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OPEN FILE 4994

Cruise Matthew 2001030
Geophysical Surveys and Sediment Sampling Operations Near Two Marine Mine Tailings Disposal Sites in Northern Newfoundland
June 27 – July 8, 2001

Breached tailings impoundment at the Little Bay Mine with CCGS Matthew in background.

D.R. Parrott, M.B. Parsons, and R. Cranston

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Introduction

From June 27 to July 8, 2001, the Geological Survey of Canada (Atlantic) (GSCA) investigated environmental impacts associated with historical disposal of sulfide-rich mine tailings into the ocean near two abandoned copper mines in northern Newfoundland (Fig. 1). The main goals of these studies were: (1) to determine the volume and distribution of tailings on the seafloor; (2) to assess the potential for reworking of the tailings by oceanographic processes; and (3) to characterize the geochemical processes that control the mobility and bioavailability of potentially toxic elements (e.g. As, Cd, Cr, Cu, Hg, Pb, Zn) from mine tailings in the marine environment. This study addressed outstanding research issues in a recent multi-stakeholder investigation (by the Canada Centre for Mineral and Energy Technology (CANMET), Fisheries and Oceans Canada (DFO), and Memorial University of Newfoundland (MUN)), which assessed contamination of sediments, clams, mussels, and seaweed by metals and metalloids near these mine sites (Blanchette et al., 2001). The present investigation: (1) extended the existing multibeam bathymetry data and bottom sampling into deeper water at both sites; (2) updated multibeam coverage for the main areas of tailings deposition; and (3) examined the vertical distribution of metals in sediments and pore waters in gravity cores from the tailings deposits.

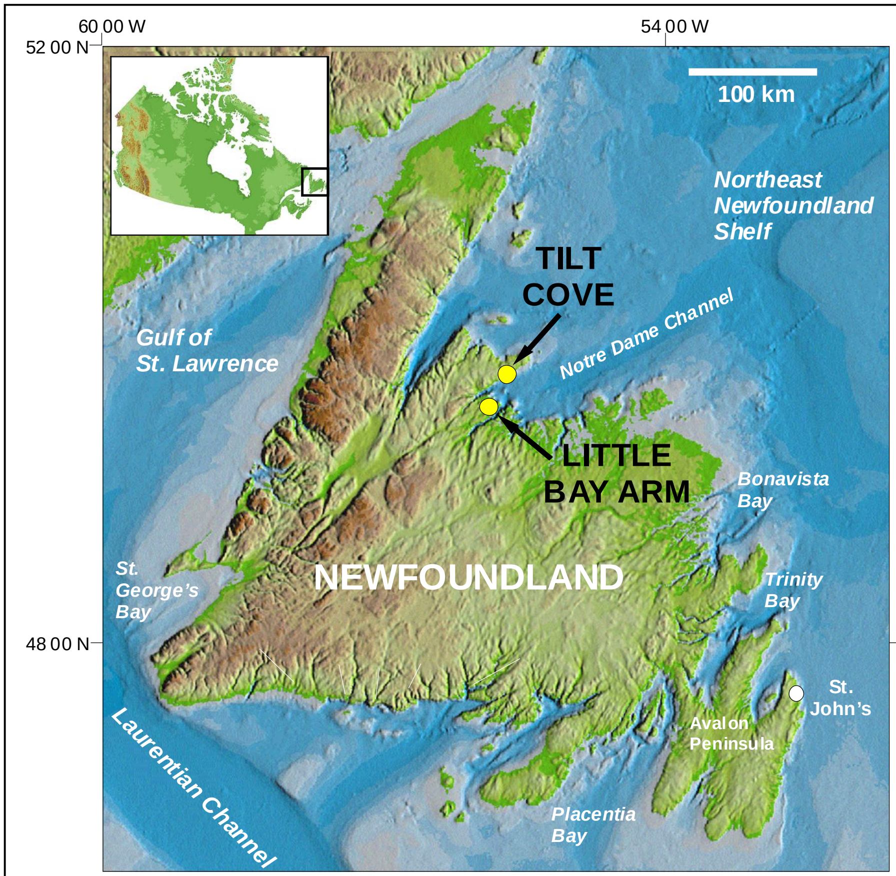


Figure 1. Map of Newfoundland showing the location of the Tilt Cove and Little Bay Arm sampling sites (base map from John Shaw, GSCA).

Mine tailings were examined near the abandoned Tilt Cove and Little Bay copper mines, located along the shores of Notre Dame Bay in north-central Newfoundland (Fig. 1). Details of the geological setting and metallogeny of these volcanogenic massive sulfide deposits can be found in Hibbard (1983), Swinden and Kean (1988), Swinden et al. (1991), Bédard et al. (2000), Sangster and Pollard (2001), and references therein. The historical mining and milling operations at these sites were recently summarized by Dimmell (1999).

Copper mineralization was discovered at Tilt Cove in 1857 and mining was carried out intermittently between 1864 and 1917. No tailings were produced during this initial phase of mining. The Tilt Cove Mine was reactivated by the Maritime Mining Corporation in 1957 and operated continuously until 1967. During this time, the ore was crushed in an on-site mill and copper concentrates were produced using flotation methods. At least 5 to 6 million tons of tailings were generated during this period (Dimmell, 1999), most of which were slurried into the ocean through a pipeline located on the rocky point on the south side of Tilt Cove Bight (Fig. 2).

Figure 2. Remnant of wooden pipe used to discharge tailings into Tilt

Copper mining at Little Bay commenced in 1878 and continued intermittently through 1918. Most of the ore mined during these early years was sorted by hand and shipped directly to market, although some coarse tailings were generated from an on-site milling/smelting operation (Dimmell, 1999). Atlantic Coast Copper reactivated the Little Bay Mine from 1961 to 1969 and processed copper ore at an on-site mill. Approximately 1.8 million tonnes of tailings were produced during this period and placed in an impoundment formed by damming off a shallow estuary (Shoal Arm). By the time the mine closed in 1969, the tailings pond was approximately 1 km long by 135 m wide, and up to 16 m deep (Collins and LeGrow, 1986). Between approximately 1989 and 1991, the central portion of the tailings dam failed (Tom Al, University of New Brunswick, pers. comm., 2001), releasing tailings into Little Bay Arm (see cover photo). Since that time, an estimated 30 to 50% of the tailings have flowed through the breached dam forming a tailings delta and seafloor deposits in Little Bay Arm (Blanchette et al., 2001).

Survey Matthew 2001030 was conducted from June 27 to July 8, 2001 near the mine tailings deposits in Tilt Cove and Little Bay Arm (Fig. 1). Geophysical data were collected from the CCGS Matthew (Fig. 3a), to provide information on the character and distribution of seafloor sediments near the tailings disposal sites. Multibeam bathymetry data were collected to provide information on seafloor morphology using the survey launch Plover (Fig. 3b) equipped with a Simrad EM3000 multibeam bathymetry system. Sediment samples were obtained with a vanVeen grab sampler and a small (150-cm long) gravity corer. Seafloor photographs were taken along a transect through the survey area in Little Bay Arm. Cores from the survey were analyzed for metals and carbon content to determine the extent of metal contamination near the tailings deposits, and to determine sedimentation rates.

a) b)

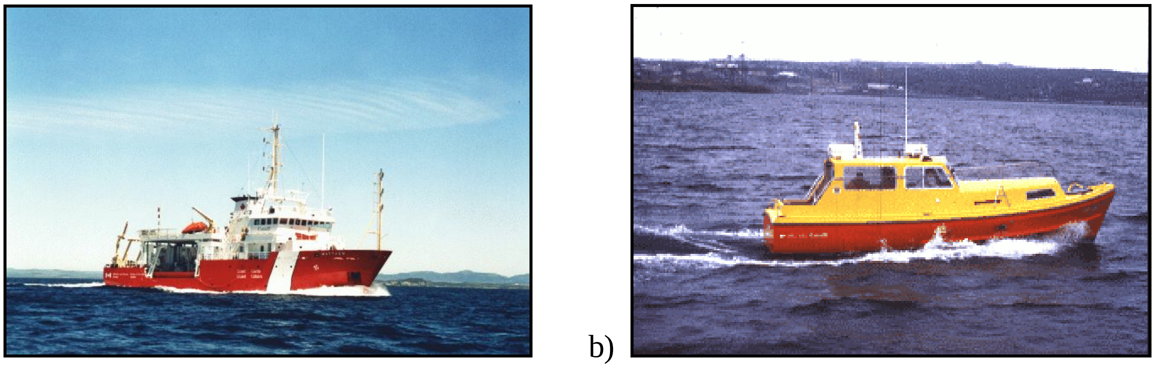


Figure 3. The geophysical survey and seafloor sampling program were performed using the CCGS Matthew (a). Multibeam bathymetry data were collected using the survey launch Plover (b).

Data Acquisition and Processing

The following geophysical and sampling equipment was used during Matthew 2001030:

- Simrad MS992 sidescan sonar system in a neutrally buoyant tow configuration
- IKB Seistec® high resolution sub-bottom profiler
- AGCDIG 4-channel digital geophysical data acquisition system
- ORE TrackPoint II ultra short baseline towfish positioning system
- Regulus and Hydropak survey navigation packages with input from differential GPS
- Simrad EM3000 multibeam bathymetry system
- LINUX workstations running GRASS version 5 with GSCA extensions
- Caris HIPS multibeam bathymetry data-cleaning software running on Windows NT
- GSCA Icehole camera
- vanVeen grab sampler
- 1.5 meter long gravity corer

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 13 metres behind a dead weight depressor (a 120 kg iron blister weight on a swivel). The towfish was deployed about 50 metres behind the vessel. This configuration was chosen to reduce noise on the sidescan sonar records due to vessel-induced heave. The sidescan sonar system was capable of resolving objects of 15 cm and larger. An ORE TrackPoint II acoustic position system was used to position the towfish. A hardcopy graphic record of the 120 kHz portion of the sidescan sonar data was produced on an Alden 9315CTP thermal recorder.

Sidescan sonar data were collected at 100-metre range for lines near the main areas of tailings deposition and at 200-metre range for lines outside the main tailings sites. This provided swaths of 200 and 400 metres, respectively. Lines run at the 100-m range were typically 75 or 100 metres apart, with a 300-metre spacing used for the 200-metre range lines.

Sidescan sonar data from survey Matthew 2001030 (both 120 and 330 kHz) were collected digitally using an AGCDIG digitizer with version 2.3 software. A sample interval of 80 microseconds was used. Approximately 3400 samples per ping were collected at 200-metre range and 1700 samples at the nominal 100-metre range setting. Digital gain settings for the sidescan sonar system and digitizers were logged on field sheets.

IKB Technologies Seistec Sub-bottom profiler

An IKB Technologies Seistec high-resolution, sub-bottom profiler system was used to map the thickness and structure of materials on the sea floor and provide information on the genesis of the sediments. The system uses an electrodynamic (boomer) source to produce a repeatable impulse-like output which provides vertical resolution of acoustic reflections of 25 cm or better. The Seistec system is equipped with an internal line-and-cone array and an external streamer. The external streamer was attached to the front of the catamaran, so that the lead-in section of the streamer was positioned under the boomer and line-and-cone array with the receiving elements trailing behind the catamaran. The catamaran was deployed by crane on the starboard side of the vessel and towed on the port side at the surface. The system was fired 2 times per second, or faster, and graphic records displayed on a thermal graphic recorder. The power supply to the boomer was operated at a nominal setting of 175 Joules. Graphic records were printed on an EPC9800 recorder set for 125 millisecond scans in two-channel mode. Data were sampled at a 38 microsecond interval for 124 milliseconds to provide 3845 samples per channel. Bandpass filtered signals were recorded. External steamer data were filtered at 1000 to 7000 hertz. The internal hydrophone data were filtered at 1.5-3.5 kHz. Data collected on the external streamer had a pronounced noise spike on the printed signal 120 times per second.

Digital data acquisition

The sidescan sonar and sub-bottom profiler data were digitized and logged on an AGCDIG digitizer developed at GSCA 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

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

Sub-bottom profiler – IKB Seistec: 38 microseconds sample interval

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

Navigation

Navigation was by a Global Positioning System utilizing differential corrections broadcast by the Canadian Coast Guard. Positional accuracy of the navigation was about 4 m. Tracks and survey lines were run with the ICAN Regulus and the HydroPack navigation packages.

Multibeam bathymetry

Multibeam bathymetry data were collected to provide information on the morphology of the seafloor, and to assess re-working of the tailings between 1999 and 2001. Data were collected using a Simrad EM3000 multibeam bathymetry system mounted in the hydrographic survey launch Plover (Figure 3b). The EM3000 system uses a 300 kHz transducer with 127 beams with a beamwidth of 1.5^o x 1.5^o. The system provides a depth resolution of 1 cm with an accuracy of 5 cm RMS. Each beam insonifies an area of approximately 1.35 m^2 at 50 metres water depth.

The Plover used an Applied Analytics Corporation POS-MV 320 attitude sensing system with integrated differential GPS navigation system to determine the position and attitude. The systems integrate data from an inertial measurement unit and differential GPS signals. A positional accuracy 0.5 to 4 metres can be obtained using the phase differential of the GPS carrier frequency when using DGPS, and of 0.02-0.10 metres when using an RTK source. This survey was performed using DGPS data for an accuracy of 0.5 to 4 metres. A heading aiding accuracy of 0.1^o - 0.5^o can be obtained from the raw GPS data. A Kalman filter is used to improve the heading estimate to 0.05^o - 0.1^o. Vessel attitude is measured using an inertial measurement unit to provide an accuracy of 0.0003^o for pitch, roll and heading. More information on this system can be found at www.applanix.com.

Lines were run at various spacing throughout the survey areas to provide 200 percent coverage of the seafloor in depths greater than about 20 metres. During the survey, data were processed using version

5.0 of the HIPS data cleaning program (CARIS by Universal Systems Limited, Fredericton, NB) on a Windows NT workstation to remove spurious soundings and navigation data and to correct for tidal variations. Data were also imported into a Linux-based workstation and processed using the MBTools software developed by the Lamont-Doherty Geological Institute. 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.

Seafloor photographs

Figure 4. GSCA Icehole camera used to collect photographs during Matthew 2001030.

Seafloor photographs were taken at two stations in Little Bay (~30 photos total) with the GSCA Icehole camera (Fig. 4). Images were obtained on two transects through the main areas of tailings deposition. Camera station locations are shown in Fig. 7, and provided in Appendix IV.

Seafloor samples

Seafloor samples were taken at sites chosen based on an interpretation of the multibeam bathymetry, acoustic backscatter, sidescan sonar and sub-bottom profiler data. A 1.5 m gravity corer (Fig. 5a) was used to collect 8 sediment cores near Tilt Cove and 3 sediment cores in Little Bay Arm. All cores were collected within the main areas of tailings deposition to determine the vertical distribution of metals in the bottom sediments. Grab samples were taken throughout the survey area, using a vanVeen sampler (Fig. 5b), to provide information on the type(s) of sediment present, and to provide material for subsequent chemical and physical analysis.

Sample locations from Tilt Cove and Little Bay Arm are plotted in Figs. 6 and 7, respectively, and the latitudes, longitudes, and water depths are tabulated in Appendix IV. All sediment cores were stored in an upright position on the ship and transported to the field laboratory for processing within 24 hours of collection. In one core from Tilt Cove (Stn. 24), two diffusion gradient thin film (DGT) pore water samplers (Fig. 16a) were inserted into the core top such that 15 cm of the thin film were located in the sediment, and 5 cm were located in the overlying water. The DGTs were equilibrated with the pore/overlying water for approximately 24 hours (exact time recorded) before the samplers were removed. The DGT probes were then placed in acid-washed plastic bags and stored on ice before shipment to CANMET for analysis of metal concentrations using inductively coupled plasma – mass spectrometry (ICP–MS).

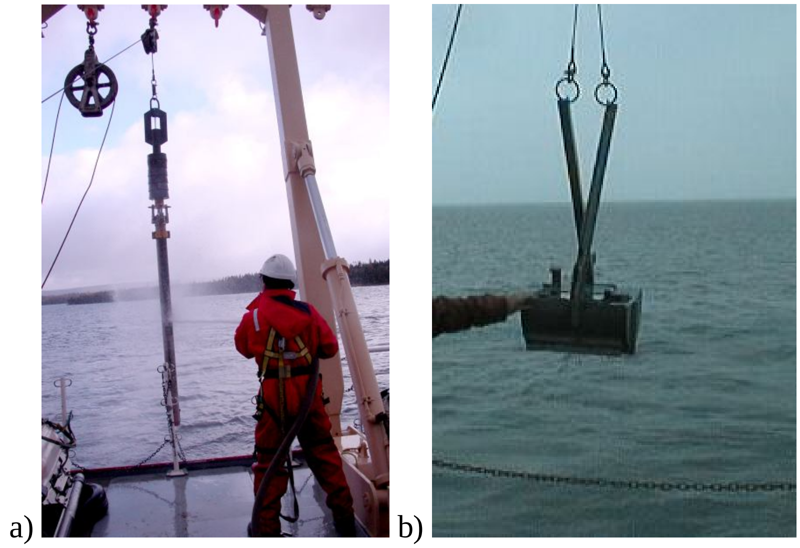


Figure 5. Samples were collected during Matthew 2001030 with (a) a 1.5 m gravity corer and (b) a vanVeen grab sampler.

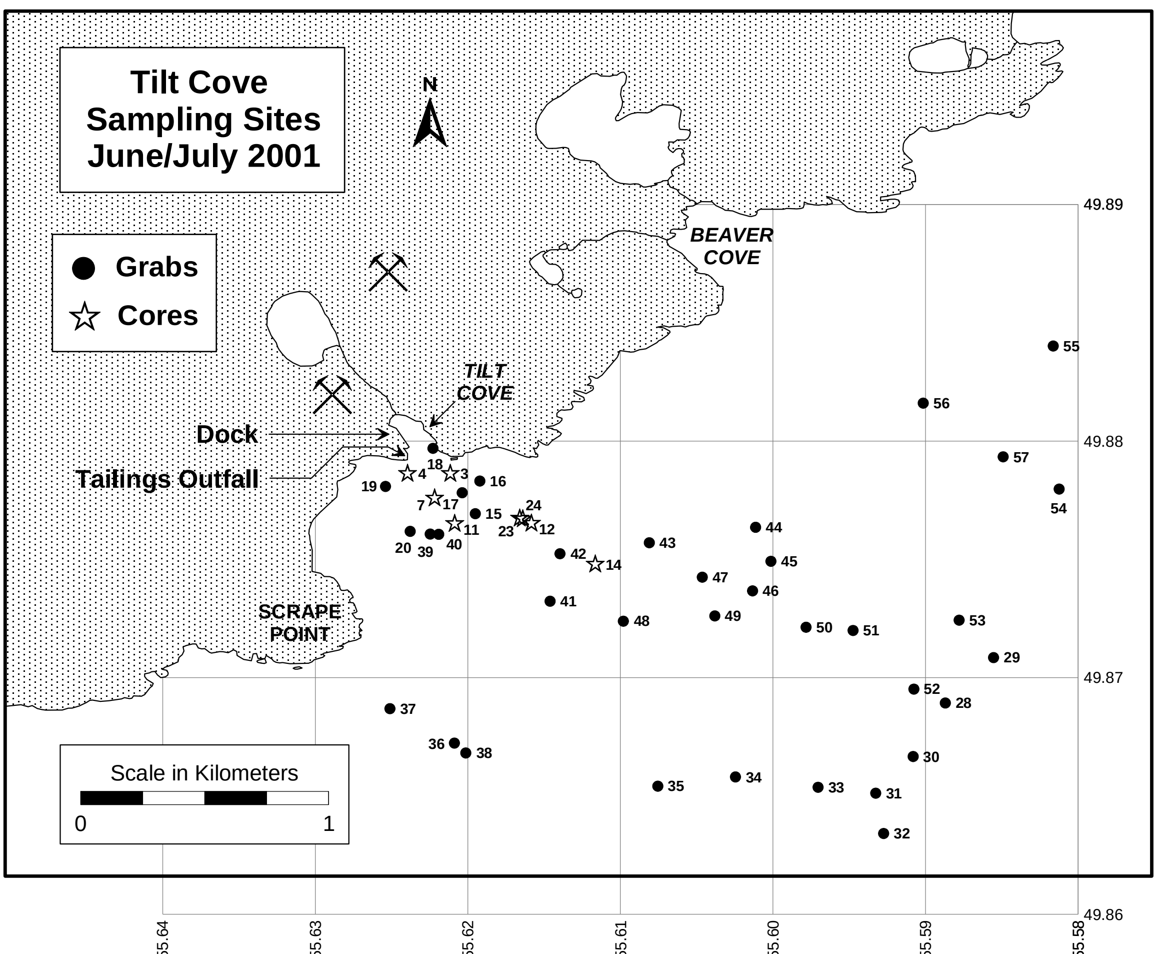


Figure 6. Location of grab samples and gravity cores taken near Tilt Cove during survey Matthew 2001030.

A vanVeen grab sampler (Fig. 5b) was used to collect 36 sediment samples near Tilt Cove and 33 sediment samples near Little Bay. Grab sample locations for the Tilt Cove and Little Bay areas are shown in Figs. 6 and 7, respectively, and the positions and water depths for all samples are listed in Appendix IV. All grab samples were subsampled immediately following collection for geochemical analyses (0-5 and 5-10 cm depth intervals), grain size measurements (0-10 cm depth interval), and benthic foraminiferal analyses (0-5 cm depth interval). Subsamples for foram analysis were preserved using a borax-$CaCl_2$ solution (two 16-dram vials of borax plus one 16-dram vial of $CaCl_2$ into 20 L of seawater).

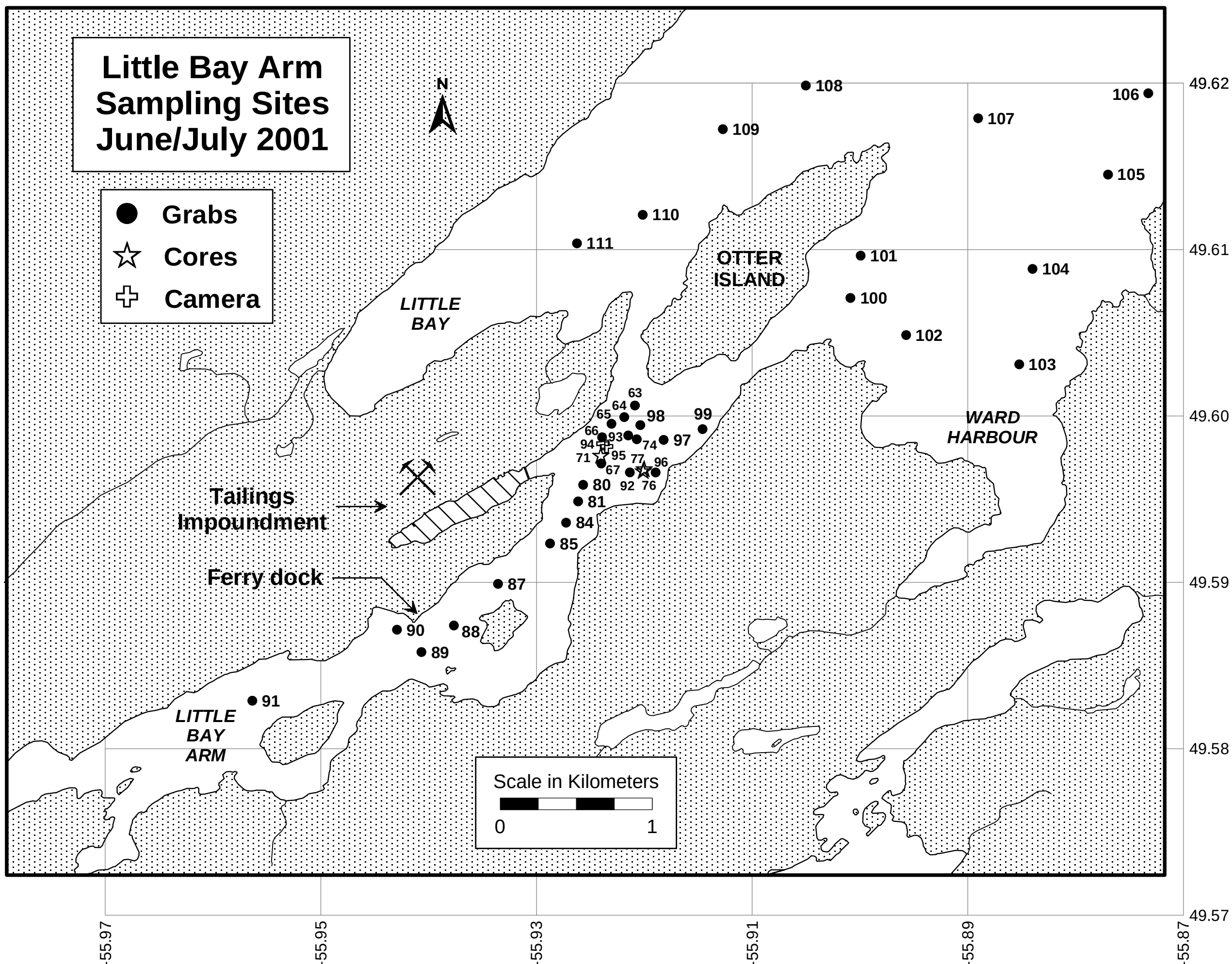


Figure 7. Location of grab samples and gravity cores taken near Little Bay during survey Matthew 2001030.

Tides

The Canadian Hydrographic Service installed tidal recording stations at several locations near the Tilt Cove and Little Bay survey sites prior to the GSCA surveys. Tides recorded at Nippers Harbour were applied to the Tilt Cove bathymetry survey, and those recorded at Triton were applied to the Little Bay bathymetry survey. Both tide stations recorded heights every 15 minutes. Both stations were surveyed into known locations.

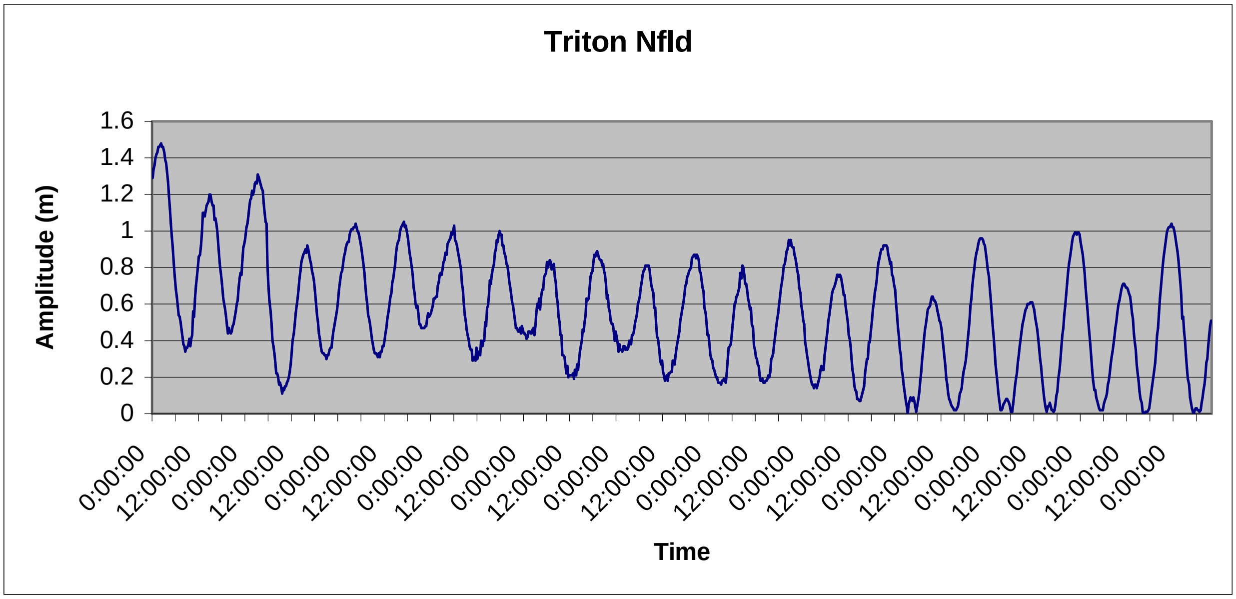


Figure 8. Tidal amplitudes recorded in Triton, Newfoundland from 26 June to 7 July 2001

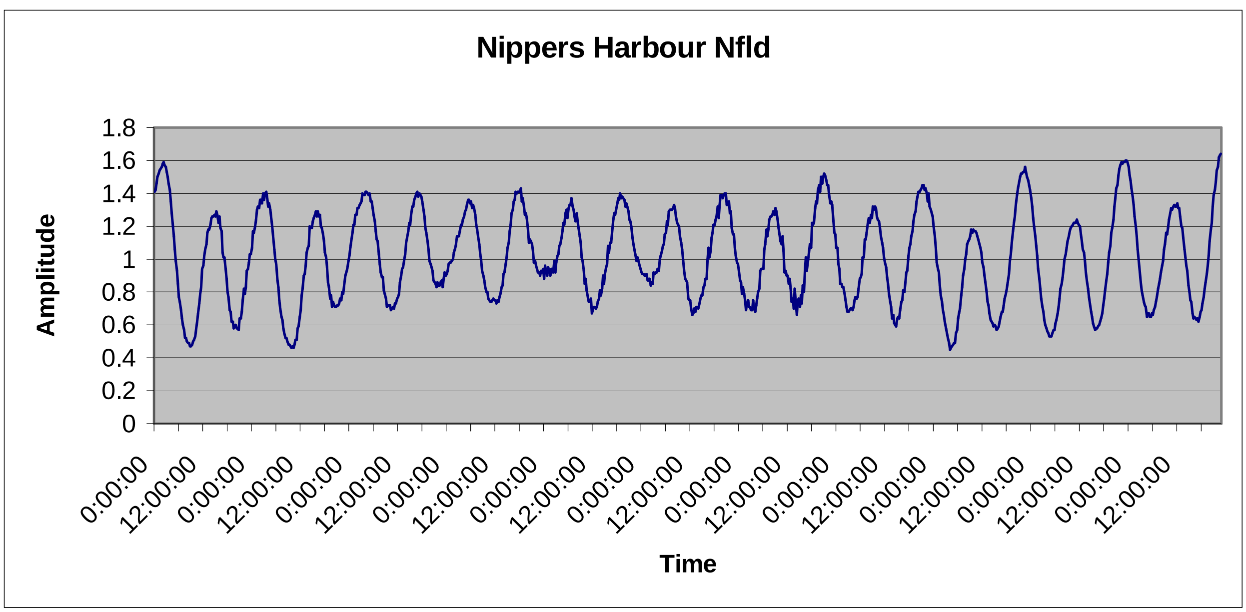


Figure 9. Tidal amplitudes recorded in Nippers Harbour, Newfoundland from 26 June to 7 July 2001

Preliminary Results of Geophysical / Multibeam Program

Tilt Cove

Stirling and Roy (2000) detected the presence of a large deposit of material just off the entrance to Tilt Cove based on multibeam bathymetry surveys performed in 1999 by the Canadian Hydrographic Service. An estimated 5 to 6 million tons of mine tailings were slurried into the ocean through a pipeline near this location (Fig. 2; Dimmell, 1999) during copper mining and miling activities from 1957 to 1967. The tailings were deposited along an exposed rocky coast, with no protection from storms. Coloured shaded relief images generated from the 1999 data, shown in Figures 10a and 11a, indicate a large tailings deposit near the location of the old discharge pipe. The surface of the tailings deposit showed evidence of pitting by grounded icebergs and slumping of the tailings into deeper water. Shaw et al. (1999) noted that the seafloor in the surrounding area generally consists of exposed bedrock highs, with an infilling of soft sediment, and reported extensive iceberg pitting.

The multibeam bathymetry survey was repeated in 2001 to determine if changes had occurred in the tailings deposit, and to extend the coverage of the data. A composite of the 1999 and 2001 survey data is shown in Figure 10b.

Examination of the data over the main tailings deposit from 1999 and 2001 (Figure 11) shows very little change in the appearance in the two years between surveys. In the 2001 survey data, a large furrow is present on the western edge of the tailings deposit that was not present in 1999. This furrow was probably caused by an iceberg grounding. The remainder of the deposit appears, after a preliminary investigation, to be unchanged.

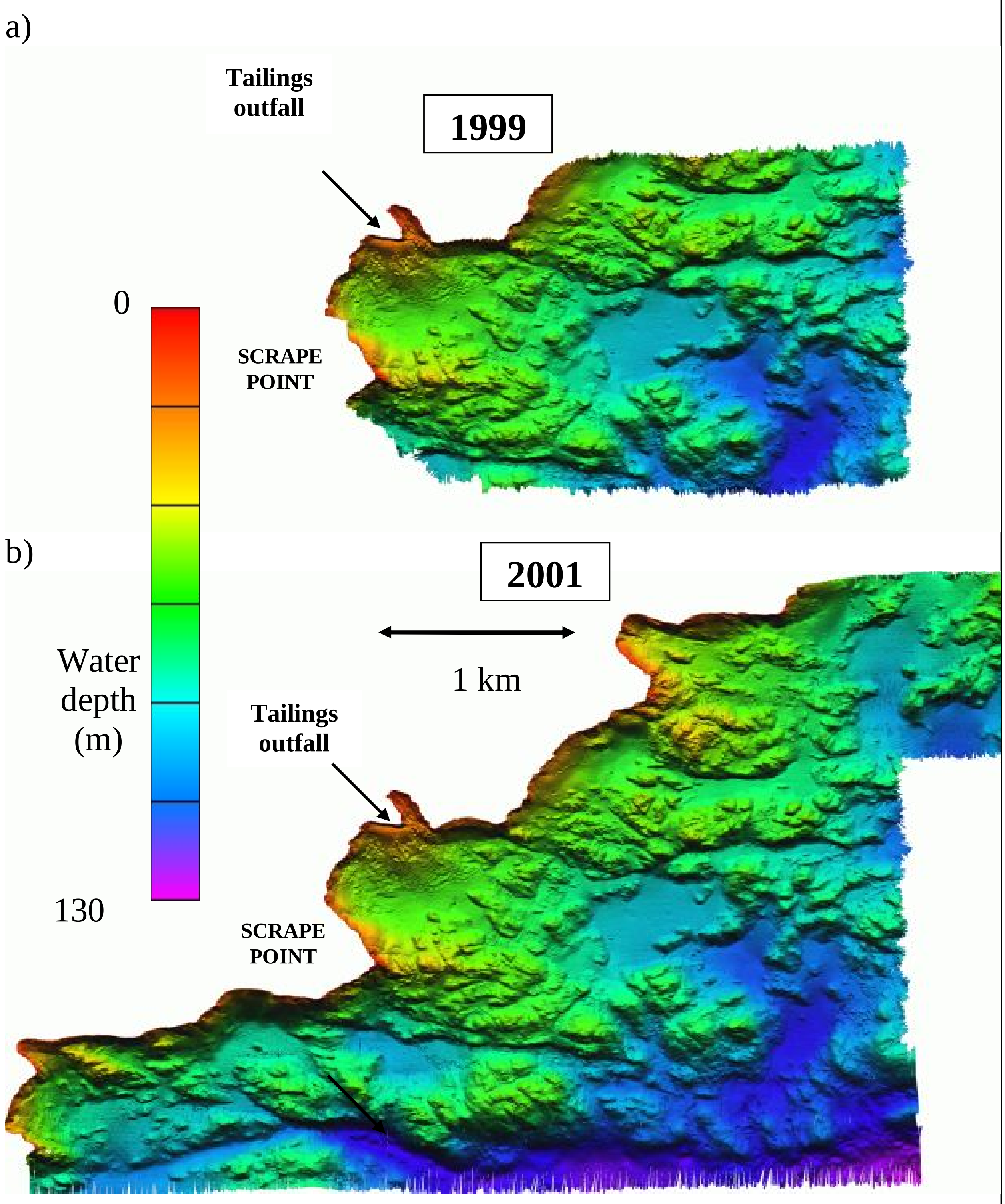


Figure 10. Shaded relief images generated from Simrad EM3000 multibeam bathymetry data collected (a) in 1999 and (b) new data collected in 2001 overlain on the 1999 data near Tilt Cove, in the northwest corner of the image. The data were processed at a cell resolution of 2.0 metres.

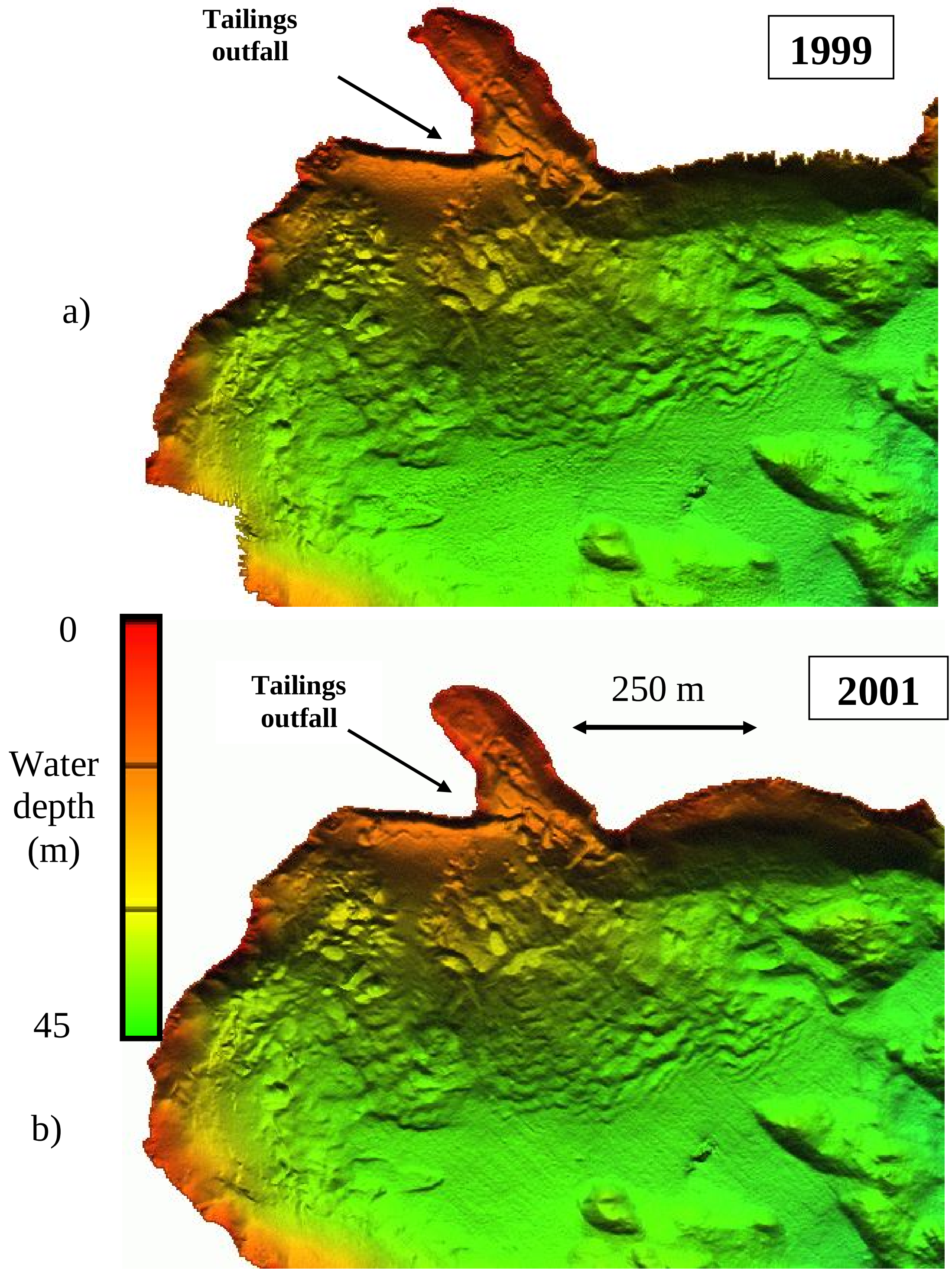


Figure 11. Shaded relief images generated from Simrad EM3000 multibeam bathymetry data collected at the tailings disposal site in Tilt Cove in (a) 1999 and (b) 2001. Data were processed at a cell resolution of 2.5 m.

Little Bay

Multibeam bathymetry surveys performed in 1999 by the Canadian Hydrographic Service revealed a large deposit of copper mine tailings on the bottom of Little Bay Arm (Stirling and Roy, 2000). These tailings have been accumulating on the ocean floor since approximately 1990, when a tailings dam failed releasing an estimated 0.5 to 1.0 million tons of mine wastes into the sea. Coloured shaded relief images generated from the CHS data, shown in Fig. 13a, show a large tailings deposit in Little Bay Arm east and south of the breached dam. The seafloor in the area generally consists of exposed bedrock highs, with an infilling of soft sediment. Tailings in Little Bay Arm are relatively protected, with little exposure to storm-driven waves

The multibeam bathymetry survey was repeated in 2001 to determine if changes had occurred in the tailings deposit, and to extend the coverage of the data outside of Little Bay Arm (Fig. 12).

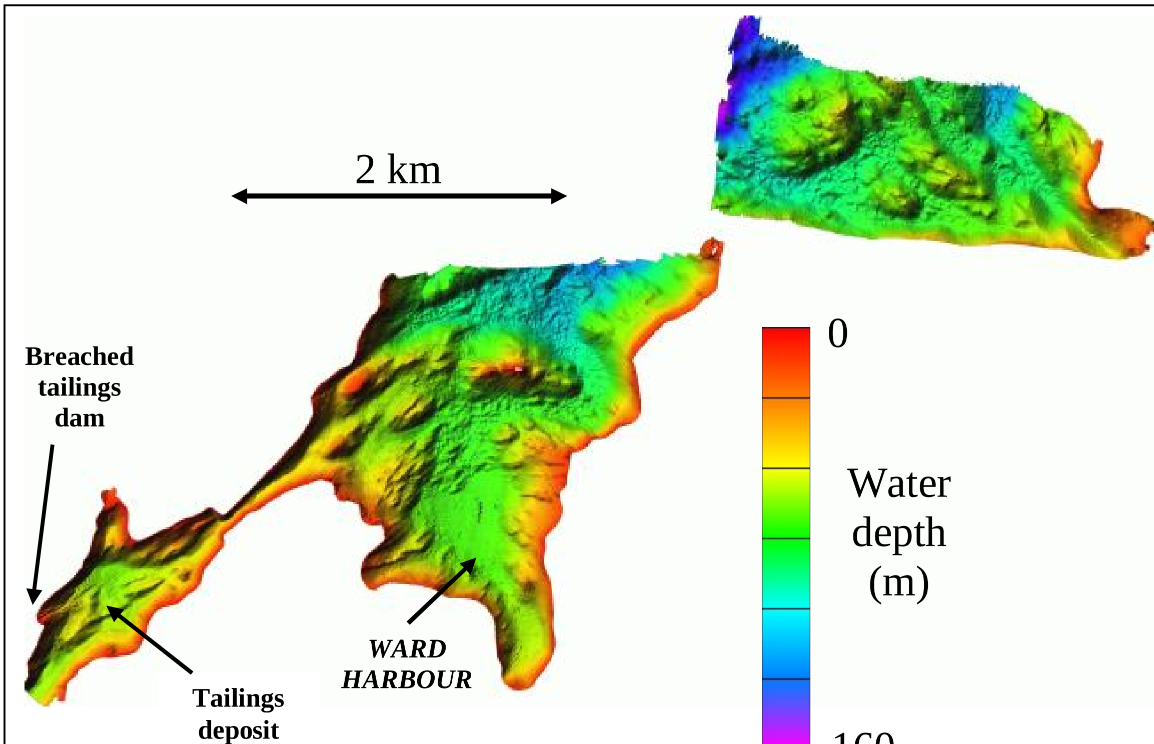


Figure 12. Shaded relief image generated from Simrad EM3000 multibeam bathymetry data collected in 2001 showing the tailings disposal site in Little Bay, on the western side of the image, and the approaches to Little Bay. The data were processed at a cell resolution of 2.5 metres.

Comparison of multibeam bathymetry data over the tailings pile from 1999 and 2001 (Figure 13) shows some significant changes in the seafloor morphology between surveys. The subaerial tailings deposit east of the breached dam had extended seaward of the 1999 location. The slope of the tailings deposit is characterized by two deep channels which coalesce near the toe of the slope. A series of sand waves is present beyond the coalesced channels. In 2001, the channels appear deeper beyond the point where they coalesce. A small basin, immediately south of the delta, has received additional sediments. Some of these sediments may have originated from an area where a small slump scarp is present on the slope above the basin.

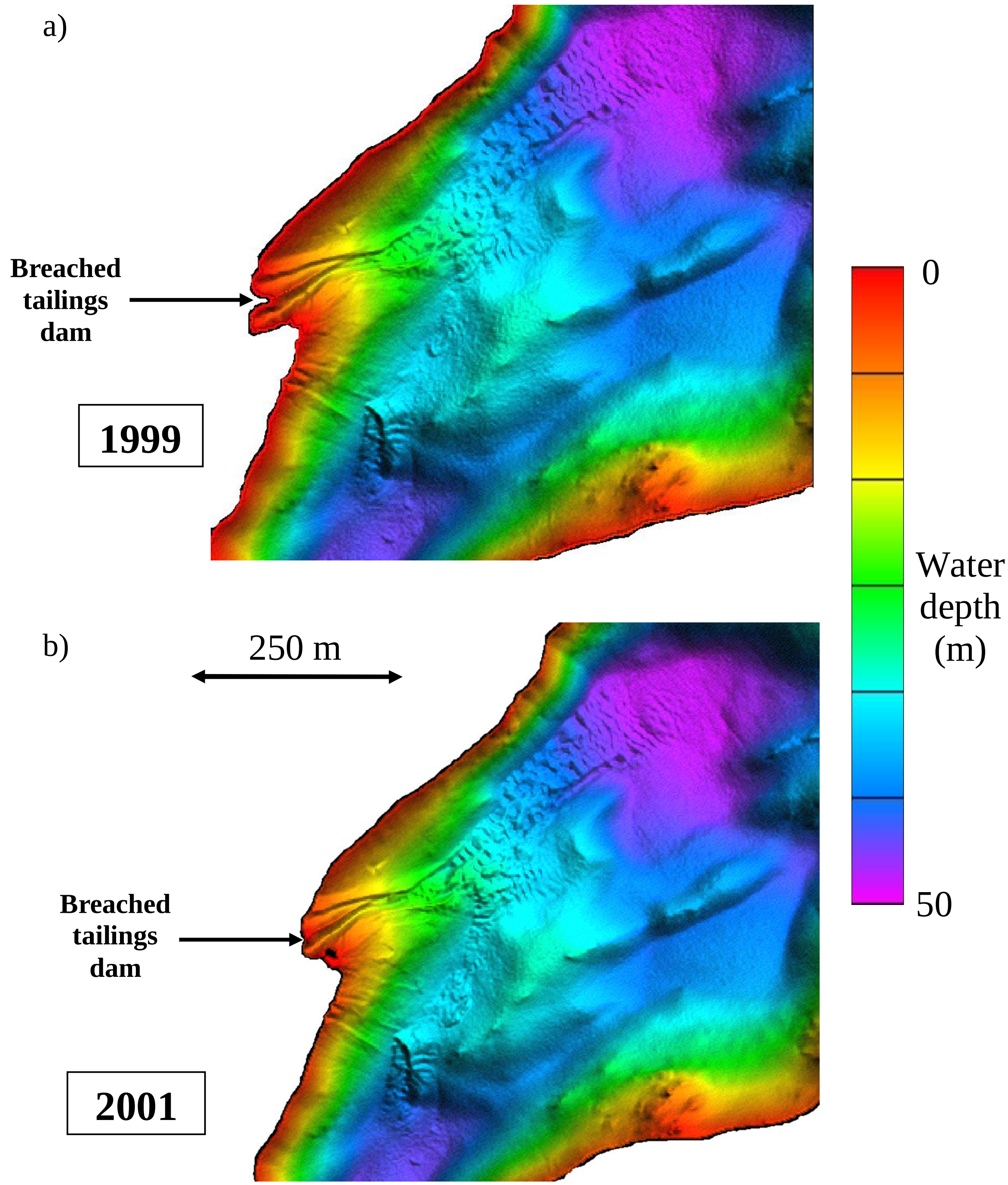


Figure 13. Shaded relief image generated from Simrad EM3000 multibeam bathymetry data collected (a) in 1999 and (b) 2001 at the tailings disposal site in Little Bay.

The Seistec sub-bottom profiler was run along the axis of the tailings debris flow, and along the northern side of Little Bay Arm as shown in Figure 14. The times on the track plots are shown as DDDHHMMSS (julian day, hour, minutes and seconds) and correspond to the times shown on the graphic records. The Seistec data over the tailings debris flow (Figure 15a) at about time 12:24 on day 187, show an accumulation of 3–5 metres of tailings, with a very rough surface, on top of the undisturbed seafloor. A smaller accumulation of sediments is present on the western side of the flow, at about 187/12:27. A large deposit of fine material was found adjacent to the concentrate loading pier at 187/12:40 as shown in Figure 15b.

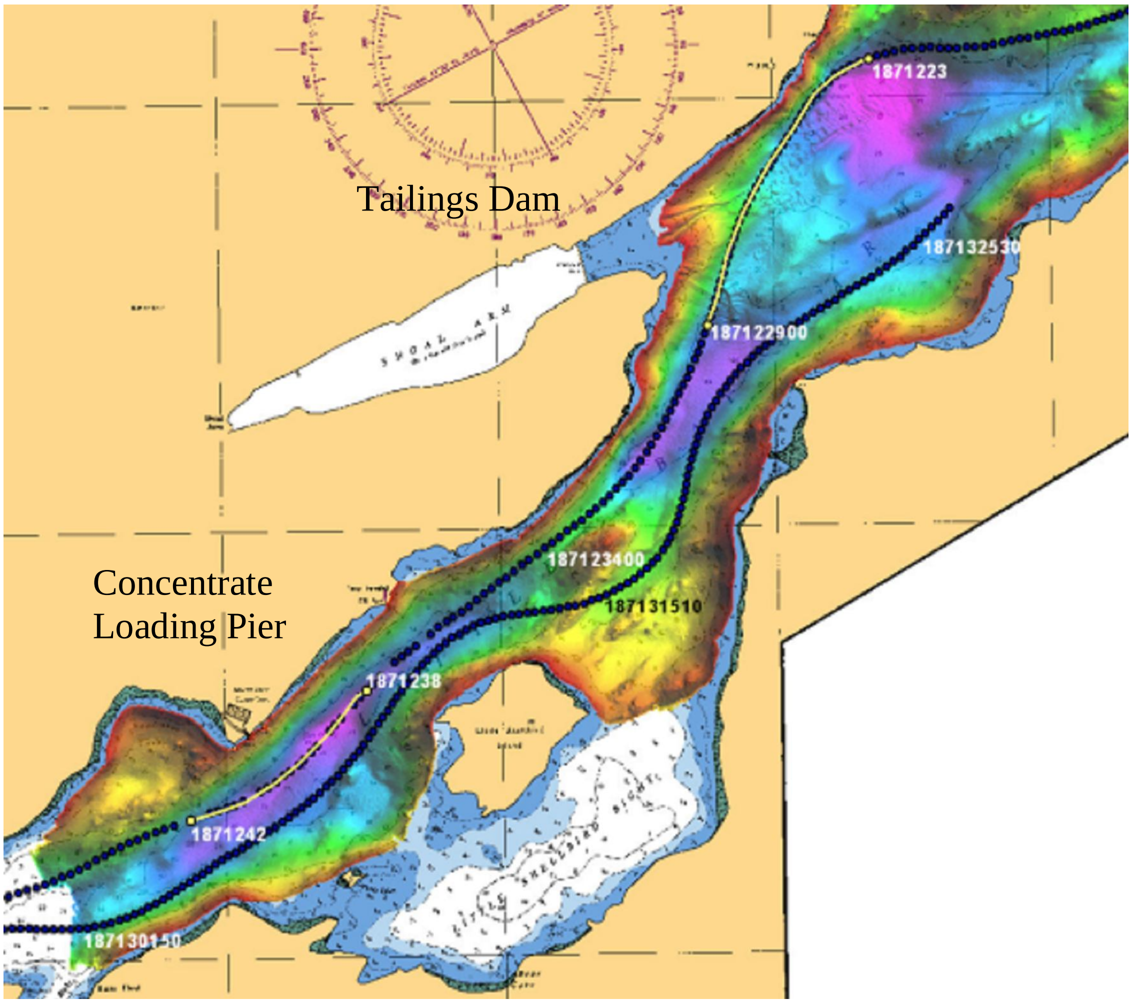


Figure 14. Shaded relief image generated from Simrad EM3000 multibeam bathymetry data collected in 1999 showing the tailings disposal site and location of the concentrate loading pier in Little Bay Arm. The yellow portion of the blue trackline shows the location of Seistec sub-bottom profiler data collected in 2001 (Fig. 15).

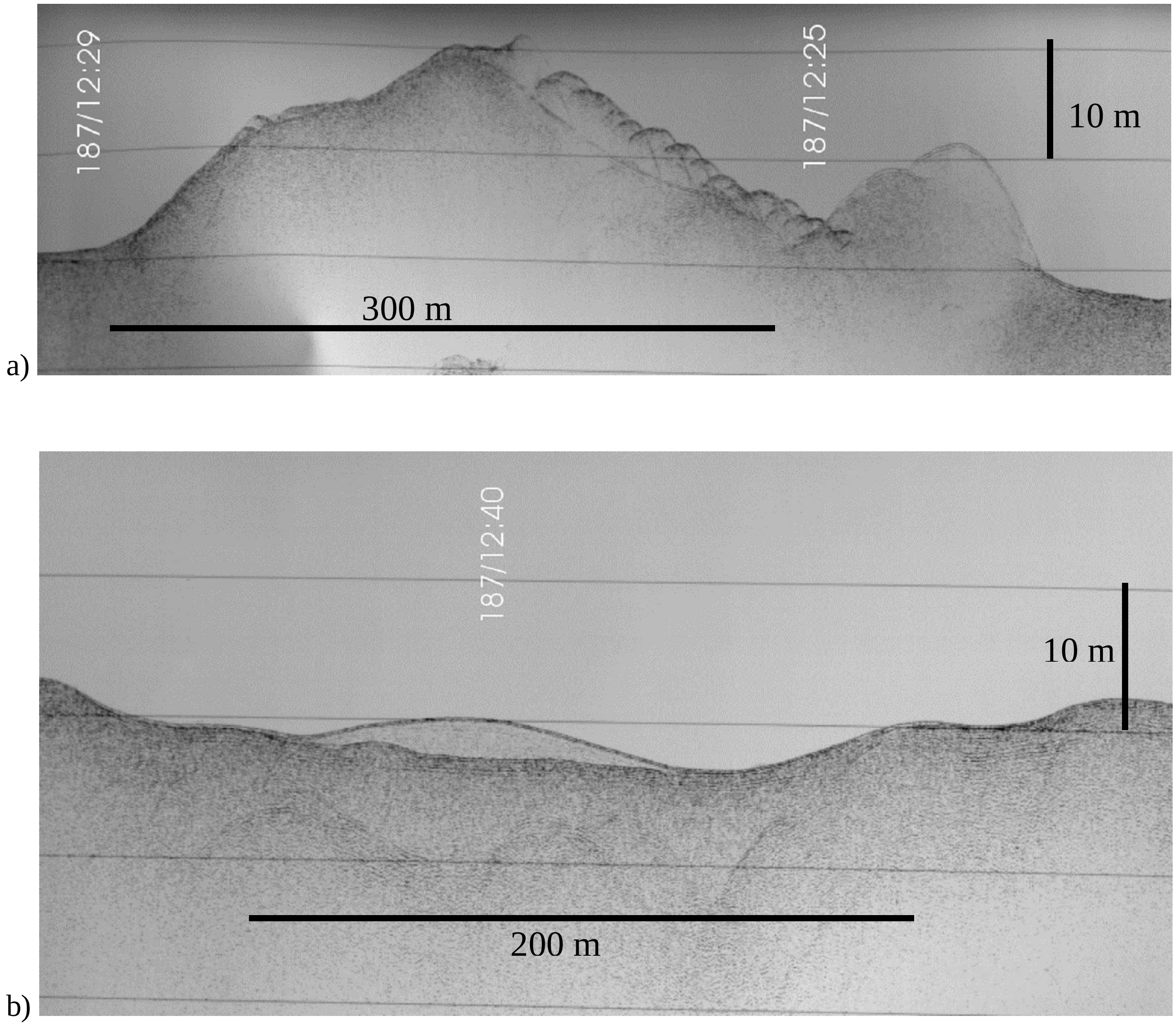


Figure 15. Seistec sub-bottom profiler data from (a) the slump in front of the tailings dam, and (b) from near the concentrate loading pier. The locations of Seistec data are shown in Figure 14 by the yellow portions of the trackline. The horizontal scale lines are about 10 metres apart.

Geochemistry Program

Lab mobilization

A pore water geochemistry laboratory was set up on June 30, 2001 by Ray Cranston, Bob Fitzgerald and Michael Parsons in an abandoned warehouse on the waterfront near the main wharf in Springdale. The facility consisted of a core extruder, a table for subsampling cores, two tables to conduct pore water analyses for ammonium, sulfate and salinity, a table for a glove box (anaerobic chamber), and a table for trace metal sample handling. An IEC Centra-8 centrifuge (capable of running at speeds up to 3000 rpm), two table-top centrifuges, and several tanks of compressed nitrogen (used for flushing the glove box) were also set up in the lab.

Core subsampling operation

Gravity cores were extruded and subsampled within 24 hours of collection. Each core was manually extruded into a split core liner. A second split liner was placed on the exposed core half and a stainless steel wire was drawn longitudinally through the core. The two split liners were turned 90 degrees and given an abrupt impact on the floor, which generally caused the two core halves to split apart into the two split liner pieces. A total of eight gravity cores were processed for aerobic pore water extraction, and two cores (Stns. 23 and 76) were processed in a nitrogen-filled glove box. Details of the station location, water depth, and length of each core are listed in Appendix IV.

Analytical procedures and methods

Aerobic subsampling

A working core half was placed on the subsample table, and 20 mL volumes of wet sediment from selected depths down the core were placed into 25 mL snap-cap plastic vials. The base of each vial had been pre-drilled with 4 holes, 1 mm in diameter and fitted with a 25 mm filter paper. The wet sediment was placed on the filter paper in the vial, then each vial was inserted into a 50 mL centrifuge tube and centrifuged in a table-top centrifuge for 10 minutes. Pore water was expelled through the filter paper, through the holes in the vials, and collected in the centrifuge tube. The sediment vial was removed from the centrifuge tubes, and the pore water (varying from 0.5 to 5 mL) was poured into pre-labelled 7 mL scintillation vials.

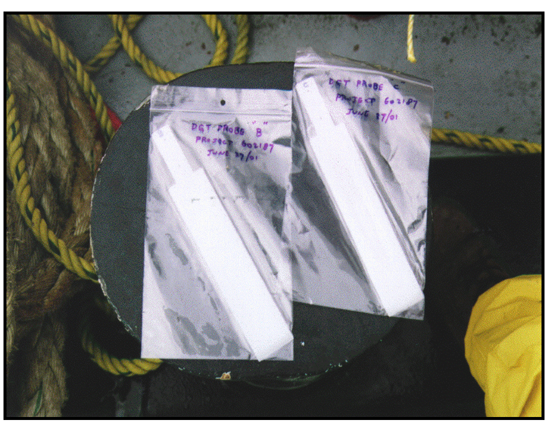
Dissolved ammonium in each pore water sample was determined using a colourimetric method. Five millilitres of deionized water were placed into a 25 mL test tube, along with 100 μL of pore water or ammonium standard. A 500 μL addition of phenol-ethanol solution (0.8 g phenol dissolved in 100 mL of ethanol) was made along with 500 μL of sodium nitroprusside solution (0.075 g of sodium nitroprusside in 50 mL of deionized water). Finally, 1 mL of oxidizing solution (1 mL of sodium hypochlorite, 0.75 g trisodium citrate and 0.04 g sodium hydroxide in 50 mL of deionized water) was added to each test tube. The tubes were shaken and allowed to stand for at least 2 hours in order for the blue colour, indicative of ammonium content, to fully develop. The colour absorbance was measured at 640 nm with a Brinkmann PC900 colourimeter. A calibration curve was acquired by measuring the absorbance of various ammonium chloride solutions. Precision and accuracy were determined to be ± 0.2 mM.

Dissolved sulfate was measured in the pore waters using a turbidimetric method. A 50 µL volume of sample or standard was placed in a cylindrical glass cuvette. Barium chloride (100 µL of 300 mM solution) was added to precipitate the available sulfate. Four mL of deionized water were added to dilute the mixture in the cuvette. The turbidity of the resulting solution and barium sulfate precipitate was measured using a Milton Roy Spectronic Mini-20 fitted with a turbidity attachment. A calibration curve was established by measuring the turbidity of various dilutions of magnesium sulfate solution. Precision and accuracy limits were estimated to be ± 2 mM.

Salinity was determined in 100 µL volumes of pore water using an Orion model 125 conductivity meter. The pore water was diluted with 6.5 mL of de-ionized water and a temperature-compensated conductivity probe was used to measure conductivity. A calibration curve was obtained by measuring the conductivity of standard International Association of the Physical Sciences of the Ocean (IAPSO) seawater. Precision and accuracy were determined to be ± 0.3 parts per thousand based on replicate analysis of the standard seawater.

Anaerobic subsampling

Sediment cores from Stns. 23 (Fig. 6) and 76 (Fig. 7) were processed in a nitrogen-filled glove box to minimize oxidation of the pore water samples (Fig. 16b). Before splitting, a 25 mL sample of overlying water was drawn off the top of Core 23 using a 60 mL syringe, filtered through a 0.45 µm pore-diameter Arcodisc syringe filter into an acid-cleaned high-density polyethylene bottle, and then acidified to a pH < 2 using 25 drops of Optima-grade nitric acid.

a) 

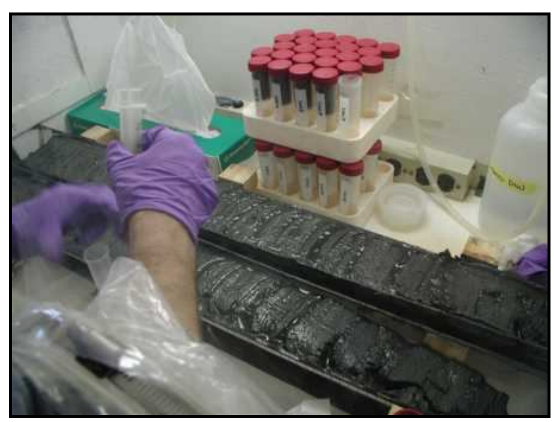
b) 

Figure 16. Anaerobic pore water sampling methods used during survey Matthew 2001030: (a) Diffusion gradient thin film samplers used to measure dissolved metal concentrations in pore waters at Stn. 24; (b) Glove box subsampling of a tailings-filled core from Stn. 23.

Each sediment core was split using the methods described above, and both core halves were immediately transferred to the glove box. Once the box had been purged with nitrogen, a total of 60 mL of wet sediment from each depth interval were placed into acid-washed Costar centrifuge tube inserts. Each of these plastic inserts has a mesh base that was pre-loaded with an 8 μm pore-diameter Whatman 540 filter paper. The centrifuge tubes were then tightly sealed, removed from the glove box, and centrifuged at 3000 rpm for 30 minutes. Following centrifugation, the tubes were transferred back into the glove box and the pore water was filtered through a 0.45μm syringe filter. Approximately 2 mL of the filtrate were used for pH and dissolved sulfide determinations, and the remaining pore water (varying from 15 to 23 mL) was acidified to a pH < 2 and shipped on ice to CANMET for analyses of dissolved metal concentrations. Several field blanks and blind duplicates were also submitted with the pore water samples.

The pH of the pore water samples was measured using an Orion Model 290A pH meter with a temperature-compensated pH probe. Freshly prepared pH buffers (pH 6.86 and 9.18) were used to calibrate the pH meter. Replicate analyses of the buffer solutions indicates that precision and accuracy of the pH measurements is approximately ± 0.05 pH units.

Dissolved sulfide was measured in each pore water sample using a colourimetric method modified from Cline (1969). All sample processing and measurements were carried out in the glove box to minimize oxidation of the dissolved sulfide. A 0.01 M Na_2S stock solution was prepared each morning by adding 0.1329 g of $Na_2S \cdot 3H_2O$ to 100 mL of deoxygenated reagent-grade water. Standards were prepared by diluting this stock solution with deoxygenated water to yield the following concentrations: 1000, 500, 100, 50, and 10 μM. A diamine solution (0.2 g *N,N*-dimethyl-*p*-phenylenediamine sulfate + 0.3 g ferric chloride + 50 mL cool 50% (v/v) HCl) was used to generate a blue colour, indicative of dissolved sulfide content, in the samples and standards. For the concentration range 10–100 μM, the following reagents were added to a 5 mL test tube in the order given: 1 mL sample/standard, 300 μL diamine reagent, 2.2 mL water. For the concentration range 100–1000 μM, the following reagents were added to a 5 mL test tube in the following order: 200 μL sample/standard, 300 μL diamine reagent, 3 mL water. The tubes were then capped, allowed to sit for at least 20 minutes for colour development, and then their absorbance was measured at 670 nm using a Spectronic Mini 20 spectrophotometer. Precision and accuracy of the method were determined to be ± 5 μM.

Preliminary geochemical results

Field-based measurements of sediment pore water chemistry are summarized in Appendix V. A total of 58 pore water samples from 8 gravity cores were analyzed for ammonium, sulfate and salinity, and 27 pore water samples from 2 gravity cores were analyzed for pH and dissolved hydrogen sulfide. In core 23 from Tilt Cove, pH and H_2S were also measured in the overlying water from the core tube; core 76 contained no overlying water.

Figure 17 shows pore water profiles for sediment cores from Tilt Cove (17a) and Little Bay (17b). The core from Tilt Cove is approximately 80 cm long, and consists primarily of laminated mine tailings. The decrease in sulfate and increase in ammonium concentrations downcore reflect the oxidation of organic carbon during early diagenesis—these data will be used to estimate the present-day sediment accumulation rates (Cranston, 1999). Porewater pH values in this core range from 7.5 to 8.3, which is relatively high as compared to the porewater pH in most normal marine sediments (pH 6.5–7.5; Berner, 1981). These high pH values may result from the presence of excess lime (CaO), which was added to the tailings during processing as a coagulating agent and pH regulator (Dimmell, 1999). The steady increase in pH downcore may be caused by oxidative regeneration of ammonium; however, this trend may also reflect progressive CO_2 loss from the pore waters during the pH measurements (Pederson, 1983). All H_2S concentrations were below the analytical detection limit of approximately 3 μM.

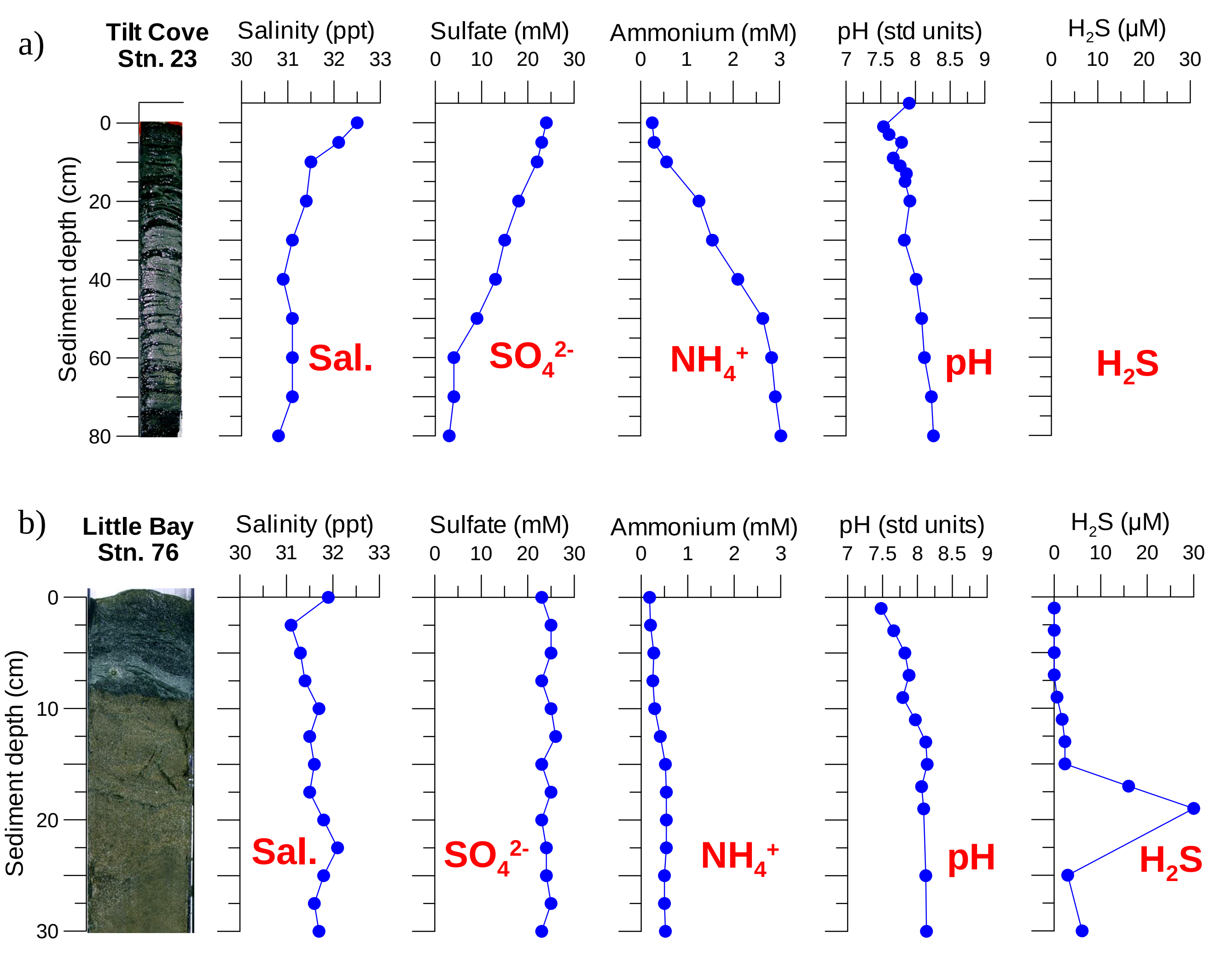


Figure 17. Pore water profiles for gravity cores from (a) Tilt Cove and (b) Little Bay. Each of these profiles includes data from two cores collected at approximately the same location. Salinity, sulfate and ammonium concentrations at Tilt Cove and Little Bay were measured in cores from Stns. 12 and 77, respectively. The pH and H_2S measurements were measured in cores from Stns. 23 and 76, respectively.

The core from Little Bay is about 30 cm long, and consists of approximately 8 cm of mine tailings overlying olive-green marine muds. The sulfate and ammonium concentrations in this core are relatively constant with depth as compared to the core from Tilt Cove. Once again the pore water pH is relatively high (pH 7.5–8.1), which may result from excess lime in the tailings and/or loss of CO_2 during the analyses. There is a pronounced peak in H_2S at approximately 20 cm depth; however, H_2S concentrations in the tailings are less than 3 μM.

Access to Data and Samples

The sidescan sonar data, sub-bottom profiler records, 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 sub-bottom 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 ExaByte tapes of the raw data are available for viewing.

Acknowledgements

We would like to thank the officers and crew onboard the CCGS Matthew for their assistance in the geophysical and multibeam surveys and in collecting and delivering the sediment samples. Bob Murphy of GSC-A is thanked for his tireless efforts at coring in the hard and/or cohesive sediments. The image of the Little Bay tailings impoundment shown on the report cover was taken by Ray Cranston. The image of the CCGS Matthew in Figure 1a was taken by Fergus Francey, chief officer, CCGS Matthew.

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Appendices

Appendix I. Survey Particulars

Name of Vessel:	CCGS *Matthew*
Vessel captain:	Paul Bragg
Dates of Survey:	27 June – 8 July 2001
Area of Operation:	Northern Newfoundland
Senior Scientist:	Russell Parrott, GSCA

Appendix II. Survey Personnel

<u>Geological Survey of Canada (Atlantic)</u>

Russell Parrott	Senior Scientist
Anthony Atkinson	Electronics Technologist
Bruce Wile	Electronics Technologist
Robert Murphy	Sampling/photography
Darrell Beaver	Multibeam bathymetry data collection
William LeBlanc	Navigation/Sampling
Michael Parsons	Geochemistry (on-board and at lab in Springdale)
Ray Cranston	Geochemistry (based at lab in Springdale)
Robert Fitzgerald	Geochemistry (based at lab in Springdale)

<u>CANMET, NRCan</u>

John Chaulk	Geochemistry (on-board and at lab in Springdale)

Appendix III. Summary of Activities (all times in GMT)

Day 178 Wednesday 27 June 2001 Springdale Newfoundland

16:00 Murphy, Beaver, Atkinson and Wile depart BIO for vessel in Springdale, Newfoundland to take night crossing on ferry to Newfoundland

Day 179 Thursday 28 June 2001 Springdale Newfoundland

15:00 Murphy, Beaver, Atkinson and Wile arrive at CCGS Matthew docked in Springdale, Newfoundland. Container with GSC gear stored on wharf.

14:00 Cranston, Parrott, Fitzgerald, LeBlanc and Parsons depart BIO.

20:00 Cranston, Parrott, Fitzgerald, LeBlanc and Parsons depart Sydney on ferry.

Day 180 Friday 29 June 2001 Springdale Newfoundland

10:00 Murphy, Beaver, Atkinson and Wile continue with mobilization of gear on CCGS Matthew.

15:00 Cranston, Parrott, Fitzgerald and Parsons arrive at CCGS Matthew docked in Springdale .Parrott mobilize computer workstations. Cranston, Fitzgerald, LeBlanc and Parsons commence mobilization of geochemistry laboratory in warehouse near end of wharf.

Day 181 Saturday 30 June 2001 Tilt Cove Newfoundland

10:00 Depart Springdale for survey site in Tilt Cove.
12:30 Deploy multibeam bathymetry launch.
13:00 Launch returns to Matthew for technical support.
13:15 Launch away again.
13:30 Start sampling program.
13:49 Start multibeam bathymetry lines in Tilt Cove.
16:00 Launch returns to get navigation materials and check inputs.
16:30 Launch away – continue sampling.
19:30 End of multibeam lines for day.
20:00 Launch pick up sediment samples, and deliver samples, with Parsons and Chaulk, to jetty in Tilt Cove.
20:30 Recover launch and start data download.
21:30 Deploy sidescan sonar, Seistec sub-bottom profiler and TrackPoint II towfish positioning system for survey off Tilt Cove.
21:45 Gear in water. Tuning gear. Start survey lines.

Day 182 Sunday 1 July 2001 Tilt Cove Newfoundland

00:01 Continue with sidescan and sub-bottom profiler survey off Tilt Cove.

09:00 Recover sidescan sonar, Seistec sub-bottom profiler and TrackPoint.
10:45 Deploy multibeam bathymetry launch – pick up Parsons and Chaulk from Tilt Cove jetty .
11:15 Take SVP measurement and start multibeam bathymetry survey.
11:30 Start coring operations near Tilt Cove.
20:30 Recover multibeam launch and download data.
22:15 End of sample program for the day.
Steam to Springdale due to forecast of high winds.

Day 183 Monday 2 July 2001 Springdale Newfoundland

02:00 Secure at wharf in Springdale.
11:00 High winds and problems with ship's compressor. Remain at wharf.
Download tides from Nippers Harbour (Murphy Atkinson Beaver) .
Process geochemical samples.
Process multibeam bathymetry and sidescan sonar data.

Day 184 Tuesday 3 July 2001 Springdale Newfoundland

11:00 High winds and problems with ships compressor. Remain at wharf.
Continue with geochemistry processing.
Field observations of site in Tilt Cove to study on-shore aspects of mining and processing operations.
Process multibeam bathymetry and sidescan sonar data. Initial comparison of differences in multibeam bathymetry data from previous survey and present to determine changes in seafloor.
Problems with engine in launch. Stalls under full power. Engineer pulling fuel system apart.
Problem traced to problems with fuel deliver and filter system.

Day 185 Wednesday 4 July 2001 Springdale Newfoundland

11:00 High winds. Remain at wharf. Field trip to Little Bay to investigate conditions near mine and to determine conditions for survey in confined space within Little Bay.
Process multibeam bathymetry and sidescan sonar data.
Atkinson working on AGCDIG problems.
12:00 Deploy launch and start multibeam bathymetry survey of Springdale Harbour.
19:30 Recover multibeam launch.

Day 186 Thursday 5 July 2001 Little Bay Newfoundland

09:00 Depart Springdale for Little Bay.
11:10 Deploy multibeam launch in Little Bay.
11:15 Start sample operation with corer. Switch between cores and grabs.
14:45 Recover launch.
15:30 Redeploy launch and start sampling.
16:30 Corer lost over the side. Continue with grab samples.
20:00 Winds increasing. Launch returns to Matthew and ferries personnel and cores to shore.
Anchor in Wards Cove.

Day 187 Friday 6 July 2001 Little Bay Newfoundland

10:30 Deploy launch and recover anchor
11:00 Deploy seistec and sidescan sonar for survey of Little Bay, near Otter Island and approaches.
11:22 Logging on.
11:36 A/C for incoming vessel traffic. Sidescan at surface.
11:41 Sidescan sinking. Recover to investigate. Stop logging.
12:05 Resume survey. Seistec only. Survey into Little Bay near tailings ponds and continue near shoreline into Bay.
13:23 End of Seistec line through Little Bay. Recover gear.
14:00 Commence grab sample program of Little Bay and Approaches.
18:40 Complete sampling program.
19:00 Recover launch and start to transit to Springdale. Start demobilization of geophysical gear.
21:00 Secure at Springdale wharf. Start to load container with gear from lab.
24:00 Finish loading contained.

Day 188 Saturday 7 July 2001 Springdale Newfoundland

11:00 Download tides from Triton. Continue with demobilization of all gear.
12:00 Truck and flatbed arrive to transport gear back to BIO.
13:00 Crane arrives to unload gear from vessel and load container etc unto flatbead truck.
15:00 Gear loaded. All personnel travel to Port aux Basques to catch ferry.
17:30 Arrive Port aux Basques.

Day 189 Sunday 8 July 2001 Demobilization of survey gear.

03:00 Arrive North Sydney, NS. Atkinson, Beaver, Murphy and Wile continue to Halifax. Cranston, Fitzgerald, LeBlanc, Parrott and Parsons overnight in Sydney.
12:00 Depart North Sydney, NS for Halifax.
08:00 Atkinson, Beaver, Murphy and Wile arrive BIO and unload gear.
22:00 Cranston, Fitzgerald, LeBlanc, Parrott and Parsons arrive BIO and unload gear.

Appendix IV. Camera and Sample Station Locations

Camera stations

Location	Cruise No.	Station No.	Lat.	Long.	Water depth
			dd	dd	m
Little Bay NF	2001030	94	49.5983	-55.9238	32
Little Bay NF	2001030	95	49.5982	-55.9235	34

Grabs

Location	Cruise No.	Station No.	Lat.	Long.	Water depth
			dd	dd	m
Tilt Cove NF	2001030	15	49.8769	-55.6195	41
Tilt Cove NF	2001030	16	49.8783	-55.6192	37
Tilt Cove NF	2001030	17	49.8778	-55.6204	31
Tilt Cove NF	2001030	18	49.8797	-55.6223	13
Tilt Cove NF	2001030	19	49.8781	-55.6254	27
Tilt Cove NF	2001030	20	49.8762	-55.6238	41
Tilt Cove NF	2001030	28	49.8689	-55.5887	104
Tilt Cove NF	2001030	29	49.8708	-55.5855	93
Tilt Cove NF	2001030	30	49.8667	-55.5908	106
Tilt Cove NF	2001030	31	49.8651	-55.5933	105
Tilt Cove NF	2001030	32	49.8634	-55.5928	101
Tilt Cove NF	2001030	33	49.8654	-55.5970	97
Tilt Cove NF	2001030	34	49.8658	-55.6025	91
Tilt Cove NF	2001030	35	49.8654	-55.6075	81
Tilt Cove NF	2001030	36	49.8672	-55.6209	80
Tilt Cove NF	2001030	37	49.8687	-55.6251	77
Tilt Cove NF	2001030	38	49.8668	-55.6201	79
Tilt Cove NF	2001030	39	49.8761	-55.6225	43
Tilt Cove NF	2001030	40	49.8761	-55.6219	43
Tilt Cove NF	2001030	41	49.8732	-55.6146	54
Tilt Cove NF	2001030	42	49.8752	-55.6140	55
Tilt Cove NF	2001030	43	49.8757	-55.6081	78
Tilt Cove NF	2001030	44	49.8764	-55.6011	77

Location	Cruise No.	Station No.	Lat.	Long.	Water depth
Tilt Cove NF	2001030	45	49.8749	-55.6001	81
Tilt Cove NF	2001030	46	49.8737	-55.6013	81
Tilt Cove NF	2001030	47	49.8742	-55.6046	79
			dd	**dd**	**m**
Tilt Cove NF	2001030	48	49.8724	-55.6098	69
Tilt Cove NF	2001030	49	49.8726	-55.6038	81
Tilt Cove NF	2001030	50	49.8721	-55.5978	91
Tilt Cove NF	2001030	51	49.8720	-55.5948	98
Tilt Cove NF	2001030	52	49.8695	-55.5908	103
Tilt Cove NF	2001030	53	49.8724	-55.5878	93
Tilt Cove NF	2001030	54	49.8780	-55.5812	94
Tilt Cove NF	2001030	55	49.8840	-55.5816	85
Tilt Cove NF	2001030	56	49.8816	-55.5902	65
Tilt Cove NF	2001030	57	49.8793	-55.5849	79
Little Bay NF	2001030	63	49.6006	-55.9209	48
Little Bay NF	2001030	64	49.5999	-55.9219	47
Little Bay NF	2001030	65	49.5995	-55.9230	43
Little Bay NF	2001030	66	49.5987	-55.9239	35
Little Bay NF	2001030	67	49.5971	-55.9240	33
Little Bay NF	2001030	74	49.5986	-55.9207	44
Little Bay NF	2001030	80	49.5959	-55.9257	37
Little Bay NF	2001030	81	49.5949	-55.9261	44
Little Bay NF	2001030	84	49.5936	-55.9273	44
Little Bay NF	2001030	85	49.5923	-55.9287	34
Little Bay NF	2001030	87	49.5899	-55.9336	41
Little Bay NF	2001030	88	49.5874	-55.9377	45
Little Bay NF	2001030	89	49.5858	-55.9407	43
Little Bay NF	2001030	90	49.5872	-55.9429	12
Little Bay NF	2001030	91	49.5829	-55.9564	39
Little Bay NF	2001030	92	49.5966	-55.9213	37
Little Bay NF	2001030	93	49.5988	-55.9215	45
Little Bay NF	2001030	96	49.5966	-55.9189	33
Little Bay NF	2001030	97	49.5986	-55.9182	42
Little Bay NF	2001030	98	49.5995	-55.9204	48
Little Bay NF	2001030	99	49.5992	-55.9146	23
Little Bay NF	2001030	100	49.6071	-55.9009	22
Little Bay NF	2001030	101	49.6096	-55.8999	27
Little Bay NF	2001030	102	49.6049	-55.8957	26
Little Bay NF	2001030	103	49.6031	-55.8852	47
Little Bay NF	2001030	104	49.6088	-55.8840	59
Little Bay NF	2001030	105	49.6145	-55.8770	59
Little Bay NF	2001030	106	49.6194	-55.8733	119
Little Bay NF	2001030	107	49.6179	-55.8890	66
Little Bay NF	2001030	108	49.6199	-55.9050	69

Location	Cruise No.	Station No.	Lat.	Long.	Water depth
			dd	dd	m
Little Bay NF	2001030	109	49.6172	-55.9127	69
Little Bay NF	2001030	110	49.6121	-55.9202	74
Little Bay NF	2001030	111	49.6104	-55.9262	64

Gravity cores

Location	Cruise No.	Station No.	Lat.	Long.	Length core	Water depth
			dd	dd	cm	m
Tilt Cove NF	2001030	3	49.8786	-55.6212	18	24
Tilt Cove NF	2001030	4	49.8786	-55.6240	25	19
Tilt Cove NF	2001030	7	49.8776	-55.6222	30	28
Tilt Cove NF	2001030	11	49.8765	-55.6209	15	40
Tilt Cove NF	2001030	12	49.8765	-55.6158	85	49
Tilt Cove NF	2001030	14	49.8748	-55.6117	30	60
Tilt Cove NF	2001030	23	49.8767	-55.6166	88	47
Tilt Cove NF	2001030	24	49.8767	-55.6164	84	47
Little Bay NF	2001030	71	49.5973	-55.9240	30	33
Little Bay NF	2001030	76	49.5968	-55.9200	30	36
Little Bay NF	2001030	77	49.5967	-55.9201	30	37

Appendix V. Sediment Pore Water Data

Aerobic subsampling

Cruise	Station	Sed Depth	Lab ID	Salinity	NH_4	$S0_4$
		cm		ppt	mM	mM
2001030	3	0	20010301	30.9	0.37	22
2001030	3	5	20010302	30.4	0.76	19
2001030	3	10	20010303	29.7	1.67	15
2001030	3	15	20010304	29.9	1.68	16
2001030	4	0	20010305	30.4	0.64	23
2001030	4	5	20010306	30.4	0.60	23
2001030	4	10	20010307	29.9	0.84	18
2001030	4	15	20010308	29.9	0.96	17
2001030	4	20	20010309	29.9	0.94	15
2001030	7	0	20010310	30.7	1.63	14
2001030	7	5	20010311	30.1	1.93	13
2001030	7	10	20010312	30.1	1.86	13
2001030	7	15	20010313	30.1	1.90	15
2001030	7	20	20010314	30.7	0.73	20
2001030	7	25	20010315	30.3	1.75	13
2001030	7	30	20010316	29.9	1.66	13
2001030	11	0	20010317	31.7	0.16	23
2001030	11	5	20010318	31.4	0.16	23
2001030	11	10	20010319	31.6	0.23	23
2001030	12	0	20010320	32.5	0.25	24
2001030	12	5	20010321	32.1	0.29	23
2001030	12	10	20010322	31.5	0.56	22
2001030	12	20	20010323	31.4	1.26	18
2001030	12	30	20010324	31.1	1.55	15
2001030	12	40	20010325	30.9	2.10	13
2001030	12	50	20010326	31.1	2.64	9
2001030	12	60	20010327	31.1	2.83	4
2001030	12	70	20010328	31.1	2.91	4
2001030	12	80	20010329	30.8	3.03	3
2001030	14	0	20010330	32.5	0.35	23
2001030	14	5	20010331	32.2	0.31	23
2001030	14	10	20010332	32.0	0.75	21
2001030	14	15	20010333	31.7	1.23	20
2001030	14	20	20010334	31.4	1.61	19
2001030	77	0	20010335	31.9	0.18	23
2001030	77	2.5	20010336	31.1	0.20	25
2001030	77	5	20010337	31.3	0.27	25
2001030	77	7.5	20010338	31.4	0.25	23

Cruise	Station	Sed Depth	Lab ID	Salinity	NH_4	$S0_4$
		cm		ppt	mM	mM
2001030	77	10	20010339	31.7	0.29	25
2001030	77	12.5	20010340	31.5	0.41	26
2001030	77	15	20010341	31.6	0.52	23
2001030	77	17.5	20010342	31.5	0.54	25
2001030	77	20	20010343	31.8	0.54	23
2001030	77	22.5	20010344	32.1	0.54	24
2001030	77	25	20010345	31.8	0.50	24
2001030	77	27.5	20010346	31.6	0.50	25
2001030	77	30	20010347	31.7	0.52	23
2001030	71	0	20010348	31.5	0.36	26
2001030	71	2.5	20010349	31.3	0.41	26
2001030	71	5	20010350	31.4	0.42	23
2001030	71	7.5	20010351	31.1	0.51	23
2001030	71	10	20010352	31.5	0.62	24
2001030	71	12.5	20010353	31.1	0.64	23
2001030	71	15	20010354	30.9	0.75	24
2001030	71	17.5	20010355	30.9	0.78	23
2001030	71	20	20010356	31.1	0.93	21
2001030	71	22.5	20010357	30.9	1.08	21
2001030	71	25	20010358	31.3	1.13	23

Anaerobic subsampling

Cruise	Station	Sed Depth	Lab ID	pH	H_2S
		cm		std units	μM
2001030	23	Overlying water	20011001	7.91	< 3
2001030	23	0-2	20011002	7.54	< 3
2001030	23	2-4	20011003	7.62	< 3
2001030	23	4-6	20011004	7.80	< 3
2001030	23	6-8	20011005	na	< 3
2001030	23	8-10	20011006	7.68	< 3
2001030	23	10-12	20011007	7.78	< 3
2001030	23	12-14	20011008	7.87	< 3
2001030	23	14-16	20011009	7.85	< 3
2001030	23	20	20011010	7.92	< 3
2001030	23	30	20011011	7.84	< 3
2001030	23	40	20011012	8.01	< 3
2001030	23	50	20011013	8.09	< 3
2001030	23	60	20011014	8.13	< 3
2001030	23	70	20011015	8.23	< 3

Cruise	Station	Sed Depth	Lab ID	pH	H_2S
		cm		std units	μM
2001030	23	Overlying water	20011001	7.91	< 3
2001030	23	0-2	20011002	7.54	< 3
2001030	23	2-4	20011003	7.62	< 3
2001030	23	4-6	20011004	7.80	< 3
2001030	23	6-8	20011005	na	< 3
2001030	23	8-10	20011006	7.68	< 3
2001030	23	10-12	20011007	7.78	< 3
2001030	23	12-14	20011008	7.87	< 3
2001030	23	14-16	20011009	7.85	< 3
2001030	23	80	20011016	8.26	< 3
2001030	76	0-2	20011017	7.48	< 3
2001030	76	2-4	20011018	7.66	< 3
2001030	76	4-6	20011019	7.82	< 3
2001030	76	6-8	20011020	7.88	< 3
2001030	76	8-10	20011021	7.79	0.6
2001030	76	10-12	20011022	7.97	1.7
2001030	76	12-14	20011023	8.12	2.3
2001030	76	14-16	20011024	8.14	2.3
2001030	76	16-18	20011025	8.06	16
2001030	76	18-20	20011026	8.09	30
2001030	76	25	20011027	8.12	2.9
2001030	76	30	20011028	8.13	6.0

Appendix VI. Graphic Records and Digital Tapes

Expedition Code: 2001030
Year Conducted: 2001
Chief Scientist: Parrott, R.
Records Stored at: Storage Facility Geological Survey of Canada (Atlantic) Data Section

Datatype /Instrument	Medium	Start/End Day	Start/End Time	Record Location	Box Number	Record Number	Box Comments	Record Comments
Logs General	Paper	181 –187	Unknown	Rack 2, Section 2	L130	1	N/A	Data Acquisition Log
Navigation Regulus	Compact Disk	181 –187	Unknown	Rack 7, Section 5	T74	2	N/A	Nav Backup. E-Files
Navigation Regulus	Compact Disk	Unknown	Unknown	Rack 7, Section 5	T74	1	N/A	Hydro Pak Grass Project
Navigation Regulus	Tape	Unknown	Unknown	Rack 7, Section 5	T74	1	N/A	Zip Disk, Hypack Nav Files
Seistec	Paper	181 – 182	2130 – 0900	Rack 2, Section 2	R104	1	N/A	N/A
Seistec	Paper	187 – 187	1030 – 1330	Rack 2, Section 2	R104	2	N/A	N/A
Seistec	Tape	181 – 182	2202 – 0843	Rack 7, Section 5	T74	1	N/A	Exabyte
Seistec	Tape	187 – 187	1122 – 1328	Rack 7, Section 5	T74	2	N/A	Exabyte
Sidescan Simrad	Paper	181 – 182	2130 – 0900	Rack 2, Section 2	R104	1	N/A	N/A
Sidescan Simrad	Paper	187 – 187	1022 – 1144	Rack 2, Section 2	R104	2	N/A	N/A
Sidescan Simrad	Tape	181 – 182	2202 – 0843	Rack 7, Section 5	T74	1	N/A	Exabyte
Sidescan Simrad	Tape	187 – Unknown	1119 – Unknown	Rack 7, Section 5	T74	2	N/A	Exabyte

Datatype /Instrument	Medium	Start/End Day	Start/End Time	Record Location	Box Number	Record Number	Box Comments	Record Comments
Multibeam EM 3000	Tape	164 -164	Unknown	Rack 7, Section 5	T74	11	N/A	Exabyte. All raw EM 3000 files for barcheck and Fleur de Lys, Newfoundland
Multibeam EM 3000	Tape	168 - 168	Unknown	Rack 7, Section 5	T74	12	N/A	Exabyte. Raw Data Files for La Scie, Newfoundland
Multibeam EM 3000	Tape	173 - 173	Unknown	Rack 7, Section 5	T74	13	N/A	Exabyte. Raw EM 3000 and Svp Files, Nippers Harbour
Multibeam EM 3000	Tape	Unknown	Unknown	Rack 7, Section 5	T74	10	N/A	Exabyte. Raw Data. Springdale, Little Bay, Tilt Cove
Multibeam EM 3000	Tape	Unknown	Unknown	Rack 7, Section 5	T74	14	N/A	Exabyte. HDCS Data
Sidescan EM 3000	Compact Disk	181 - 181	Unknown	Rack 7, Section 5	T74	1	N/A	Raw Data, Tilt Cove, Newfoundland
Sidescan EM 3000	Compact Disk	185 - 185	Unknown	Rack 7, Section 5	T74	2	N/A	Raw Data, Springdale, Newfoundland
Sidescan EM 3000	Compact Disk	186 - 186	Unknown	Rack 7, Section 5	T74	3	N/A	Raw Data, Little Bay, Newfoundland
Sidescan EM 3000	Tape	181 - 181	Unknown	Rack 7, Section 5	T74	1	N/A	Exabyte. Raw Data, Tilt Cove, Newfoundland
Sidescan EM 3000	Tape	181 - 181	Unknown	Rack 7, Section 5	T74	2	N/A	Exabyte. Raw Data, Tilt Cove, Newfoundland
Sidescan EM 3000	Tape	182 - 182	Unknown	Rack 7, Section 5	T74	3	N/A	Exabyte. Raw Data, Tilt Cove, Newfoundland
Sidescan EM 3000	Tape	182 - 182	Unknown	Rack 7, Section 5	T74	4	N/A	Exabyte. Raw Data, Tilt Cove, Newfoundland
Sidescan EM 3000	Tape	185 - 185	Unknown	Rack 7, Section 5	T74	5	N/A	Exabyte. Raw Data, Springdale, Newfoundland
Sidescan EM 3000	Tape	185 - 185	Unknown	Rack 7, Section 5	T74	6	N/A	Exabyte. Raw Data, Springdale, Newfoundland
Sidescan EM 3000	Tape	186 - 186	Unknown	Rack 7, Section 5	T74	7	N/A	Exabyte. Raw Data, Little Bay, Newfoundland
Sidescan EM 3000	Tape	186 - 186	Unknown	Rack 7, Section 5	T74	8	N/A	Exabyte. Raw Data, Little Bay, Newfoundland
Sidescan EM 3000	Tape	187 - 187	Unknown	Rack 7, Section 5	T74	9	N/A	Exabyte. Raw Data, Outer Little Bay, Newfoundland