron Island. 15 June 2004
*Creed*2004-099-005	Beach linking Mackenzie Point and George Island. 15 June 2004
*Creed*2004-099-006	Beach linking Mackenzie Point and George Island. 15 June 2004
*Creed*2004-099-007	Mackenzie Point. 15 June 2004
*Creed*2004-099-008	Mackenzie Point. 15 June 2004
*Creed*2004-099-009	*Creed* at St. Peters. 16 June 2004
*Creed*2004-099-010	Marble Mountain. 16 June 2004
*Creed*2004-099-011	Marble Mountain. 16 June 2004 Look north towards Cameron and George Islands.
*Creed*2004-099-012	Marble Mountain. 16 June 2004 Spoil at coast.
*Creed*2004-099-013	Marble Mountain. 16 June 2004 Spoil at coast.
*Creed*2004-099-014	Looking for directions – Denys River area. 16 June 2004
*Creed*2004-099-015	Lost – Denys River area. 16 June 2004
*Creed*2004-099-016	Iona tide gauge. 16 June 2004
*Creed*2004-099-017	Cape St. George. 17 June 2004
*Creed*2004-099-018	Poor Point or headland just to east of it. 17 June 2004
*Creed*2004-099-019	MacLeods Point. 17 June 2004
*Creed*2004-099-020	Pringle I . 17 June 2004
*Creed*2004-099-021	Cameron I. 17 June 2004
*Creed*2004-099-022	Cameron I. 17 June 2004
*Creed*2004-099-023	Cameron I. 17 June 2004
*Creed*2004-099-024	Cameron I. 17 June 2004
*Creed*2004-099-025	Cameron I. 17 June 2004
*Creed*2004-099-026	Green I. 17 June 2004
*Creed*2004-099-027	Green I. 17 June 2004
*Creed*2004-099-028	Green I. 17 June 2004
*Creed*2004-099-029	St. Peters sunset 17 June 2004
*Creed*2004-099-030	St. Peters sunset 17 June 2004
*Creed*2004-099-031	St. Peters sunset 17 June 2004
*Creed*2004-099-032	St. Peters sunset 17 June 2004
*Creed*2004-099-033	Dawn St. Peters 18 June 2004
*Creed*2004-099-034	Dawn St. Peters 18 June 2004
*Creed*2004-099-035	MacRaes Point, 08:40, Monday 21 June 2004
*Creed*2004-099-036	MacRaes Point, 08:50 (approx), Monday 21 June 2004
*Creed*2004-099-037	MacLeods Point, Pringle Point in distance, 21 June 2004
*Creed*2004-099-038	North side Georges Island, 21 June 2004
*Creed*2004-099-039	North side Georges Island, 21 June 2004

*Creed*2004-099-040	North side Georges Island, 21 June 2004
*Creed*2004-099-041	Pistol Island, 21 June 2004
*Creed*2004-099-042	Rocky shore, MacKenzie Cove, 21 June 2004
*Creed*2004-099-043	Vegetated till bluff, just west of entrance Little Harbour, Mackenzie Cove, 21 June 2004
*Creed*2004-099-044	Till bluff, Militia Point, Mackenzie Cove, 14:50, 21 June 2004
*Creed*2004-099-045	George Island barriers from north side, Mackenzie Cove, 21 June 2004
*Creed*2004-099-046	Rainbow St. Peters, 21 June 2004
*Creed*2004-099-047	Rainbow St. Peters, 21 June 2004
*Creed*2004-099-048	Danny and rainbow St. Peters, 21 June 2004
*Creed*2004-099-049	*Creed* at St. Peters.
*Creed*2004-099-050	Green I, 22 June 2004
*Creed*2004-099-051	Green I, 22 June 2004
*Creed*2004-099-052	Green I, 22 June 2004
*Creed*2004-099-053	South side Green I, 23 June 2004
*Creed*2004-099-054	Clarke I., 23 June 2004
*Creed*2004-099-055	Clarke I., 23 June 2004
*Creed*2004-099-056	Clarke I., 23 June 2004
*Creed*2004-099-057	Calf I., 23 June 2004
*Creed*2004-099-058	Calf I., 23 June 2004
*Creed*2004-099-059	Calf I., west side, 23 June 2004
*Creed*2004-099-060	N side MacRaes I, 23 June 2004
*Creed*2004-099-061	Ronald I, 23 June 2004
*Creed*2004-099-062	Floda I, 23 June 2004
*Creed*2004-099-063	Floda I, 23 June 2004
*Creed*2004-099-064	John Shaw and Mike Lamplugh, 24 June 2004, St. Peters
*Creed*2004-099-065	John Shaw and Mike Lamplugh, 24 June 2004, St. Peters
*Creed*2004-099-066	Rip rap at Dunphys Head, 24 June 2004
*Creed*2004-099-067	Rip rap at Dunphys Head, 24 June 2004
*Creed*2004-099-068	Campbells Point, eroding drumlins, bouldery foreshore, 24 June 2004
*Creed*2004-099-069	Slumping eroding bluff, N side Campbells Cove, 24 June 2004
*Creed*2004-099-070	S. side Pringle Hr., 24 June 2004
*Creed*2004-099-071	S. side Pringle Hr., 24 June 2004
*Creed*2004-099-072	S. side Pringle Hr., 24 June 2004
*Creed*2004-099-073	Pringle Hr., 24 June 2004

Appendix 4: Ship's tracks



Appendix 5: Multibeam bathymetry