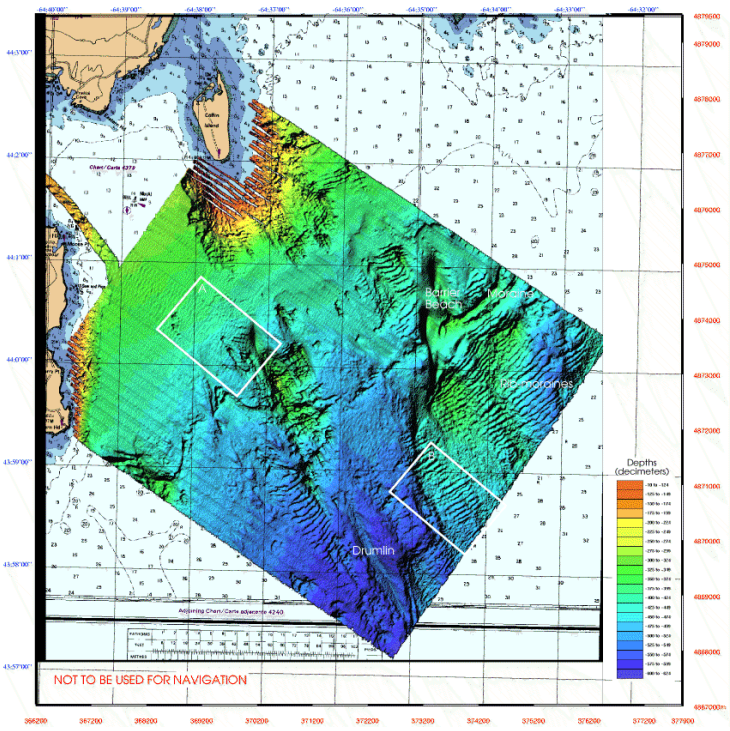
GEOLOGICAL SURVEY OF CANADA
OPEN FILE 4990

Cruise MA98-074 Geophysical and Multibeam Bathymetric Surveys of the Liverpool Offshore Dumpsites 13-19 October 1998



D.R. Parrott

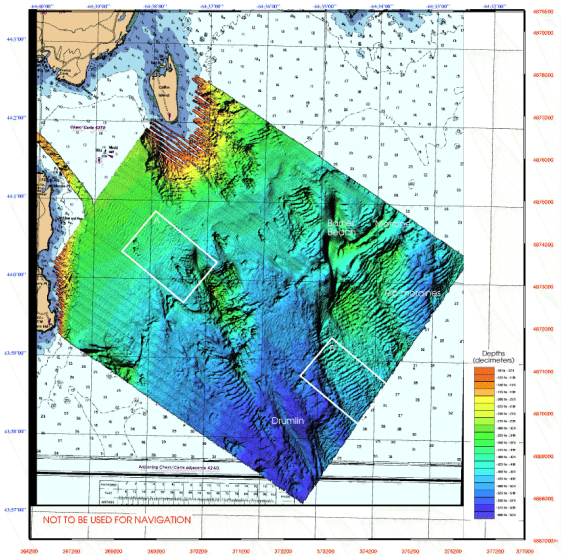
2010

Natural Resources Canada
Ressources naturelles Canada

Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 4990

Cruise MA98-074 Geophysical and Multibeam Bathymetric Surveys of the Liverpool Offshore Dumpsites 13-19 October 1998



D.R. Parrott

2010

This publication is available from the Geological Survey of Canada Bookstore (http://gsc.nrcan.gc.ca/bookstore_e.php). It can also be downloaded free of charge from GeoPub (http://geopub.rncan.gc.ca/).

Parrott, D.R. 2010. Cruise MA98-074 Geophysical and Multibeam Bathymetric Surveys of the Liverpool Offshore Dumpsites, 13-19 October 1998; Geological Survey of Canada, Open File 4990, 35 p.

Background

The shipping channel for Liverpool, Nova Scotia has required extensive dredging to allow the passage of vessels into the inner harbour. Much of the dredged material has been disposed of in offshore marine dumping grounds. Environment Canada and the Geological Survey of Canada (GSC) have undertaken a joint project to determine the effects of offshore dumping on seafloor conditions in dumpsites located in the approaches to Liverpool Harbour, Nova Scotia (Fig. 1).

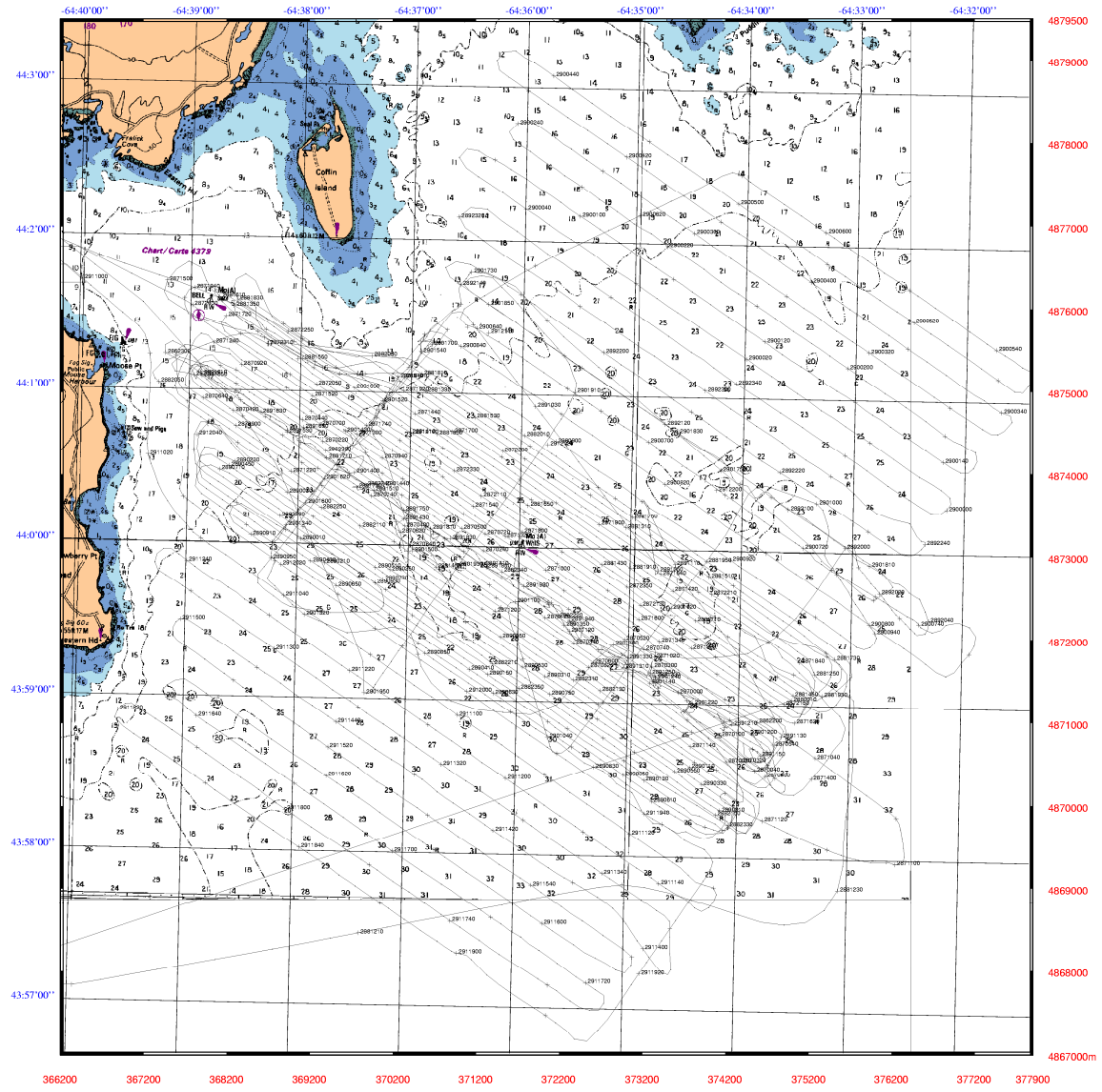


Figure 1 Trackplot of CCGS Matthew during survey MA98074, of the offshore Liverpool dumpsites. Sidescan sonar, sub-bottom profiler and QTC View seafloor classification data were collected along these tracks. Seafloor photographs and samples were collected along a transect along the central corridor and perpendicular to the transect, through Dumpsite A.

Survey Matthew 98-074, conducted from 13-19 October 1998 from the CCGS Matthew, (Fig. 2) collected geophysical and multibeam bathymetric data to provide information on the geological attributes of the dump site and the geological and oceanographic processes which have affected material placed in the offshore dumpsites. Geophysical equipment used during the survey consisted of a Simrad MS992 dual frequency (120 and 330 kHz) sidescan sonar system; Huntec DTS and IKB Seistec sub-bottom profilers; Quester Tangent Corp View seafloor classification system. In addition, sediment samples were collected with a vanVeen grab sampler and bottom photographs were taken along two transects through the survey area. Concurrent with the geophysical survey, a multibeam bathymetry survey was performed using a Simrad EM3000 system operated from the survey launch Plover (Fig. 2).

Figure 2. The geophysical survey and seafloor sampling program were performed using the CCGS Matthew shown above (left). Multibeam bathymetry data were collected using a Simrad EM3000 system mounted in the hydrographic survey launch Plover (right). The launch can be seen in the starboard davit of the CCGS Matthew.

Previous Work

Previous multibeam bathymetry and sidescan sonar surveys had been conducted to provide information on seafloor conditions at the two offshore dumpsites as part of an earlier Environment Canada study. A multibeam bathymetry and geophysical survey (Parrott, 1994) was run to determine seafloor conditions before dumping about 200,000 cmsm (cubic metres scow measure) of materials dredged from the inner harbour. The geophysical surveys were repeated in September 1995 (Parrott, 1995) to determine the effects of dumping of the material. These surveys were jointly performed by the GSC and Public Works and Government Services Canada (PWGSC) using a Simrad MS992 dual frequency (120 and 330 kHz) sidescan sonar system and sub-bottom profiler. Grab samples were taken (Table 1) to assist with the interpretation of the sidescan sonar and sub-bottom profiler data, and to provide information on the potential for sediment transport in the area. Navigation was provided by PWGSC using differential Global Positioning System (DGPS).

Bathymetry data, with continuous coverage, were collected at the dumpsites by Public Works and Government Services Canada in 1994, using a 14 channel Navitronics sweep bathymetry system mounted on the 10 metre survey vessel Miramichi Surveyor.

Preliminary Results

During the survey, multibeam bathymetric and sidescan sonar data were processed on-site and imported into a 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. Seafloor samples and photographs were also taken to provide information for the interpretation of the various acoustic data sets. A variety of seafloor features are presented, using both sidescan sonar and multibeam bathymetric data.

Interpretation of the data shows that the seafloor is dominated by glacial features deposited during the recession of the last glaciers across the area (ca. 12,000-14,000 years BP). These include a large curvilinear moraine, smaller rib-moraines and glaciomarine sediment. Bedrock outcrops in many areas to form shoals. The glacial features were slightly modified, largely by shore face processes, during a subsequent rise of post-glacial sea level to its present position from a low stand of approximately 65 m below present-day sea level. During the marine transgression, several coastal sand bodies were deposited at the northern flank of bedrock outcrops. Ribbed or lift-off moraines, which were previously considered to be absent from transgressed zones, are seen to dominate the study area. Their distribution across this inner shelf, in depths as shallow as 15 m, suggests that they survived the effects of the transgression largely intact. Bottom photographs confirm that the moraines are erosional remnants, armoured by boulders and cobbles.

Data Processing

Sidescan sonar

Sidescan sonar data from MA98-074 were collected digitally using an AGCDIG digitizer using version 2.3 software, at a sample interval of 65 microseconds. During the survey, data were imported into HP Unix workstations where the seafloor was detected, slant range and beam corrections applied, the data integrated with navigation and imported into the GRASS GIS system. Individual lines were then combined to form a digital sidescan sonar mosaic which was overlaid on a scanned bathymetry map of the area (Figure 3). The start and end times of each sidescan sonar tape are given in Table 3.

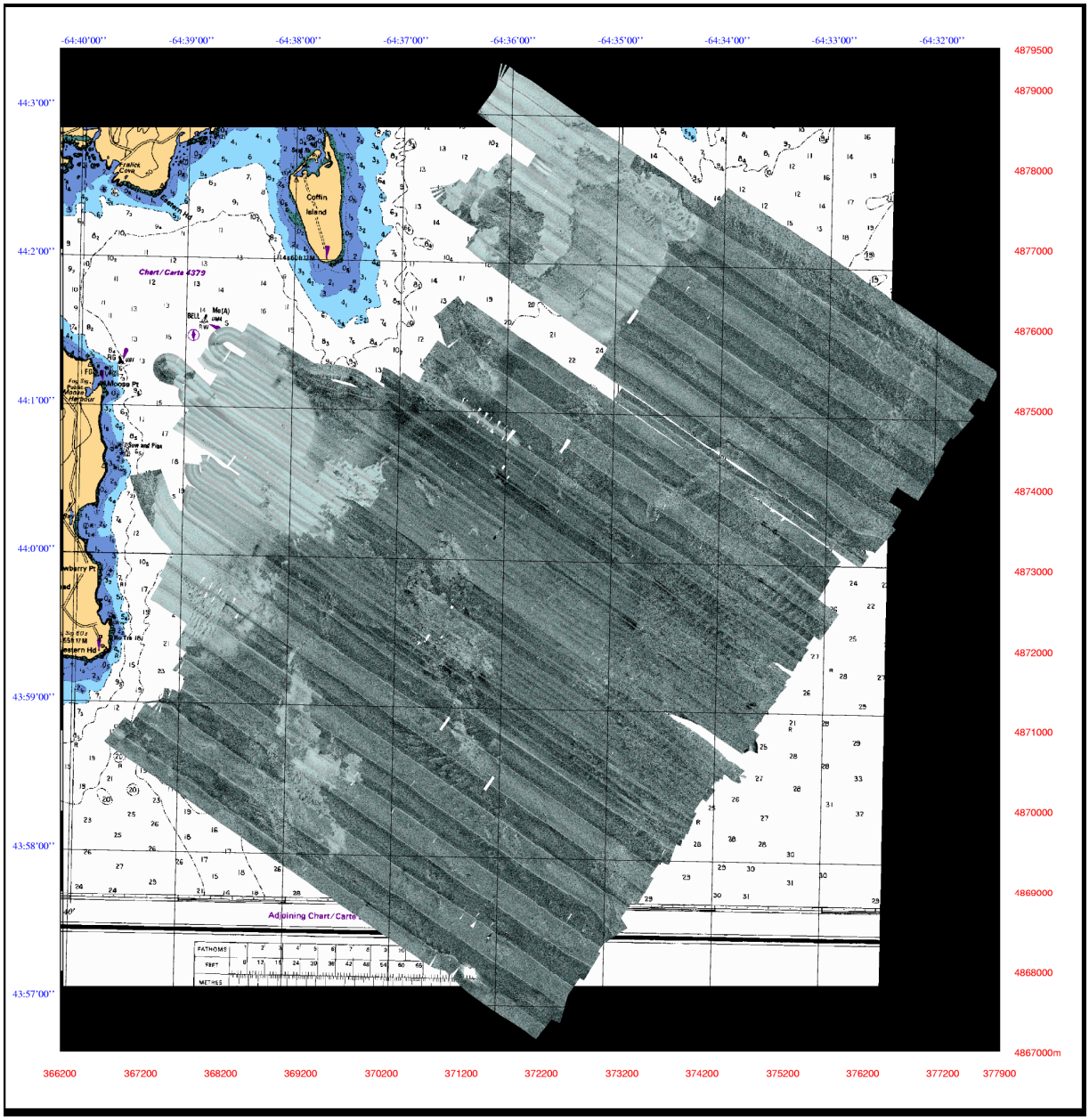


Figure 3. Sidescan sonar mosaic of Liverpool approaches generated from the October 1998 data.

Multibeam Bathymetry

Multibeam bathymetry data were collected using a Simrad EM3000 multibeam bathymetry system mounted in the hydrographic survey launch Plover. During the survey, data were imported into a HP Unix workstation, and processed using the HIPS data cleaning program (CARIS by Universal Systems Limited, Fredericton, NB) to remove spurious soundings and navigation data and to correct for tidal variations. The processed data were imported into the GRASS GIS system where shaded colour relief images were generated and overlaid on scanned bathymetry maps of the area.

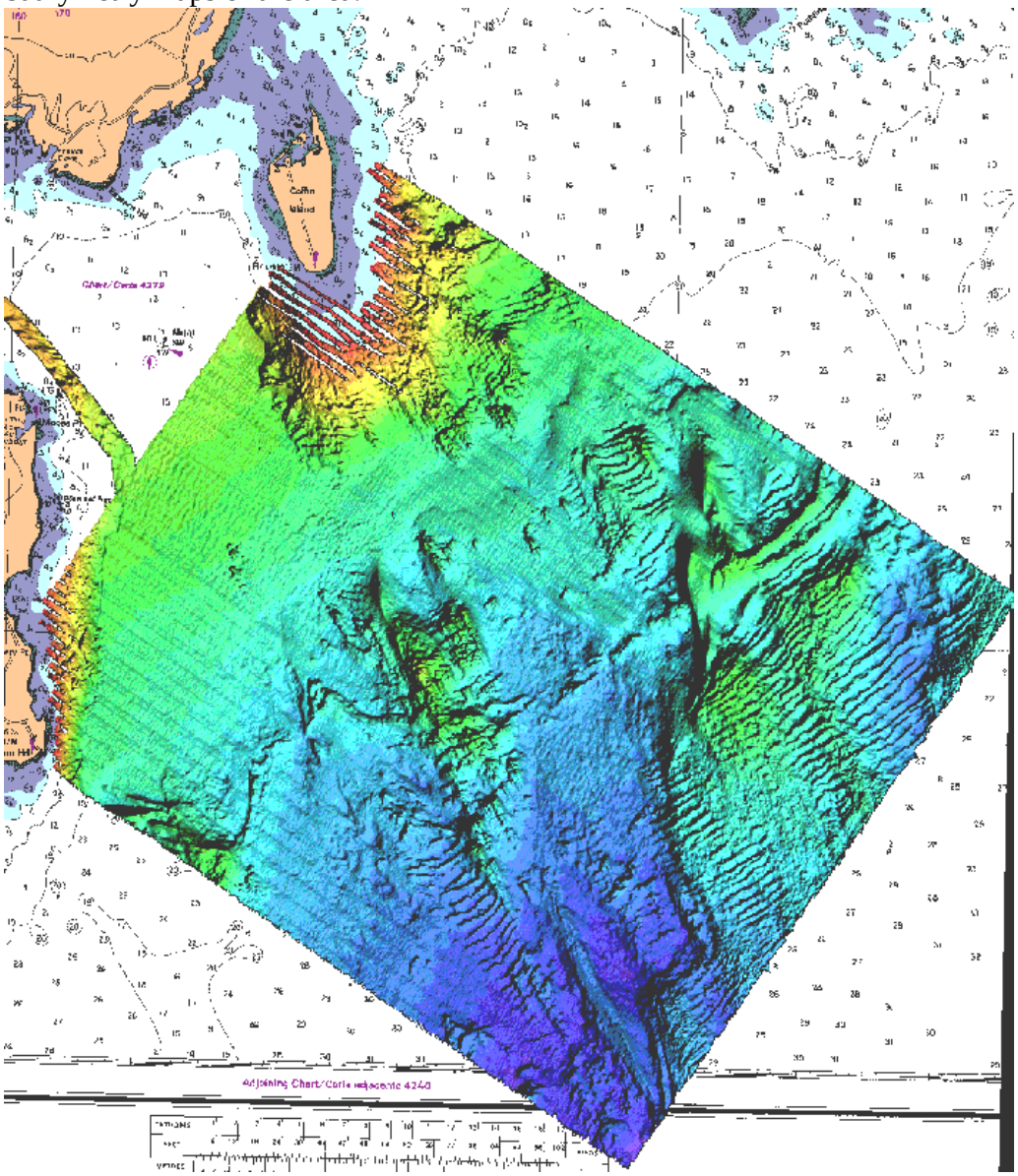


Figure 4. Shaded relief image generated from Simrad EM3000 multibeam bathymetry data collected in October 1999.

After the survey, data were processed by the Ocean Mapping Group at the University of New Brunswick to extract backscatter information to determine the resolution limits of the data. Figure 5 shows the backscatter intensity generated from Simrad EM3000 data.

Multibeam backscatter

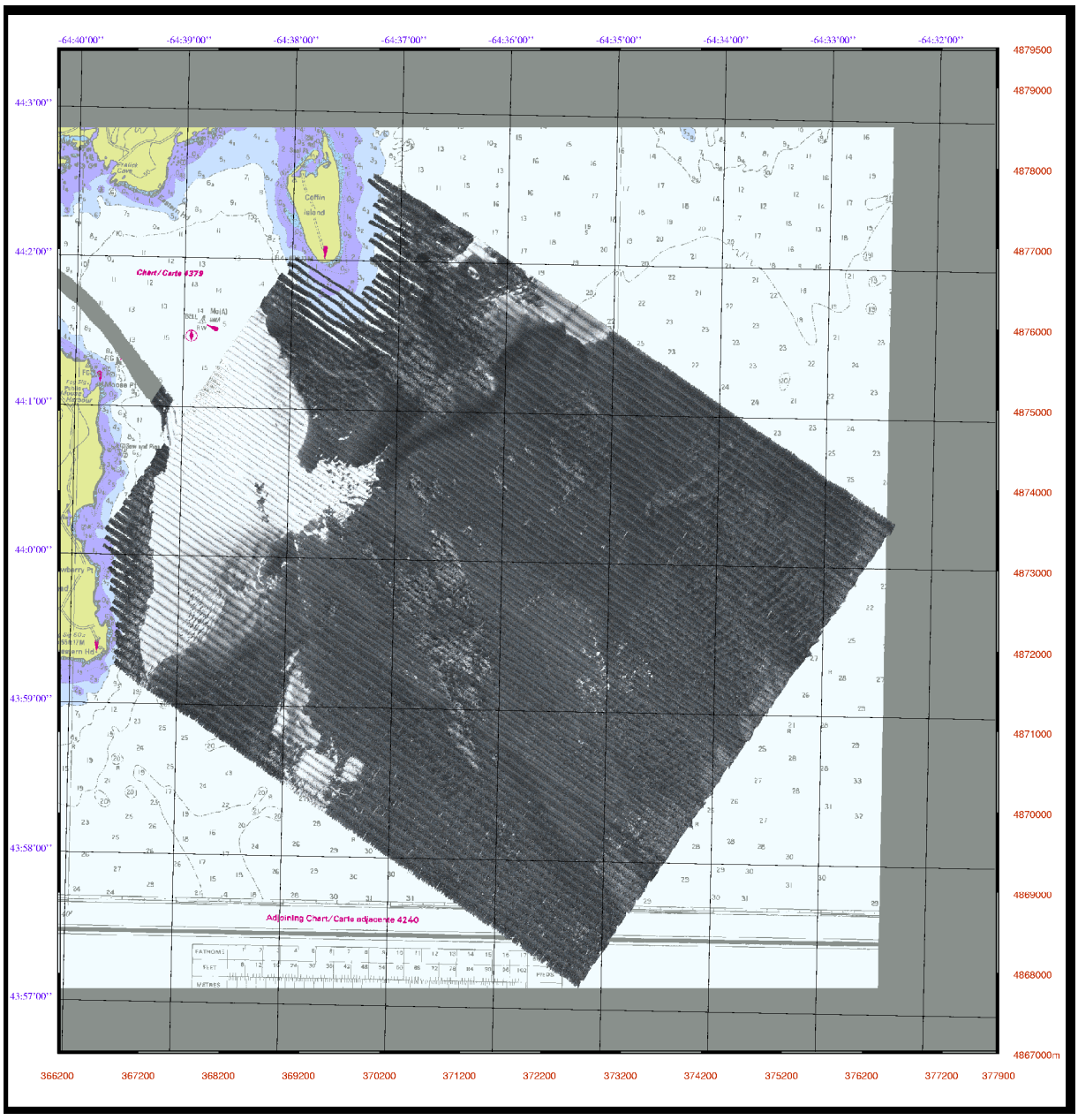


Figure 5. Backscatter intensity generated from Simrad EM3000 multibeam bathymetry data collected in October 1998.

Sub-bottom profiler

Sub-bottom profiler data were collected with a Huntec DTS system and a IKB Seistec system. The start and end times of each sub-bottom profiler tape are given in Table 4. The example of Huntec DTS sub-bottom profiler data, displayed in Figure 6, shows a glacial moraine to the right on the image. Material winnowed from this, and other glacial features, have been shaped into a barrier beach, shown to the left on the image. Note the stratification present in the relict barrier beach.

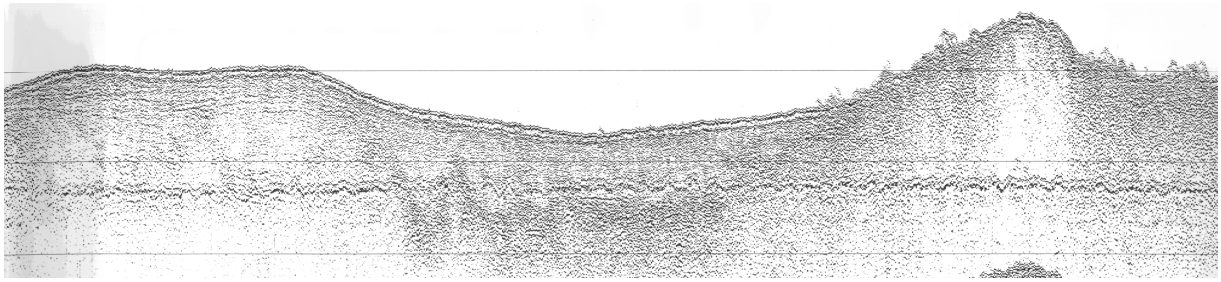


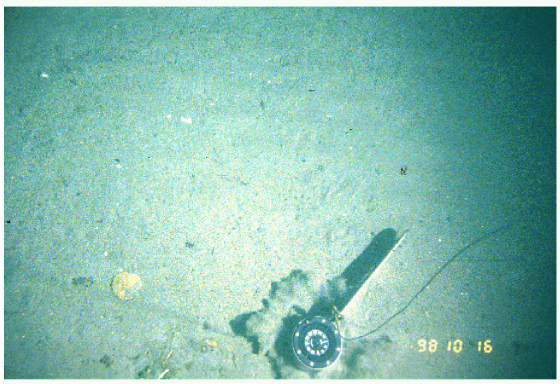
Figure 6 High-resolution sub-bottom profiler data collected during cruise MA98074.

Samples

Sediment samples were taken with a vanVeen sampler to provide groundtruth for the interpretation of the sidescan sonar and sub-bottom profiler data. The sample positions are provided in Table 1.

Seafloor Photographs

Photographs were taken with the “Icehole” camera developed by GSCA. Images were obtained on a roughly north-south transect through both dumpsite A and B, and east-west through dumpsite A. Images were digitized and stored on a CD-ROM in Photo CD-ROM (PCD) format. Sample images are shown in Figure 6. Locations are provided in Table 2.



Dumpsite A

near Dumpsite B

Figure 6. Seafloor photographs showing the fine-grained sediments found at dumpsite “A” and the much coarser material found near dumpsite “B”.

Access to Geophysical Data

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 GSCA 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 data in SEG-Y format, and ExaBytes tapes of the raw multibeam bathymetry data are available for viewing.

Proposed Future Work

Seafloor conditions at Dumpsite A and B have been surveyed before, and immediately after a large-scale offshore marine dumping program. Several sediment types were interpreted, and the effects of dumping have been studied. Indications of reworking of the seafloor sediments by modern seafloor processes have been found, probably by wave action during storms. Evidence of dumping of dredged material at site A has been found. Multibeam bathymetry data have been collected over the dumpsites in the November 1998 survey. A current meter deployment is scheduled for late winter 1999.

Repetitive multibeam bathymetry, sidescan sonar and sub-bottom profiler surveys are scheduled for April 1999 to determine the net effect of reworking of the sediments in this area over the winter. Additional surveys are tentatively scheduled for November 1999 to determine the effects of dumping activities during the summer and fall of 1999. Additional surveys should be performed over the next 2-5 years to determine the effect of winter storms and of present day seafloor processes on the dumped materials. Additional surveys should also be performed before and after any major dumping activities at the site to establish seafloor conditions and determine the effects of dumping.

Multibeam bathymetry, sidescan sonar and sub-bottom profiler surveys provide a quick, remote-sensing technique for determining the distribution of seafloor sediments; repetitive surveys with these techniques will allow interpretation of reworking of the dumped materials by modern day oceanographic processes. The response of the dumped material to the effects of dynamic loading, as caused by waves and ship’s passages should be determined. The GSCA Sea Carousel, uses a small annular flume to determine the shear strength of the seafloor sediments, by accelerating the water in the flume until the critical velocity is reached and sediments within the flume are suspended in the water. This system has been employed in earlier studies at the Black Point dumpsite in Saint John, NB and should be deployed at Liverpool. Detailed information on the oceanographic conditions is required to accurately predict conditions for sediment reworking or for the magnitude and direction of sediment transport. This would require monitoring of tides, currents and waves, potentially with concurrent time-lapse photography of the seafloor. The combination of direct measurement of the parameters required for suspension of the sediments at the dumpsite, and determination of the oceanographic conditions at the site, would greatly enhance the understanding of the stability of the dumpsite, and allow prediction of the most likely direction(s) of sediment transport.

References

Parrott, D.R., Sidescan Sonar and Bathymetry Survey of Offshore Marine Dumpsites in Liverpool, Nova Scotia May 1994. Unpublished report to Public Works and Government Services Canada A&ES, Atlantic Region and Transport Canada Marine Navigational Aids. May 1994.

Parrott, D.R., Sidescan Sonar Survey of the Liverpool Offshore Dumpsites 26-28 September 1995. Report to Public Works and Government Services Canada A&ES, Atlantic Region and Transport Canada Marine Navigational Aids. November 1995. Geological Survey of Canada Open File Report 3249.

Appendix A

Survey Particulars

Name of Vessel:	CCGS Matthew
Vessel captain:	Anthony Potts
Dates of Survey:	13-19 October 1998
Area of Operation:	Liverpool, Nova Scotia
Senior Scientist:	Russell Parrott, GSC

Personnel

Geological Survey of Canada Atlantic

Russell Parrott	Senior Scientist
Robert Miller	Second Scientist
Borden Chapman	Electronics Technologist
Robert Murphy	Sampling/photography
Peter Pledge	Geophysical watchkeeping
Darrel Beaver	Multibeam bathymetry data collection
Paul Girouard	Navigation/multibeam data cleaning
Craig Dickson	Geophysical watchkeeping/database entry

Geoforce Associates

Martin Uyesugi	Seismic operator

Equipment Specifications and Performance

The Liverpool offshore dumpsites were surveyed with multibeam bathymetry, sidescan sonar and sub-bottom profiler equipment using the hydrographic launch Plover deployed from CCGS Matthew. The sidescan sonar and sub-bottom profiler survey equipment were positioned on the afterdeck of the Matthew.

- Hydrographic Survey launch Plover equipped with a Simrad EM3000 multibeam bathymetry system, Applied Analytics POS-MV attitude sensing system, and differential GPS navigation system.
- Huntec DTS high resolution sub-bottom profiler
- IKB Seistec high resolution sub-bottom profiler
- Simrad MS992 sidescan sonar system
- ORE TrackPoint II ultra short baseline towfish positioning system
- AGCNAV survey navigation package with input from differential GPS, version 3.1 software
- HP workstations running GRASS with GSCA extensions

SIMRAD MS992 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 behind a dead weight depressor. This configuration was chosen to reduce noise on the sidescan sonar records due to vessel induced heave. 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 dumpsites. This provided swaths of 200 and 400 metres. Lines run at the 100 m range

were typically 75 metres apart, with a 300 metre spacing used for the 200 metre range lines. About 75 metres of towcable were deployed. Data (both 120 and 330 kHz) were digitized and stored on an AGCDIG digital data recorder using version 2.3 software. A hardcopy graphic record of the sidescan sonar data was produced on an Alden 9315CTP thermal recorder. The sidescan sonar system was capable of resolving objects down to a size of about 25 cm. The digital gain settings for the system were logged on field sheets. The Simrad sidescan sonar was deployed from the starboard side of the vessel.

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 - 65 microseconds sample interval

Channel	Use
0	120 kHz port
1	120 kHz starboard
2	330 kHz port
3	330 kHz starboard

Sub-bottom profiler – Huntec DTS - 30 microseconds sample interval

Channel	Use
0	GF10/15 element streamer
1	GF24/24 element streamer

Sub-bottom profiler – IKB Seistec - 30 microseconds sample interval

Channel	Use
0	STB Seistec line cone receiver
1	STB GF10/15P streamer hydrophone

BATHYMETRY

Multibeam bathymetry data were collected using the hydrographic survey launch Plover equipped with a Simrad EM3000 multibeam bathymetry system, Applied Analytics POS-MV attitude sensing system, and differential GPS navigation system. Lines were run at a 75 metre spacing throughout the survey area to provide 100 percent coverage of the seafloor in depths greater that about 20 metres.

SAMPLING EQUIPMENT

Samples of the surficial sediment in the area were obtained primarily with a small van Veen grab sampler. A Shipek sampler failed to recover sediment in the coarse material encountered in the offshore areas.

BOTTOM PHOTOGRAPHY
Bottom photographs were collected on two transects through the survey area using the Ice-hole camera developed at GSCA. Images were digitized and stored on a CD-ROM in PCS format.

SUB-BOTTOM PROFILER
Sub-bottom profiler data were collected using either the Huntec Deep Towed Seismic (DTS) system or the IKB Seistec system. Both system use an electrodynamic source ("boomer") to produce a repeatable impulse-like output. The DTS system, equipped with two external streamers, was deployed from the stern gantry and towed about 10-30 metres above the seafloor. The Seistec system, equipped with an internal line-and-cone array and an external streamer, was deployed by crane on the starboard side of the vessel and towed at the surface. The systems were fired 2 times per second, and graphic records displayed on a thermal graphic recorder.

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
The sidescan sonar and sub-bottom profiler records were interpreted in the field to provide an overview of the surficial geology of the survey area, and sites were selected to collect seafloor samples and photographs.

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.

Multibeam bathymetry data were processed in the field, using the Universal Systems Ltd. Caris HIPS data cleaning system, to remove spurious navigation and depth values and integrate tidal corrections. The processed depths were imported into a GIS system (GRASS developed by the US Army Corps of Engineers) and overlain on maps of the survey area.

After the survey, the multibeam bathymetry data were reprocessed, by the Ocean Mapping Group at the University of New Brunswick, to correct for heave artifacts and to improve the resolution of the data.

Summary of Activities (all times in GMT)

Day 286 - Tuesday 13 October 1998 – Mobilization, field test of gear, start survey

12:00 Commence mobilization of various computers and Quester Tangent Corp View seafloor classification system.
16:00 Depart Halifax and transit to Liverpool.
21:45 Deploy sidescan sonar, Huntec DTS and Track Point II system. Sidescan sonar and Huntec data logged on AGCDIG (4 channel digitizers) running version 2.3 software. Navigation and line running capability provided by AGCNAV. Survey from centre of the dumpsites out.

Day 287 Wednesday 14 October 1998 – continue with survey near centre of dumpsites

00:06 High flyer buoy tangled in survey gear.
00:52 Discover Track Point II boom broken – recover Track Pt and continue survey.
10:35 Recover gear to deploy hydrographic survey launch with D. Beaver on board.
11:30 Survey gear re-deployed and operational.
19:48 All gear on board to recover hydrographic launch. R. Miller and R. Murphy join vessel.
20:40 Survey gear re-deployed and operational.

Day 288 Thursday 15 October 1998 – continue with survey near centre of dumpsites

00:00 Continue with survey – winds increasing.
00:20 Recover Gear and head to Port Mouton to Wait out the high winds.

12:40 Re-deploy survey gear in Liverpool Bay.
15:38 Recover gear to deploy hydrographic survey launch with D. Beaver and P. Girouard on board.
16:23 Re-deploy survey gear in Liverpool Bay.
20:21 All gear on board to recover hydrographic launch.
20:55 Re-deploy survey gear in Liverpool Bay and continue with survey.

Day 289 Friday 16 October 1998 – continue with survey and sampling/photography

00:00 Continue with survey.
10:40 Recover gear to deploy hydrographic survey launch with D. Beaver on board.
11:00 Bottom sampling and photography along transect running through dumpsites.
20:45 Hydrographic launch recovered and survey gear deployed. Continue with survey.

Day 290 Saturday 17 October 1998 – continue with survey and sampling/photography

00:00 Continue with sidescan sonar and seismic survey.
10:55 Recover gear and deploy hydrographic launch..
11:00 Bottom sampling and photography along transect running through dumpsites.
18:10 Gear deployed to survey lines east of Liverpool Dumpsites near Coffin Island.
19:38 Recover gear and survey launch. Huntec DTS winch unable to recover the towfish. Use HIAB crane to assist with the recovery. Transit to Liverpool Harbour for the night.

Day 290 Sunday 18 October 1998 – continue with survey and sampling/photography

09:35 Deploy hydrographic launch and survey gear. R. Murphy ferried to Liverpool to drive vehicle back to Halifax. IKB Seistec system deployed to provide high resolution seismic data.
10:00 Run transit line out of Liverpool Harbour.
11:25 Survey lines west of Liverpool Dumpsites.
20:30 Recover gear to recover survey launch.
20:50 Deploy gear and complete geophysical survey.
22:11 Recover all gear and steam to Halifax.

Day 291 Monday 19 October 1998 – transit to Halifax and demobilization

00:00 In transit to Halifax.
07:00 Arrive at BIO jetty and start demobilization.

Table 1 Grab sample Locations

Station No	Day/Time	Type	Latitude	Longitude	Depth (m)
0001	289/1136	Grab	43.978620	-64.564380	45
0002	289/1157	Grab	43.980790	-64.568600	46
0003	289/1216	Grab	43.982500	-64.574520	44
0004	298/1233	Grab	43.985420	-64.579550	43
0005	289/1316	Grab	43.988598	-64.584820	52
0006	289/1335	Grab	43.991140	-64.590130	52
0007	289/1356	Grab	43.993800	-64.595330	53
0008	289/1404	Grab	43.996030	-64.600880	51
0009	289/1411	Grab	43.998200	-64.606140	47
0010	289/1419	Grab	44.000900	-64.611430	42
0011	289/1426	Grab	44.003130	-64.616950	46
0012	289/1511	Grab	44.005960	-64.622830	44
0013	289/1517	Grab	44.008500	-64.627520	42
0014	289/1524	Grab	44.010960	-64.632510	40
0015	289/1533	Grab	44.013590	-64.637700	36
0016	289/1542	Grab	44.016000	-64.642730	34
0017	289/1550	Grab	44.018540	-64.648190	32
0036	290/1607	Grab	44.000470	-64.636330	43
0037	290/1615	Grab	44.003900	-64.632750	43
0038	290/1621	Grab	44.007520	-64.628850	41
0039	290/1626	Grab	44.010980	-64.624420	41
0040	290/1632	Grab	44.015210	-64.621400	40
0041	290/1638	Grab	44.018640	-64.618880	37
0042	290/1646	Grab	44.022470	-64.614870	27
0043	290/1651	Grab	44.020430	-64.616250	30
0044	290/1703	Grab	44.022210	-64.615610	26
0045	290/1714	Grab	44.025720	-64.610360	32
0046	290/1726	Grab	44.029650	-64.608170	33

Table 2 Camera Station Locations

Station No	Day/Time	Type	Latitude	Longitude	Depth (m)
0018	289/1611	Camera	44.017770	-64.646740	32
0019	289/1622	Camera	44.015970	-64.641620	35
0020	289/1632	Camera	44.013730	-64.637710	36
0021	289/1700	Camera	44.010840	-64.632290	39
0022	289/1735	Camera	44.006540	-64.621820	44
0023	289/1827	Camera	44.000800	-64.610840	41
0024	289/1918	Camera	43.995720	-64.599080	52
0025	290/1125	Camera	43.989540	-64.589380	55
0026	290/1154	Camera	43.978130	-64.562680	49
0027	290/1204	Camera	43.981090	-64.567070	48
0028	290/1226	Camera	43.982800	-64.574310	47
0029	290/1237	Camera	43.985750	-64.578320	47
0030	290/1249	Camera	43.987260	-64.582870	49
0031	290/1332	Camera	43.998960	-64.637030	46
0032	290/1411	Camera	44.010840	-64.625200	42
0033	290/1514	Camera	44.014550	-64.621730	41
0034	290/1525	Camera	44.018570	-64.618220	37
0035	290/1541	Camera	44.022040	-64.615250	28

TABLE 3 – SIDESCAN SONAR DIGITAL TAPE FILES

TAPE	FILE	DAY	START	STOP
1	1	286	21:50	21:54
1	2	286	21:56	22:57
1	3	286	22:57	23:59
1	4	287	0:00	0:19
1	5	287	0:51	2:00
1	6	287	2:00	2:08
1	7	287	2:08	3:00
1	8	287	3:00	3:18
1	9	287	3:18	4:25
1	10	287	4:26	4:29
1	11	287	4:29	5:39
1	12	287	5:39	5:43
1	14	287	5:43	6:40
1	15	287	6:40	6:47
1	16	287	6:47	7:54
1	17	287	7:54	8:02
1	18	287	8:02	9:04
1	19	287	9:04	9:16
1	20	287	9:16	10:35
2	3	287	11:30	11:37
2	4	287	11:37	err
2	5	287	12:30	12:38
2	6	287	12:38	13:49
2	7	287	13:49	14:08
2	8	287	14:08	14:32
2	9	287	14:32	14:52
2	11	287	15:09	15:43
2	12	287	15:43	16:17
2	13	287	16:17	16:24
2	14	287	16:24	16:51
2	15	287	16:51	17:12
2	16	287	17:12	17:22
2	17	287	17:22	18:00
2	21	287	18:01	18:31
2	22	287	18:31	18:38
2	23	287	18:38	19:33
2	24	287	19:34	19:35
2	25	287	20:40	21:13
2	26	287	21:13	21:50
2	27	287	21:50	22:00
2	28	287	22:01	22:27
2	29	287	22:27	22:53

3	3	288	0:16	0:20
3	5	288	13:00	13:47
3	6	288	13:47	13:51
3	7	288	13:51	13:59
3	9	288	14:21	14:49
3	10	288	14:49	14:59
3	12	288	15:00	15:25
3	13	288	15:25	15:37
3	15	288	16:22	16:29
3	16	288	16:50	17:22
3	17	288	17:22	17:30
3	18	288	17:30	17:57
3	19	288	17:57	18:12
3	20	288	18:12	18:31
3	21	288	18:31	19:27
3	24	288	19:27	19:36
3	25	288	19:36	20:06
3	26	288	20:06	20:21
4	3	288	20:55	20:59
4	4	288	21:00	21:18
4	5	288	21:18	21:41
4	6	288	21:41	21:45
4	7	288	21:49	22:14
4	8	288	22:14	22:38
4	9	288	22:38	22:43
4	10	288	22:43	23:23
4	11	288	23:23	23:31
4	12	288	23:31	23:59
4	13	289	0:00	0:23
4	14	289	0:23	0:26
4	15	289	0:26	0:44
4	16	289	0:44	1:13
4	17	289	1:13	1:21
4	18	289	1:21	1:57
4	19	289	1:57	2:24
4	20	289	2:24	2:27
4	21	289	2:27	2:57
4	22	289	2:57	3:32
4	23	289	3:32	3:39
4	24	289	3:39	4:15
4	25	289	4:15	4:44
4	26	289	4:44	4:47
4	27	289	4:47	5:21
4	28	289	5:21	5:55
4	29	289	5:55	6:03

4	30	289	6:03	6:38
4	31	289	6:38	7:07
5	3	289	21:51	22:03
5	4	289	22:03	22:32
5	5	289	22:32	22:37
5	6	289	22:38	22:43
5	7	289	22:43	23:06
5	9	289	23:20	23:21
5	10	289	23:21	23:57
5	11	289	23:57	23:59
5	12	290	0:00	0:05
5	13	290	0:05	0:28
5	14	290	0:28	0:45
5	15	290	0:45	0:48
5	16	290	0:48	1:41
5	17	290	1:41	1:46
5	18	290	1:46	2:38
5	19	290	2:38	2:42
5	20	290	2:42	3:33
5	21	290	3:33	3:40
5	22	290	3:40	4:32
5	23	290	4:32	4:35
5	24	290	4:35	5:30
5	25	290	5:30	5:36
5	26	290	5:36	6:10
5	27	290	6:10	6:37
5	29	290	7:28	7:28
5	30	290	8:00	8:27
5	31	290	8:27	8:41
5	32	290	8:42	8:46
5	33	290	8:46	8:56
5	34	290	8:56	9:32
5	35	290	9:32	10:09
5	36	290	10:09	10:34
6	4	290	1810	1851
6	5	290	1851	1908
6	6	290	1908	1937
7	3	291	0942	0959
7	4	291	1000	1019
7	5	291	1019	1059
7	6	291	1100	1125
7	7	291	1125	1138
7	8	291	1138	1159
7	9	291	1200	1242
7	10	291	1242	1242

7	11	291	1243	1246
7	12	291	1246	1345
7	13	291	1345	1401
7	14	291	1401	1458
7	15	291	1458	1504
7	16	291	1504	1548
7	17	291	1548	1553
7	18	291	1553	1632
7	19	291	1632	1635
7	20	291	1635	1720
7	21	291	1720	1725
7	22	291	1725	1816
7	23	291	1816	1821
7	24	291	1821	1911
7	25	291	1911	1933
7	26	291	1933	2029
7	27	291	2049	2110
7	28	291	2110	2121
7	29	291	2135	2211

TABLE 4 - SUB-BOTTOM PROFILER DIGITAL TAPE FILES

Tape	File	Start DayTime	End DayTime
1	2	2862200	2862251
2	2	2862320	2862359
2	3	2870000	2870011
2	4	2870011	2870054
2	5	2870054	2870200
2	6	2870200	2870205
3	2	2870245	2870300
3	3	2870300	2870314
3	4	2870314	2870318
3	5	2870319	2870425
3	6	2870425	2870429
3	7	2870429	2870538
3	8	2870538	2870543
3	9	2870543	2870641
3	10	2870641	2870647
3	11	2870647	2870754
3	12	2870754	2870802
3	14	2870802	2870802
3	15	2870802	2870904
3	16	2870904	2870916
3	17	2870916	2871035
3	18	2871035	2871035
4	2	2871134	2871230
4	3	2871230	2871238
4	4	2871238	2871350
4	5	2871350	2871408
4	6	2871408	2871452
4	7	2871452	2871524
4	8	2871524	2871543
4	9	2871543	2871617
4	10	2871618	2871624
4	11	2871625	2871652
4	12	2871652	2871713
4	13	2871713	2871722
4	14	2871722	2871831
4	15	2871831	2871838
4	16	2871838	2871934
4	17	2871934	2871935
4	18	2872040	2872113
4	19	2872113	2872150
4	20	2872150	2872201

4	21	2872201	2872227
4	22	2872227	2872307
4	23	2872307	2872359
4	24	2880000	2880010
5	4	2881347	2881351
5	5	2881351	2881450
5	6	2881450	2881459
5	7	2881459	2881503
6	3	2882118	2882141
6	4	2882141	2882141
6	5	2882141	2882149
6	6	2882149	2882214
6	7	2882214	2882238
6	9	2882238	2882243
6	10	2882243	2882323
6	11	2882323	2882331
6	12	2882331	2882359
6	13	2890000	2890023
6	14	2890023	2890026
6	15	2890026	2890044
6	16	2890044	2890114
6	17	2890114	2890121
6	18	2890121	2890157
6	19	2890157	2890224
6	20	2890224	2890257
6	21	2890257	2890258
6	22	2890258	2890332
6	23	2890332	2890339
6	24	2890339	2890415
6	25	2890415	2890444
6	26	2890444	2890447
6	28	2890521	2890555
6	30	2890603	2890638
6	31	2890638	2890707
6	32	2890707	2890711
6	33	2890711	2890737
6	34	2890737	2890809
6	35	2890809	2890815
6	36	2890815	2890849
6	37	2890849	2890912
6	38	2890912	2890951
6	39	2890951	2891004
6	40	2891004	2891015
7	2	2892054	2892129
7	3	2892130	2892142

7	4	2892142	2892144
7	5	2892144	2892203
7	6	2892203	2892233
7	7	2892233	2892243
7	8	2892243	2892306
7	9	2892306	2892320
7	10	2892320	2892322
7	11	2892322	2892357
7	12	2892357	2892359
7	13	2900000	2900005
7	14	2900005	2900028
7	15	2900028	2900046
7	16	2900046	2900048
7	17	2900048	2900141
7	18	2900141	2900146
7	19	2900146	2900238
7	20	2900238	2900242
7	21	2900243	2900333
7	22	2900333	2900340
7	23	2900340	2900432
7	24	2900432	2900435
7	25	2900435	2900531
7	26	2900531	2900536
7	27	2900536	2900610
7	28	2900610	2900638
7	29	2900639	2900728
7	30	2900801	2900802
7	31	2900802	2900827
7	32	2900827	2900842
7	33	2900842	2900846
7	34	2900846	2900856
7	35	2900856	2900932

Sub-bottom Profiler Operations

TECHNICAL REPORT
DEEP TOW OPERATIONS
LIVERPOOL BASIN
NOVA SCOTIA
C.C.G.S. MATTHEW #98-074
OCTOBER 13 - 19, 1998

Submitted by:

Geoforce Consultants Ltd.
P.O. Box 696
Dartmouth, Nova Scotia
B2Y 3Y9

Prepared for:

Geological Survey Canada - Atlantic Region
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, Nova Scotia
B2Y 4A2

Distribution: R. Parrott (GSCA)
M. Gorveatte (EMG)
A. Boyce (Curation copy)
Project File #C135-28 Dated: October 19, 1998

1.0 INTRODUCTION

This is a technical review of the Deep Tow Seismic (DTS) operations aboard the Canadian Coast Guard Ship Matthew, during Geological Survey Canada mission #MA98-074. This marine geophysical, geological sampling and multibeam hydrographic survey was located off Liverpool harbour, Nova Scotia, from October 13 - 19, 1998. The field program was directed by Senior Scientist, Mr. Russell Parrott (GSC-Atlantic Region).

The DTS was part of the geophysical survey program, which consisted of the following equipment systems.

* Deep Tow Boomer/Sparker profiling system
* Simrad MS992 Dual frequency side scan sonar system
* AGCDIG Digital Logger (Simrad and DTS)
* IKB Seistec Surface Tow Boomer profiling system

Overall, DTS operations went well with no major problems to report. At the end of the survey , the DTS winch experienced difficulty lifting the tow fish out of the water. There was no equipment down-time, however, some time was lost due to weather downtime. For details see Equipment Performance in section 2.2. In general, the DTS sub-bottom data quality was good to excellent, depending on weather conditions. The Huntec Deep Tow boomer system was used to collect the majority of sub-bottom profiles. On the last day of survey the Seistec Surface Tow Boomer (STB) was used due to concerns with the DTS winch.

Geoforce Consultants Limited provided technician, Martin Uyesugi under the standing offer contract #23420-95-01HAL to supervise the installation, operation and maintenance of the DTS system during the field program. The Geoforce technician stood nightly watches on the IKB Seistec and Simrad side scan system when the DTS system was not being used.

1.1 DAILY SUMMARY

A daily summary of operations follows. All times are UTC unless otherwise noted.

Date	JD	Event
13/10/98	286	Equipment previously installed for cruise MA98049.
		Depart BIO jetty at 1500 hours.
		Proceed to Liverpool survey area.
		Deploy DTS and Simrad at 2150 hours.
		Survey lines # 020 2305 - 0000
14/10/98	287	Continue survey operations.
		020 0000 - 0010 (continuation)
		Recover gear to remove high flyer snagged by vessel.
		Redeploy DTS and Simrad at 0040 hours.
		Survey lines # 023 0055 - 0200
		020 0208 - 0314
		024 0318 - 0423
		019 0428 - 0538
		025 0543 - 0640
		018 0646 - 0754
		026 0802 - 0904
		017 0916 - 1132
		027 1137 - 1230
		016 1239 - 1349
		008 1407 - 1452
		015 1509 - 1618
		007 1624 - 1713
		014 1722 - 1830
		006 1839 - 1934
		Recover gear at 1948 hours and proceed to recover launch.
		Deploy DTS and Simrad at 2035 hours.
		Survey lines # 013 2040 - 2150
		005 2201 - 2253
		012 2307 - 0000
15/10/98	288	Continue survey operations.
		012 0000 - 0009 (continuation)
		Recover gear at 0020 hours due to weather forecast.
		Proceed to Port Methune and anchore.
		Winds decreasing, proceed to survey area.

Deploy DTS and side scan at 1240 hours.

Survey lines #	004	1252 - 1347
	011	1351 - 1449
	003	1459 - 1537
	010	1623 - 1729
	002	1730 - 1812
	009	1831 - 1927
	001	1936 - 2021

Recover gear at 2030 hours.
Deploy DTS and side scan at 2050.

Survey lines #	028	2058 - 2141
	034	2149 - 2238
	029	2244 - 2323
	035	2331 - 0000

16/10/98 289 Continue survey operations.

	035	0000 - 0019 (continuation)
	030	0026 - 0113
	036	0121 - 0224
	031	0227 - 0332
	037	0339 - 0444
	032	0447 - 0555
	038	0602 - 0707
	033	0711 - 0809
	039	0815 - 0912
	T01	0951 - 1015

Recover gear at 1030 hours.
Deploy DTS and side scan at 2045 hours.

Survey lines #	040	2050 - 2141
	041	2144 - 2232
	042	2243 - 2320
	043	2321 - 2357

17/10/98 290 Continue survey operations.

044	0005 - 0046
045	0048 - 0141
046	0146 - 0238
047	0242 - 0333
048	0340 - 0432
049	0435 - 0530
050	0536 - 0610
transit	0610 - 0638
040A	0638 - 0728
040B	0801 - 0842
040C	0846 - 0932
TIE03	1010 - 1034

Recover gear at 1034 hours.

Service Note: *Problem lifting tow fish out of water. Required use of ship's crane to assist lifting tow fish on board.*

Deploy DTS and side scan at 0805 hours.

Survey lines#	040	1810 - 1849
	TIE02	1908 - 1938

Recover gear to pick up launch.

Service Note: *Continued problems lifting tow fish out of water. Had to rely on ship's crane to recover tow fish. Senior Scientist decides to deploy the STB system due to the problems with the DTS winch.*

Vessel standing by at anchor.

18/10/98 291 Deploy STB and side scan at 0950 hours.
Stand Seistec and side scan watch.
Recover gear at 2215 hours.
End of survey operations.
In transit to BIO.

19/10/98 292 Arrive at the Bedford Institute.
****** END OF MISSION ******

2.0 DESCRIPTION OF EQUIPMENT

a) Deep Tow Seismic System

Geoforce Consultants Limited of Dartmouth, Nova Scotia is contracted under Standing Offer #23420-95-01/HAL to supervise the operation, maintenance and ongoing engineering development of the GSC's Deep Tow Seismic (DTS) systems. The DTS system, originally manufactured by Huntec (70) Limited, is a high resolution, sub-bottom profiler with the acoustic source, energy supply, motion sensor, and two receiving hydrophones housed in an underwater deep towed body. Due to ongoing repairs to the AGC#2 tow fish, the larger AGC #3 tow fish was substituted for this mission.

The maximum power output of this system is 1000 joules (60 mfd storage capacitance) with an ED 10 F/C Boomer and multi tip sparker source. For this mission, the internal LC10 hydrophone was disconnected and a Geoforce GF15/10P streamer hydrophone was connected as Seismic #1 (overall streamer length 15 feet, with a 10 foot active section, ten parallel wired AQ1 elements spaced 12 inches). A Geoforce GF24/24P2 streamer hydrophone was connected as Seismic #2 (overall streamer length 24 feet, combined fourteen foot active section, with two interspliced sections, twenty-four AQ1 elements and an effective spacing of 12 inches).

The ED10 boomer source is depth compensated and outputs a highly repeatable broadband pulse, capable of resolving 10 centimetres. Peak output intensity is 118 db relative to 1 micro bar at 1 metre, with a pulse duration of 110 microseconds. The sparker source has twenty, # 22 awg, solid core tips. Sparker peak amplitude and pulse width are depth dependant.

The deck equipment consists of a Huntec Model 1000 Oceanographic winch, which includes a multi-way slip ring and a 305 metre, fourteen conductor, armoured tow cable. The winch is powered by a 440 VAC, 15 HP hydraulic pump unit. The tow cable is handled by a 36 inch diameter roller cluster rigged on the centre position of the aft A frame.

The lab instrumentation consists of the Huntec Systems Console and DC high voltage power supply (PCU). The Systems Console houses the Bottom Motion Compensator circuits, the +24 volt fish supply, and modules for signal processing and tape outputs. The Huntec Mk III PCU provides DC power to the boomer in switchable ranges from 2 to 6 kilovolts.

b) Graphic Display, Signal Processing and System Key

The two DTS seismic channels were displayed on a EPC 9800 dual channel recorder (s/n 126). Seismic #1 (GF10/15P streamer) was processed by the Systems Console's Adaptive Signal Processor (ASP) module then displayed on Channel A of the EPC recorder. Seismic #2 (GF24/24P2 streamer) was passed thru a Krohnhite filter with a low pass setting of 3500 hertz, then to the second Adaptive Signal Processor for display on Channel B of the EPC recorder. A TSS 312B graphic annotator provided time marks on the hard copy records.

When surveying with the Seistec Surface Tow boomer (STB) the line cone receiver was displayed on channel A and the Geoforce GF15/10P streamer displayed on channel B of the EPC 9800 recorder. Two ORE 5210A signal processors were used for the STB signal channels.

c) Data Recording

The DTS and STB signals were recorded on an older version of AGCDIG digital four channel logger (with software version 3.0).

AGC DIG Inputs	Description
Ch. #1	DTS Seismic #1 - GF10/15 element streamer or STB Seistec line cone receiver
Ch. #2	DTS Seismic #2 - GF24/24 element streamer or STB GF10/15P streamer hydrophone
Trigger	DTS +5 volt master trigger or IKB +5 volt master trigger

d) Equipment List

Unit Description	Serial Number
Tow Fish Body	AGC #3
ED10F/C Boomer Source	2023
MK5-2 Attitude Sensor Unit	5010
S1000-1 Energy Storage Unit	1203
Internal GF16 Hydrophone	100
External GF10/15P Streamer	GF100
External GF24/24P2 Streamer	GF102
Huntec 1000 Oceanographic Winch and Power Pack	---
Roller Cluster 36" Dia.	---
Systems Console	105
EPC 9800 Graphic Recorder	126
MK 3 Power Control Unit	106
Second ASP Console	101
Krohnhite 3550 Filter	1849
AGCDIG Data Logger	#A

2.1 EQUIPMENT SETTINGS

The following equipment settings were used for the majority of DTS survey lines.

Parameter	Setting
Fire rate	0.50 seconds
PCU power setting	3 kilovolts (480 joules)
ESU power setting	60 microfarad (1000 joules max.)
BMC (motion compensation)	Pressure Mode
Display Gain	Seismic #1- Fixed +20 Db. Seismic #2- Fixed +20 Db.
Filter Setting	Seismic #1 - 1000 - 3500 hertz Seismic #2 - 1400 - 6000 hertz
Processor Gain (System Console)	3 KV (both channels)
DTS source	boomer
AGCDIG A/D board gain	2
AGCDIG delay	70 milliseconds
AGCDIG sample rate	30 microsecond
AGCDIG samples per channel / range	approx. 2048 / 98 meters
EPC sweep speed	125 msec.
EPC print polarity	positive

2.2 EQUIPMENT PERFORMANCE

Overview

The DTS profiling system was utilized for the majority of the survey, with the exception of the last day, when the Seistec STB system was used due to problems with the DTS winch. The DTS performance was very good, with no system downtime to report. The winch experienced difficulty lifting the tow fish clear of the water. This problem was noticed from the outset, although the AGC #2 winch was able to cope with the heavier AGC #3 tow fish until the final survey day. At the end of the cruise, the ship's crane had to be used to assist in the recovery of the tow fish on board.

Data Quality

In general, the DTS boomer data quality was considered good, bearing in mind the shallow water of the survey area. The DTS was configured with dual external streamers as the internal hydrophone would have been subject to high levels of source ringing. The Seistec STB system was on the last day of the survey and collected good data.

3.0 RECOMMENDATIONS

1) The AGC #2 winch was designed to handle the lighter and smaller AGC#2 tow fish. The heavier AGC #3 tow fish has always taxed the AGC #2 winch to its limits. However, this is the first time the AGC #2 winch has been unable to recover the larger tow fish. The recent addition of the

sparker retrofit plus associated counter balance weights, have added an additional one hundred pounds to the AGC #3 tow fish and exceeded the lifting capability of the AGC #2 winch.

The AGC #2 winch should be modified to accept remote controls. With more of the GSCA's survey activities being directed toward shallow water missions, the need for remote start/stop and in/out controls have become apparent. The distance between the aft deck and the lab on the Parizeau and Matthew, dangerously increases winching response time for avoiding bottom collisions. It is recommended that the winch's pump or hydraulic motor be upgraded at the same time as the remote controls are added.

2) The AGC #3 Systems Console used for this survey (the AGC #2 Systems Console has a problem with the BMC module (erratic depth readout)). This problem is intermittant and was first noticed this spring on Hudson. Geoforce has been conducting tests on the unit but has not been able to isolate the problem. This is the latest of a long string of problems with the System Consoles and highlights the need to replace/update these tired units.

3) The long GF24/24 streamer has proved to be a valuable upgrade for the DTS systems. When used with the sparker source, the increased penetration in " acoustically hard" bottoms is a big improvement in system capability. To this point the GSCA has been renting the streamer from Geoforce for each of this year's missions. It is recommended that the GSCA either purchase this streamer or modify their one remaining Benthos streamer. The Benthos streamer is old and in need of overhaul, and can be modified to a 20 to 25 element streamer with all new hardware and fittings during this winter's refit.

4) The bottom detect trigger box built by T. Atkinson (MEG) dramatically improves the resolution of high resolution profiling systems. During the Forbes mission, the Atkison trigger box was easy to use and significantly improved the data quality of both the STB and DTS. In shallow water, the DTS motion circuits are ineffective due to wave noise. It is recommended that a rack mount bottom flattening trigger box be added to the DTS system.

5) Other improvements and upgrades for consideration in this year's DTS systems refit
   - built in AC cooling fan for the PCU filter (AGC #3 system only)
   - built in AC cooling fans for the PCU power supply (AGC #2 & #3 systems PCU runs hotter with sparker source)
   - replace twenty year old DTS wood spares crates (falling apart) with lighter transit cases
   - new circuit boards for the tow fish as per Geoforce recent proposal (currently there is only one working set of spare circuit boards for two systems)