GEOLOGICAL SURVEY OF CANADA
OPEN FILE 4985

Cruise Hart 2001007 Geophysical Surveys of the Black Point, Saint John, NB, Offshore Disposal Site 20-27 April 2001

D.R. Parrott

2010

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Background

Survey Hart 2001007 was conducted by the Geological Survey of Canada, Atlantic (GSC-A) from 20-27 April 2001 from the CCGC *J.L. Hart* (Fig. 1a and c). Geophysical data were collected to provide information on the character and distribution of seafloor sediments, and the geological and oceanographic processes which have affected the seafloor in offshore marine disposal sites at Black Point in Saint John Harbour, NB. Geophysical equipment used during the survey consisted of a Simrad MS992 dual frequency (120 and 330 kHz) sidescan sonar system, IKB Seistec sub-bottom profiler and a Track Point II acoustic positioning system. Sediment samples were collected with a 0.1 m^3 vanVeen grab sampler and a small gravity corer. A free fall cone penetrometer was used to collect information on sediment properties. Subsequent to the GSC-A survey additional samples and photographs were taken by Envirosphere Consultants under contract to Environment Canada (Envirosphere 2001). The sample locations and results from the Envirosphere program have been entered in GSC-A databases as survey 2001600.

a) 

b) 

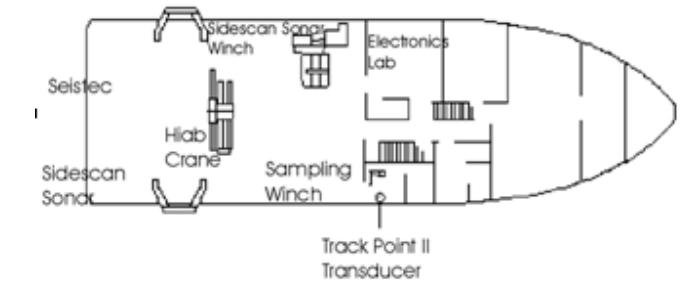
c) 

Figure 1. a) The geophysical survey and seafloor sampling program were performed using the CCGC *J.L. Hart* shown in a) above. b) Multibeam bathymetry data were collected with the hydrographic launch Plover equipped with a Simrad EM3000 sytem. c) The survey and sampling equipment were operated from the main deck

Previous Work

Earlier studies have collected single and multibeam bathymetry, sub-bottom profiler and sidescan sonar surveys at the offshore disposal sites to provide information on seafloor conditions.

Environment Canada had previously sponsored a three year monitoring program (1992-94) at the disposal site to define the zone of influence of the disposal activities; to assess the physical, chemical and biological impacts caused by disposal activities; and to evaluate the long-term use of the site for future dredging projects (Cdn. Seabed Research, 1994, Tay et al., 1997). Sidescan sonar, sub-bottom profiler, single beam bathymetry, and seafloor photographs and samples were collected over the disposal area. The study indicated that past disposal activities resulted in a significant buildup of dredged material within a one-kilometer radius of the disposal buoy.

A joint research program between Environment Canada and the Geological Survey of Canada was initiated in 1999 to determine recent changes in the disposal site and to study the possibility that material was being transported away from the disposal area and impacting nearby fisheries.

The present survey collected sidescan sonar, sub-bottom profiler, and Quester Tangent C-VIEW seafloor classification data, as well as seafloor photographs and samples, over the disposal site to determine changes in the surficial sediments since previous GSC-A surveys in 1999 and 2000 (Parrott 2000, 2001, and Parrott et al., 2001).

Data Acquisition and Processing

The offshore disposal sites were surveyed and sampled with the following equipment:

- IKB Seistec high resolution sub-bottom profiler
- Simrad MS992 sidescan sonar system
- ORE TrackPoint II ultra short baseline towfish positioning system
- REGULUS survey navigation package with input from differential GPS
- LINUX workstations running GRASS with GSC-A extensions
- GSC-A Ice-Hole Camera
- van Veen Grab Sampler
- Brooke Ocean Free Fall Cone Penetrometer

Sidescan sonar

High-resolution, acoustic images of the seabed were produced with a Simrad MS992 dual frequency (120 and 330 kHz) sidescan sonar system equipped with a neutrally buoyant towbody deployed about 10 metres behind a dead weight depressor. This configuration was chosen to reduce noise on the sidescan sonar records due to vessel-induced heave and thereby improve resolution. The sidescan sonar system had a resolution of about 0.15 m.

The sidescan sonar data were collected at 100 metre range for lines in the centre of the survey area and at 200 metre range for lines outside the primary disposal sites. This provided swaths of 200 and 400 metres. Lines run at 100 m range were typically 75 metres apart, with a 300 metre spacing used for the 200 metre range lines. The towfish was deployed about 50 metres behind the vessel. An ORE TrackPoint II acoustic position system was used to position the towfish. A hardcopy graphic record of the 330 kHz sidescan sonar data was produced on an Alden 9315CTP thermal recorder with Latitude/Longitude/time/title annotation. The paper speed was adjusted to provide a record with a 2 to 1 speed compression.

Sidescan sonar data from survey Hart 2001007 (both 120 and 330 kHz) were collected digitally using an AGCDIG digitizer with version 2.3 software, at a sample interval of 80 microseconds. A recording length of 1700 samples per shot was used at 100 metres range (which actually gave 102 meters range), and 3400 samples per shot 200 meter range. Digital gain settings for the sidescan sonar system and digitizers were logged on field sheets. During the survey, data were imported into a LINUX workstation at a resolution of 0.35 metres (across track). The seafloor was detected, slant range and beam corrections applied to the raw data. The data were integrated with navigation and imported into the GRASS GIS system at 1 metre resolution. A variable layback, based on towfish positions from the TrackPoint II positioning system, was applied to the sidescan sonar data. Individual sidescan sonar lines were combined to form a digital sidescan sonar mosaic at a resolution of 2.5 metres for the entire data set.

Sub-bottom profiler

High-resolution, sub-bottom profiler data were collected throughout the survey area using an IKB Seistec system. The system uses an electrodynamic (boomer) source to produce a repeatable impulse-like output, which provides resolution of 0.25 metre or better. The Seistec system, equipped with an internal line-and-cone array and a Benthos 10 element external streamer, was deployed by crane on the starboard side of the vessel and towed at the surface. The system was fired 2 times per second, or faster, and graphic records displayed on a thermal graphic recorder.

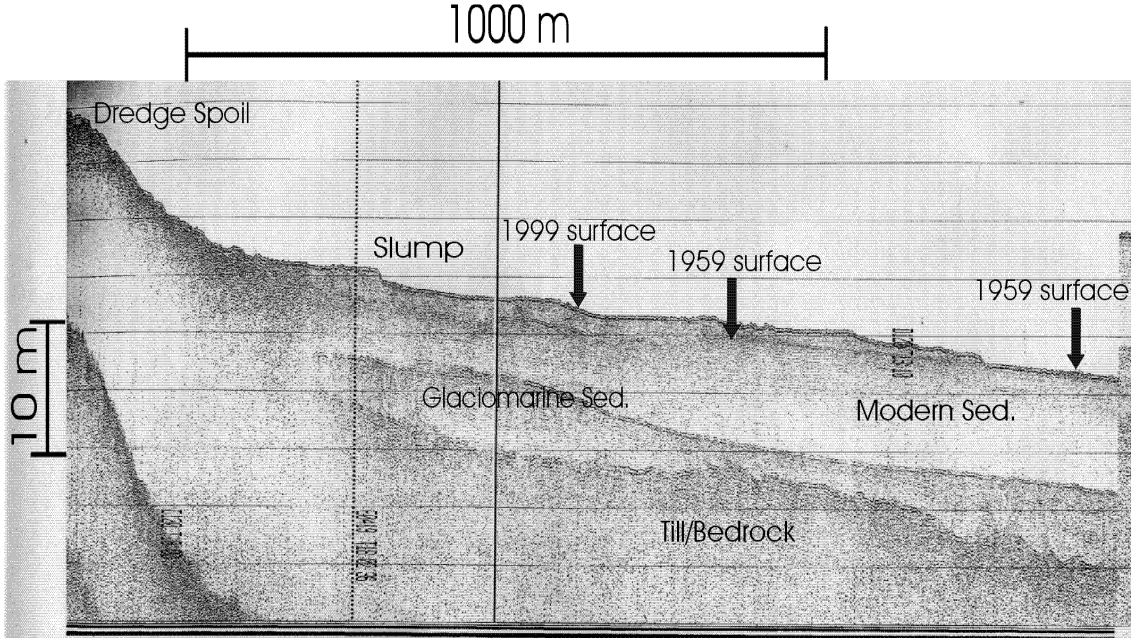


Figure 3. Seistec sub-bottom profiler section through disposal site showing the accumulated dredge spoil and slumped material overlying the naturally deposited sediments.

The Seistec system was used to map the thickness and structure of materials on the sea floor and provide information on the genesis of the sediments. Modern fine-grained sediments are currently being deposited as outwash from the Saint John River as shown on the right side of Figure 3. They overlay a sequence of stratified glaciomarine sediments, which in turn overlie coarser glacial deposits. The dredged material presently being dumped at the disposal site is being deposited on top of both the fine-grained modern sediments and the coarser, relict sediments. A large disposal pile has accumulated at the centre of the disposal zone. The large pile subsequently failed, and formed a large slump down-slope from the disposal pile with a thickness of about a metre.

The Seistec data were also recorded to Exabyte tape at a 30 micrsecond rate, using a record length of 4080 samples, a digital gain of 1. Navigational data were recorded on the Exabyte tape with the Seistec data. Prior to digitizing, the analogue signal was filtered data at 300-7000 Hz due to prevent aliasing.

Digital data acquisition

The sidescan sonar and sub-bottom profiler data were digitized and logged on an AGCDIG digital data recorder developed at the Geological Survey of Canada (Atlantic) running version 2.3 software. The clock in the AGCDIG was synchronized to the GPS time signal. No gains or corrections were applied by the digitizer to the raw logged data. Channel configurations for the logged data were:

Sidescan sonar - 80 microseconds sample interval. A record length of 1700 per shot was used at 100 metres range (which actually gave 102 meters range), and 3400 samples per shot 200 meter range.

Channel	Use
0	120 kHz port
1	120 kHz starboard
2	330 kHz port
3	330 kHz starboard
4	Navigation data

Sub-bottom profiler – IKB Seistec - 30 microseconds sample interval using a record length of 4080 samples

Channel	Use
0	Seistec line cone receiver
1	GF10/15P streamer hydrophone
4	Navigation data

Navigation

Navigation was by a differential Global Positioning System utilizing corrections broadcast from the Coast Guard station at Western Head. Accuracy of the navigation was about 4 m.

Data Processing

Multibeam bathymetric and sidescan sonar data were processed and imported into a GRASS (Geographic Resources Analysis Support System developed by the U.S. Army Corps of Engineers) Geographical Information System for further analysis and display. Shaded relief images derived from the multibeam bathymetric data and sidescan sonar mosaics were combined with data from maps and aerial photographs of the area. These maps and images formed the basis for a preliminary interpretation of geological processes and features on the seabed. Post-processing of the multibeam bathymetric data, using newly developed algorithms, improved the resolution of seafloor features and provided acoustic backscatter intensity measurements. These data were used to define the distribution of coarse and fine-grained sediments and seabed features.

Digital sidescan sonar data were recovered from the ExaByte tapes recorded on the AGCDIG recorder and processed to remove geometric distortions present in sidescan sonar data. The geometrically corrected data were integrated with navigation and processed to remove the effects of varying sensor gain with angle. The sidescan sonar data from adjacent survey lines were integrated to produce a sidescan sonar mosaic using software developed by the Geological Survey of Canada.

Seafloor Photographs

Seafloor photographs were taken with the GSC-A Ice-Hole Camera. Problems were encountered with the system at the start of survey Hart 2001007. Repairs were made to the system, but problems with the vessel prevented further use of the camera. Additional photographs of the sea floor, were obtained using the Ice-Hole Camera by Envirosphere Consultants under contract to Environment Canada (Envirosphere 2001), however problems were again encountered with the camera resulting in blurred and overexposed images.

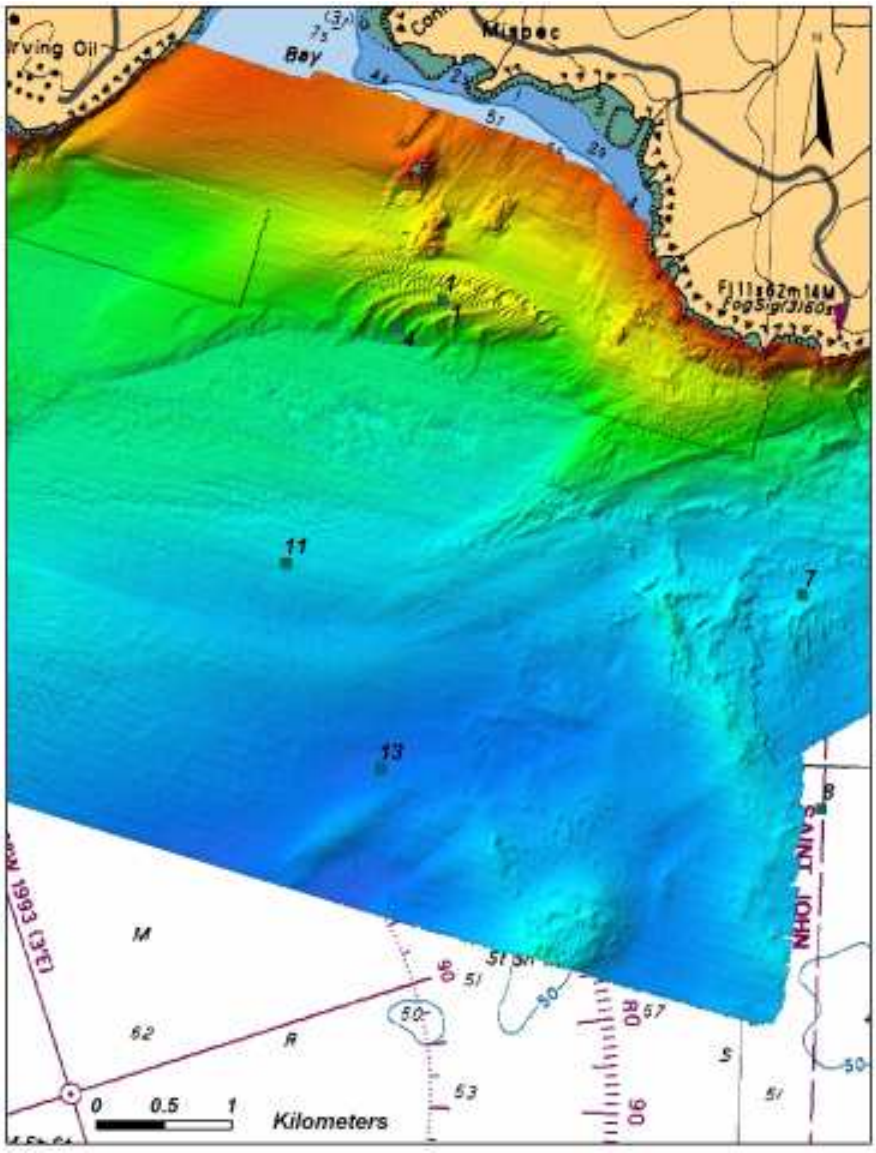


Figure 6. Location of GSCA grab samples in April 2001 during Hart 2001007. Positions are provided in Table1.

Seafloor Samples

Sediment samples were taken during Hart 2001007 with a 0.1 m^3 vanVeen grab sampler to provide groundtruth for the interpretation of the sidescan sonar and sub-bottom profiler data. Subsequent to the GSC-A survey additional samples were taken by Envirosphere Consultants under contract to Environment Canada (Envirosphere 2001). The sample locations for GSC-A samples is shown in Figure 6 and for the Envirosphere samples is shown in Figure 7. The sample positions are provided in Tables 1 and 2. Photographs of the grab samples taken by GSC-A are shown in Appendix II.

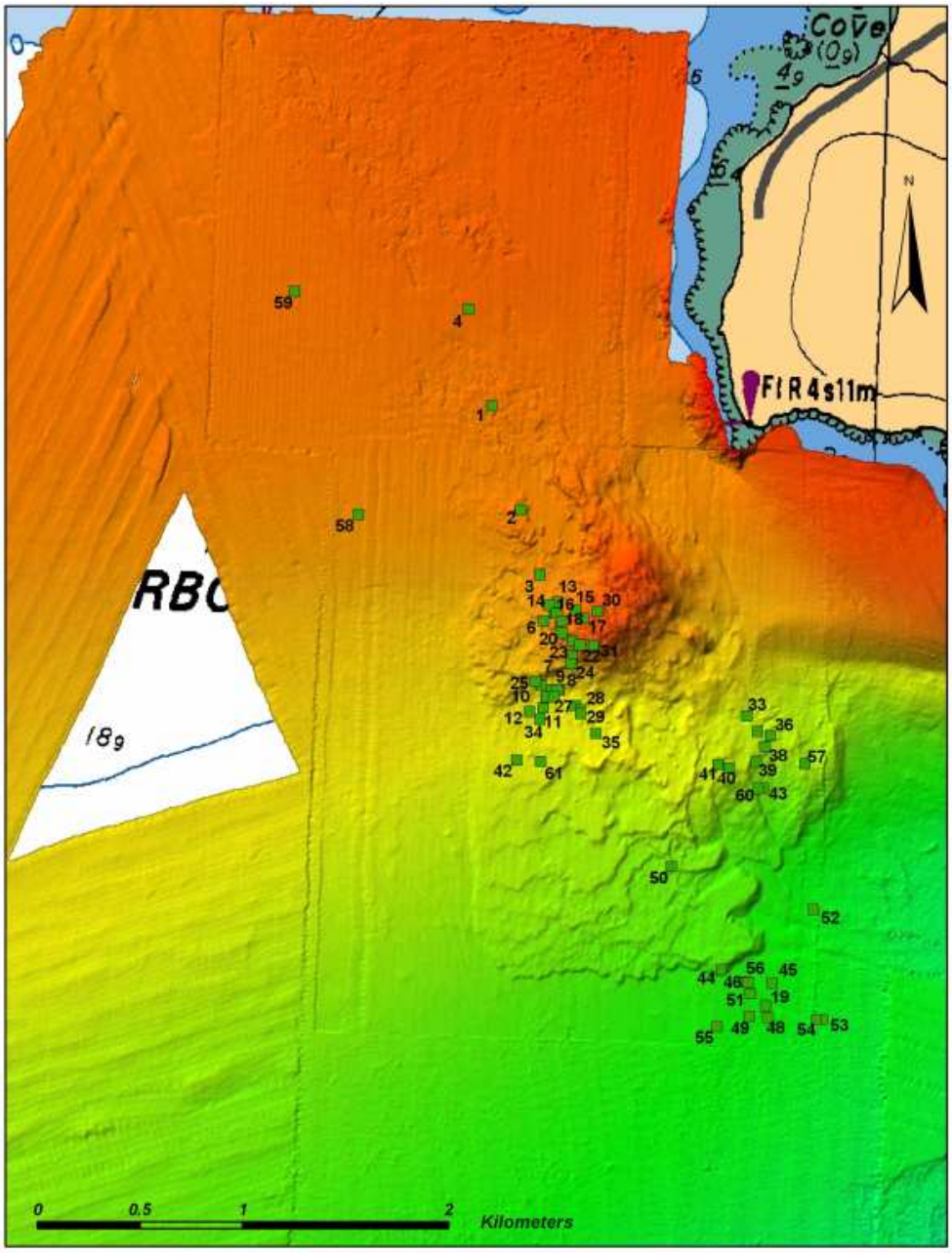


Figure 7. Location of grab samples collected by Envirosphere in July 2001 during 2001600. Positions are provided in Table2.

Brooke Ocean Free Fall Cone Penetrometer

The Free Fall Cone Penetrometer **(FFCPT)** was developed by Brooke Ocean Technology Ltd. and Christian Situ Geoscience Inc. to collect geotechnical and geophysical data during route location surveys for seabed cable and pipeline installations, for bottom classification and acoustic ground-truthing, as well as for mine countermeasures and geo-environmental studies. More information about the FFCPT can be found at http://www.brooke-ocean.com/. TheFFCPT is designed to free fall through the water column, then impact the seabed. The amount of penetration into the seabed is controlled by the sediment type, the bulk density, dynamic shear modulus and the undrained shear strength. The FFCPT records data that permit evaluation of these and other geotechnical parameters. Onboard acceleration and pressure sensors monitor the sediment penetration response, producing continuous profiles similar to a conventional piezocone penetrometer.

The FFCPT was deployed at six locations near Mispec as shown in Figure 8. Positions are provided in Table 3.

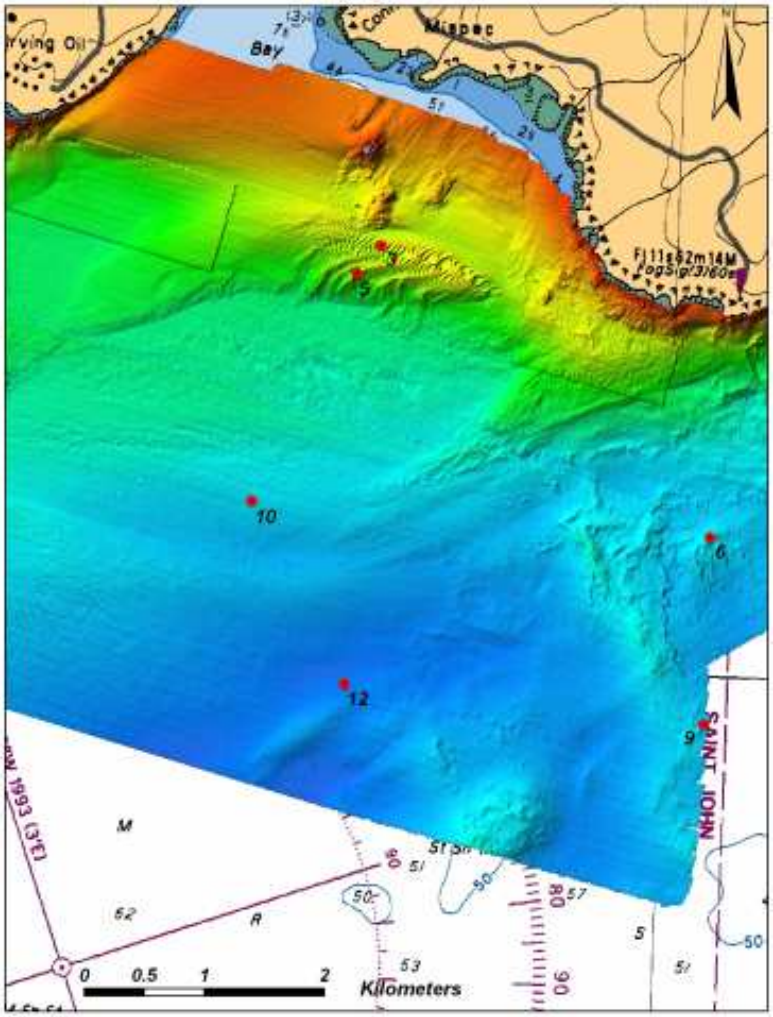


Figure 8. Location of Free Fall Cone Penetrometer stations during Hart 2001007.

Preliminary Results

A review of existing geophysical and bathymetric data for the Black Point disposal site was performed to determine existing conditions at the site and to provide background information and for the design of the new surveys. Preliminary analysis of geophysical and multibeam bathymetry data from the disposal site has shown that material deposited at the site has failed, forming a series of slumps that extend about 1.5 km south of the disposal site. Comparison of sidescan sonar mosaics from 1993 (Cdn. Seabed Research, 1994) and 1999 show that prominent features on the earlier survey (such as evidence of dredge spoils) are no longer visible and may have been buried by recent sediment deposited by the Saint John River. Detailed analysis of the sidescan sonar data from beyond the base of the slump show active bedforms, suggesting sediment transport, and the presence of fresh anchor furrows. Preliminary indications from current-formed features on the sidescan sonar records from deeper water near the base of the slump indicate transport of fine-grained sediments from east to west, out of the Bay of Fundy.

Access to Data and Samples

The sidescan sonar, sub-bottom profiler and grab samples collected during this survey are archived at the Geological Survey of Canada, Atlantic, in Dartmouth Nova Scotia. For access to the geophysical data and samples contact the senior scientist for the survey, Russell Parrott (902-426-7059) or Susan Merchant of the GSC-A Curation group (902-426-3410). Graphical records for the sidescan sonar and subbottom profiler, digitally processed sidescan sonar mosaics, ExaByte tapes containing the sidescan sonar data in SEG-Y format, CD-ROMs containing the sidescan sonar and sub-bottom profiler data in SEG-Y format, and digital copies of the navigation data are available for viewing.

References

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Tables

Table 1 Location and size of material in grabs collected during Hart 2001007 in April 2001

Station_Number	Station_Type	Latitude	Longitude	% GRAVEL <2 mm	% SAND >2 mm <63 micron	% MUD >63 micron
1	Grab	45:11.80	-65:56.83	98.2	1.8	24.3
4	Grab	45:11.68	-65:57.07	92.3	7.7	30
7	Grab	45:10.68	-65:54.75	33.9	16.6	54
8	Grab	45:9.83	-65:54.60	27.7	15.5	58
13	Grab	45:9.92	-65:57.08	39.0	40.8	68

Table 2 Positions of grab samples taken by Envirosphere in July 2001

Station_Number	Station_Type	Latitude	Longitude	% GRAVEL <2 mm	% SAND >2 mm <63 micron	% MUD >63 micron
1	Grab	45.216833	-66.023833	4.0	80.7	15.3
2	Grab	45.212333	-66.021833	0.0	11.6	88.4
3	Grab	45.209500	-66.020500	0.0	18.5	81.5
4	Grab	45.221000	-66.025500	0.0	75.7	24.3
5	Grab	45.207833	-66.019500	0.0	26.8	73.2
6	Grab	45.207500	-66.020166	23.0	36.2	40.9
7	Grab	45.204666	-66.020166	0.0	23.1	76.9
8	Grab	45.204500	-66.019000	0.0	26.3	73.7
9	Grab	45.204500	-66.019500	0.0	12.1	87.9
10	Grab	45.204166	-66.019833	0.0	18.1	81.9
11	Grab	45.203666	-66.020000	0.0	15.8	84.2
12	Grab	45.203500	-66.020833	0.0	21.1	78.9
13	Grab	45.208333	-66.019333	0.0	17.2	82.8
14	Grab	45.208166	-66.019833	0.0	31.1	68.9
15	Grab	45.208000	-66.018166	0.0	17.6	82.4
16	Grab	45.207833	-66.019333	1.0	68.6	30.4
17	Grab	45.207666	-66.017666	0.0	48.9	51.1
18	Grab	45.207500	-66.019000	0.4	18.2	81.4
19	Grab	45.191000	-66.005500	25.9	39.0	35.1
20	Grab	45.207000	-66.019000	31.6	21.3	47.1
21	Grab	45.206666	-66.018333	0.0	12.7	87.3
22	Grab	45.206500	-66.017833	0.0	8.1	91.9
23	Grab	45.206000	-66.018333	0.0	68.8	31.2
24	Grab	45.205666	-66.018333	0.0	6.4	93.6
25	Grab	45.204833	-66.020500	0.0	19.1	80.9
26	Grab	45.204500	-66.019166	0.0	29.0	71.0
27	Grab	45.204166	-66.019333	0.0	19.6	80.4
28	Grab	45.203833	-66.018000	0.0	15.8	84.2
29	Grab	45.203666	-66.017666	0.0	22.2	77.8
30	Grab	45.208000	-66.016833	0.0	38.4	61.6
31	Grab	45.206500	-66.017000	0.0	20.7	79.3
32	Grab	45.203500	-66.017666	0.0	28.5	71.5
33	Grab	45.203666	-66.007333	13.2	84.5	2.3
34	Grab	45.203166	-66.020166	0.0	20.2	79.8
35	Grab	45.202666	-66.016666	6.9	10.3	82.9
36	Grab	45.202833	-66.005833	35.3	22.4	42.2
37	Grab	45.203000	-66.006666	3.1	31.9	65.0
38	Grab	45.202333	-66.006166	0.3	15.8	83.9
39	Grab	45.201666	-66.006666	0.9	91.6	7.5
40	Grab	45.201333	-66.008333	14.0	46.3	39.6
41	Grab	45.201500	-66.009000	7.0	31.1	61.9
42	Grab	45.201333	-66.021500	0.0	26.3	73.7
43	Grab	45.200500	-66.006166	24.0	17.7	58.3
44	Grab	45.192500	-66.008333	8.6	17.7	73.7
45	Grab	45.192000	-66.005166	1.4	43.1	55.5

46	Grab	45.192000	-66.006833	8.2	39.7	52.1
47	Grab	45.195833	-66.187166	7.8	33.1	59.1
48	Grab	45.190500	-66.005333	1.0	16.6	82.4
49	Grab	45.190500	-66.006500	8.9	31.8	59.2
50	Grab	45.196945	-66.011666	15.2	40.6	44.2
51	Grab	45.191500	-66.006500	6.5	33.5	59.9
52	Grab	45.195283	-66.002783	0.0	11.8	88.2
53	Grab	45.190500	-66.002000	0.0	14.0	86.0
54	Grab	45.190500	-66.002333	9.8	36.4	53.8
55	Grab	45.190000	-66.008500	0.4	9.1	90.6
56	Grab	45.192000	-66.006666	3.8	33.0	63.2
57	Grab	45.201666	-66.003666	0.0	56.0	44.0
58	Grab	45.211833	-66.031833			
59	Grab	45.221500	-66.036333			
60	Grab	45.200500	-66.006500	0.0	6.8	93.1
61	Grab	45.201333	-66.020000	0.0	19.6	80.4

Appendix I Summary of Activities

Survey Particulars

Name of Vessel:	CCGC *J.L. Hart*
Vessel captain:	Dean Robinson
Dates	17-30 April 2001
Area of Operation	Saint John NB
Senior Scientist:	Russell Parrott, GSC

List of Participants

Geological Survey of Canada Atlantic

Russell Parrott	Senior Scientist
Darrell Beaver	Navigation and Simrad EM3000 multibeam bathymetry
Robert Murphy	Sampling and seafloor photography
Fred Jodrey	Sampling and seafloor photography
Austin Boyce	Electronics

Coast Guard

D. Kirby	Coast Guard Coxain

Summary of Activities

Tuesday 17 April 2001 (All times GMT)

10:00 *J.L. Hart* departs Bedford Institute of Oceanography jetty en route to Saint John NB. Arrive Cape Sable Island.

15:00 Beaver and Kirby depart BIO for Saint John NB.

Wednesday 18 April 2001

J.L. Hart weather bound in Cape Sable Island. CHS survey launch Plover placed in water at CCGB Saint John.

Thursday 19 April 2001

J.L. Hart departs Cape Sable Island.

Friday 20 April 2001

10:15 Arrive BIO. *J.L. Hart* en route Saint John. Load remaining computers and gear in van.

11:15 Parrott, Murphy and Boyce depart BIO for Saint John.

16:00 Parrott, Murphy and Boyce arrive Saint John and check in to hotel.

16:30 *J.L. Hart* arrives Canadian Coast Guard Base (CCGB) Saint John

17:00 Arrive *J.L. Hart* and mobilize survey gear. Camera has short circuit when all components connected. Replace metal connecting screw with RTV glue to eliminate ground contact. Regulus navigation computer program not functioning properly or consistently. Unable to display cross track display screen – calculated course not updating properly. Program reloaded – still not functioning – replacement computer ordered from GSC.
Monitor replaced on Plover. Generator now functioning.

Saturday 21 April 2001

10:00 Arrive *J.L. Hart*. D. Beaver set up Regulus navigation package on laptop computer. Load required maps on computer. AGCNAV computer setup to log navigation as a backup precaution. Murphy connects camera and load film in preparation for wet test.

11:00 Depart CCGB Saint John for Black Point disposal site survey.
11:30 On location at Black Point disposal site. Attempt camera station. Too much current to get camera to sea floor. Two unsuccessful attempts.
12:00 Inspection of Seistec system prior to deployment shows that the boomer mounts have failed and no longer supporting the boomer. Boomer lashed in place with nylon cord.
12:30 Deploy Track Point towfish positioning system on pole on starboard side of vessel. Deploy neutrally buoyant Simrad sidescan sonar system on starboard side of vessel. Seistec sub-bottom profiler deployed on port side of vessel
13:17 Seistec, sidescan sonar and Track Point systems operational. Start logging of data. Problems with Alden recorder. Problem solved by addition of ground strap to recorder.
13:25 Start running grid lines over Black Point disposal site. 100 meter range on sidescan. 75 metre offset between lines, every other line run at start of survey to ensure coverage of site.
18:21 Still running lines. Old lobster buoy observed near shore. Only sighting of lobster buoy to date.
19:00 Large tanker Colubia moored at location 45.0090N, -066.0230W. Smaller tanker at 45.1017N, 66.0132. Possible candidate for future survey to determine effect of recent anchor drag marks on seafloor.
19:30 Still running lines. Large tanker getting under way. Three tugs en route.
20:01 Recover all gear and leave area due to increase with shipping activity required to moor tanker at Canaport buoy.
20:30 Launch Plover ceases operation due to increase with shipping activity required to moor tanker at Canaport buoy.
21:00 Arrive CCGB Saint John

Sunday 22 October 2001
10:00 Arrive *J.L. Hart*. Beaver confirms that data being logged on navigation system.
10:30 Depart CCGB Saint John for survey area.
10:50 Stream gear off Mispec Bay for survey of an area identified as a zone of active fishing by Env Can. Deploy sidescan sonar operating on 200 metre range and Track Point system. Seistec sub-bottom profiler not deployed due to 1-2 metre waves. Two knot tidal current running to east.
12:00 Recover Track Point system. Too much vibration on pole. 6.2 knot speed through water results in 3.7 knots over the ground. (2.5 current tide to east)

Monday 23 April 2001
10:00 Arrive *J.L. Hart*.
10:15 Depart CCGB Saint John
11:00 Stream geophyscial survey gear – Track Point, sidescan sonar and Seistec. Run a series of lines at 300 metre offset using a 200 metre range (eash side) on the sidescan system.
17:30 Recover Track Point system. The transducer cable had come loose from the pole and was placing a strain on the connector.
17:35 Redeploy Track Point system after securing the cable to the pole.
19:20 End of survey. Recover all gear.
19:30 All gear on board. Steam for CCGB Saint John.
21:00 Secure at CCGB Saint John. Problems with pitch selector on variable pitch propellor during docking operations.

Tuesday 24 April 2001
09:00 Arrive *J.L. Hart*.
09:20 Depart CCGB Saint John. Problems with pitch selector on J.L.Hart. Adjust after leaving traffic zone.

10:30 Start camera station near Black Rock in Mispec Bay. Camera would not trigger when in the water. Replace retraction spring in magnetic switch. Continue with grab sampling and Free Fall Cone Penetrometer.
11:30 Retest camera – still not functioning. Boyce testing electrical circuits in camera. Continue with grabs and FFCPT.
14:45 Stop sampling program for lunch. The wave height increased significantly over the lunch period, with occasional large waves which caused the vessel to pitch and roll without warning. Sampling operations were hazardous with the increased motion.
15:00 Deploy sidescan sonar and Track Point system and continue with mosaic of outer Mispec Bay.
18:04 Recover gear and return to CCGB Saint John.
18:50 Secure at wharf. Problems with pitch selector on variable pitch propellor during docking operations which resulted in no reverse gear for part of the docking procedure.

Wednesday 25 April 2001
10:00 Arrive *J.L. Hart*. Still encountering problems with control of variable pitch propellor. Unable to depart jetty until problem fixed. Local contractor called in to consult with ships engineer.
11:30 Meet with John Hughes Clark and discuss plans for multibeam bathymetry and geophysical surveys.
12:00 Boyce trouble shoots camera system and finds cable with one broken wire and one flooded wire. Cable replaced and camera tested in harbour. Appears to function properly.
19:00 Transmission has been tested and found to be within specifications. Problem appears to be with connecting cable for controls from bridge to engine room.

Thursday 26 April 2001
11:30 Arrive *J.L. Hart*. Still encountering problems with control of variable pitch propellor. Unable to depart jetty until problem fixed. Engineer in contact with local contractors and head quarters about alternatives for repair or replacements of the controls.
15:00 Replacement part to be ordered from dealer in Europe. Estimated delivery early next week. Terminate *J.L. Hart* portion of survey and make arrangements for truck to demobilize gear. Start demobilization of electronics lab and deck gear.

Friday 27 April 2001
10:30 Arrive *J.L. Hart* and continue with demobilization of all gear. Welders cut winches from deck. Crane lifts winches and gear from deck. Of course all this happened at low tide requiring all gear to be lifted 8 metres to the jetty deck.
15:00 Gorveatt arrives from BIO with rental truck for transport of winches and heavy gear. Load gear on trucks for return to BIO.
17:00 Weather deteriorates – strong winds for remainder of day and into weekend. Terminate Plover surveys. Recover launch and store on jetty. Most GCSA personnel and CHS coxain (Kirby) return to BIO.
22:00 Beaver meets with D. Wildish from St. Andrews Biological Station to discuss operation of Regulus and Track point system.

Saturday 28 April 2001
09:00 Beaver departs Saint John for BIO

Appendix II Grab Sample Photographs

Hart2001007 Grab Sample Photos

Hart2001007_04.png
11/02/2005 12:58:47 PM

Hart2001007_07.png
11/02/2005 12:58:47 PM

Hart2001007_08.png
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