GEOLOGICAL SURVEY OF CANADA
OPEN FILE 5508

Surveys in Placentia Bay, Newfoundland, Cruise 2006-039, CCGS HUDSON

J. Shaw, K. Jarrett, D. Brushett, K. Asprey, B.Wile and G. Standen

2009

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GENERAL INFORMATION

Vessel	CGGS *Hudson*	
Dates	29 July – 4 August 2006	
Areas of operation	Placentia Bay, Newfoundland	
Personnel	J. Shaw	Chief scientist (GSC)
	G. Standen	Huntec system specialist (Geoforce)
	R. Murphy	Sampling technician (GSC)
	K. Jarrett	Geotechnical specialist (GSC)
	B. Wile	Electronics specialist (GSC)
	D. Brushett	Student (Memorial University)
	K. Asprey	Technical support (GSC)
	D. Jiang	Student (Dalhousie University)
	G. Middleton	Survey technician (GSC)
	D. Reimer	Airgun operator (Geoforce)
Ship's masters	Captain Gilmore	Canadian Coastguard Service

CCGS *Hudson*

Length overall	51.25 m
Breadth	10.50 m
Displacement (light)	745 tonnes
Displacement (loaded)	950 tonnes
Speed	12 knots
Range	4000 nautical miles
Crew	12 persons
Scientific staff	8 persons

OBJECTIVES

- To collect piston cores that would enable us to date the retreat of glacier ice from Placentia Bay, and in particular, provide us with new and more accurate dates for the Burin Moraine (Fader et al., 1982).

- To collect piston cores that would assist understanding the formation of megaflutes in Placentia Bay, and in particular, ascertain the date at which megaflutes started to form. The principal hypotheses are: 1) they formed during the 1929 tsunami; and 2) they formed due to onset of the Labrador Current.

- Collect piston cores containing long Holocene sections that could be used to derive high-resolution records of oceanographic changes, in particular the postulated onset of the Labrador Current.

- Collect piston cores to ascertain the age of submarine slides in Eastern Channel.

- Collect grab samples and photographs that, together with the piston cores, would facilitate production of A-Series maps of interpreted backscatter and surficial geology of Placentia Bay.

- Collect surface samples for Oceans and Habitat Management Branch, Fisheries and Oceans Canada for their hydrocarbon baseline project, thus providing reliable baseline data on hydrocarbon contamination of the deep sediments in the bay, and possibly a history of hydrocarbon deposition in bottom sediments.

CRUISE ORGANIZATION

The CCGS *Hudson* was mobilized at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia. The vessel sailed to the Gully, Scotian Shelf, to deploy three ocean bottom seismometers, then continued to Placentia Bay to begin the science program. Sampling was conducted during daylight (06:00 – 18:00) and surveying in the evenings and at night (18:00-06:00). Shaw, Brushett, Jarrett, Murphy, Middleton and Wile worked the daytime shifts, while Standen, Reimer and Asprey worked the evenings and overnight. During sampling we collected van Veen grab samples from the winch room, on the starboard side of the vessel. We also deployed the camera from here. Coring was conducted from the starboard side also. For geophysical surveys recording instruments were set up in the general purpose laboratory, near the stern. A compressor for the airgun was mounted on the flight deck and monitored by a person stationed there. Geophysical gear was deployed from the quarterdeck, where the winches were also located. Upon completing surveys in Placentia Bay the vessel proceeded to St. John's, Newfoundland, where Shaw, Wile, and Jiang left to fly back to Halifax on 4th August. Brushett remained in St. John's. A crew change was conducted on Friday 4th August, and additional GSCA staff for the next leg arrived by air from Halifax.

Figure 1: On the first day of the cruise the vessel traveled to The Gully. After deploying OBS (ocean bottom seismometer) instruments, it continued to the first coring sites, south of Placentia Bay, Newfoundland.

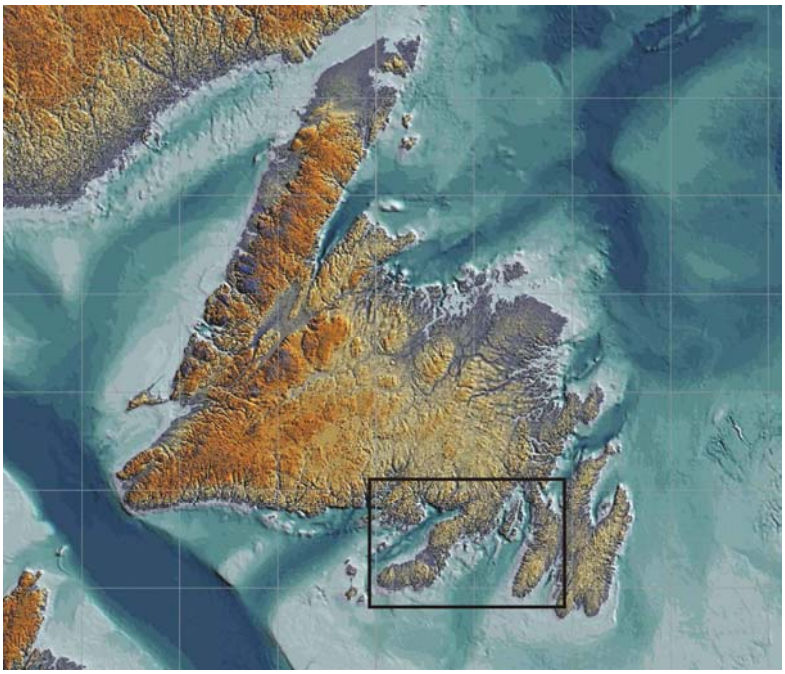

Figure 2: Location of Placentia Bay.

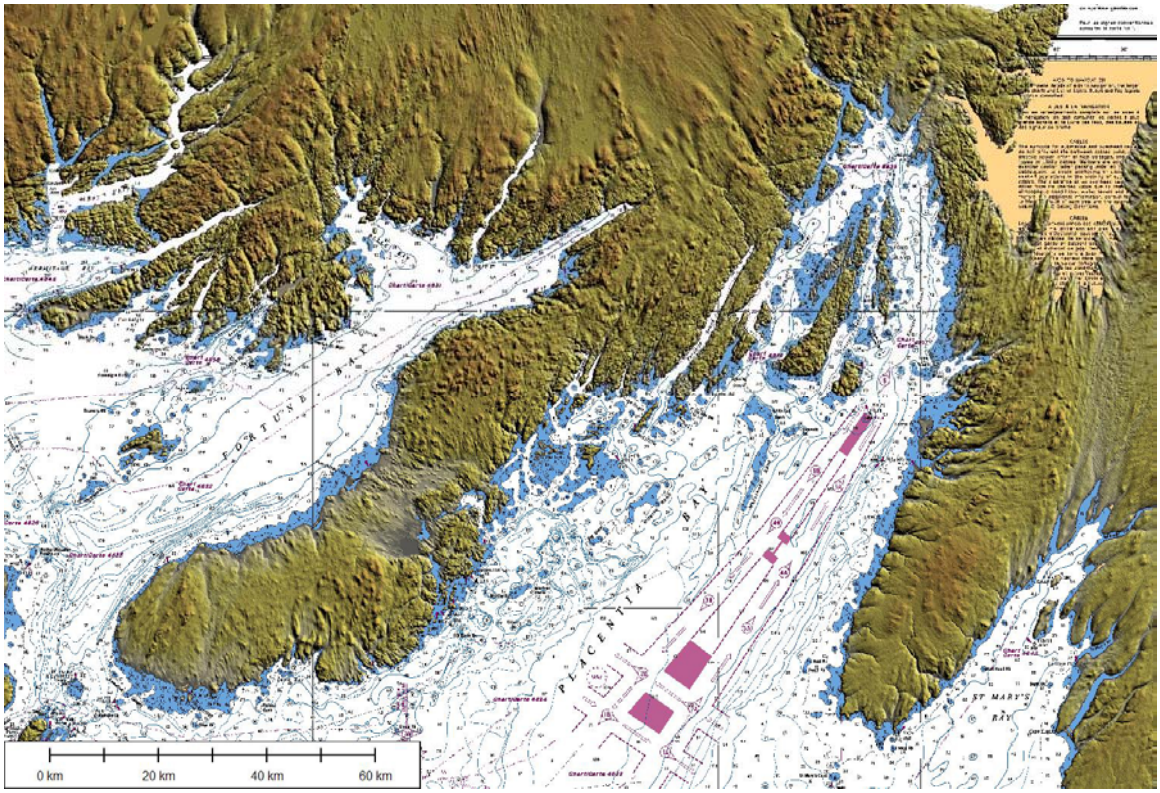

Figure 3: Placentia Bay. The Burin Peninsula is on the west side of the bay, and the Avalon Peninsula on the east.

CRUISE NARRATIVE

Note: Times are Universal Time, which is 3 hours ahead of Atlantic Daylight Saving Time.

Day 210 Saturday 29 July

It is warm and overcast in Halifax. The fog in the inner harbour clears by 12:30. By 13:30 we have completed a science meeting, familiarization, fire drill and boat drill. The vessel passes Thrumcap Shoal, at the harbour entrance, at 16:00. It is warm and sunny, with light breeze and scattered cumulus clouds. The ship proceeds towards The Gully with clear skies and light winds.

Day 211 Sunday 30 July

Dawn brings a clear sky, light breeze, and slight to moderate swell with moderate seas. We deploy three OBS systems, at 10:02 (43.9826 N, 58.9838W, approximate depth 1220 m); 10:32 (43.9266 N, 58.9941 W, approximate depth 1400 m); and 11:00 (43.8486, -58.9180, approximate depth 1770 m). The depths are based on the hydrographic chart (4050) and are shallower than the expected depths mentioned in the instructions for deployment. When we finish the OBS deployment the vessel moves south a short distance to deploy the sidescan towfish in order to straighten the cable on the drum.

After a short period we are underway for Placentia Bay. It is sunny and warm, with moderate swell and sea.

Day 212 Monday 31 July

Dawn brings clear skies (with some upper and middle cloud on the eastern horizon), and light swell and sea. At 09:50 UT we start with a grab sample (004) at SDT 78012-1390022; the sample shows a gravelly lag at the surface. This is followed by core 005. The plastic liner splits, probably due to contamination by rust, but a reasonable length of core is collected. We then proceed north to the next location – SDT 78012-1380850. As expected the grab (006) is mud. We then prepare for the core (007). The triggerweight core only contains 20 cm of sediment – did it fall over? We head south at 13:30 UT. We collect core 008 (site 2 on list of targets) without a preliminary grab sample – it is close to core 005 and the bottom is estimated to be similar. Cores 009 and 010 are collected, also without grab samples. The trigger-weight core of 010 contains more gravel at the surface that the other cores in the vicinity. By 20:00 the final core is being cut into sections and the corer is being rigged for the next day.

Gear is deployed at 21:30. This consists of the Huntec, airgun, and sidescan sonar systems. A laptop computer is set up with a navigation feed so that the operators can watch for shoal areas when the lines enter the area of multibeam coverage. The sea and swell remain slight to moderate during the survey, which proceeds without incident.

Day 213 Tuesday 1 July

It is clear at sunrise, except for some high cloud to the east, and some towering cumulus over the distant land. The wind is southwest to west at 15 knots. Gear is recovered at 06:00 and the vessel proceeds towards the nearby target, 006, as we prepare for sampling. At this site, about 5 m of postglacial mud overlies stratified glaciomarine sediments. Sampling begins at 10:25 UT, with grab sample 011, followed by camera station 012 beginning about 10:35 UT. During grab sampling, a sample for Environment Canada is collected as per instructions, and placed in the freezer. Core 13 is quite long (7.77 m) and clearly penetrated the glacial sediments (stiff red clay at base of core) but the uppermost liner was blown open, and given that the trigger weight core was empty, then an unknown amount of postglacial mud is missing from the top. We then proceed to target 7, in the zone of complete megaflute erosion, in which up to 5 m of postglacial mud has been removed, leaving residuals in places. We begin with camera (sample 014, 11 photographs). Then, discover a hydraulic leak in the overhead boom in the winch room. Rather than collect a grab sample, we proceed with the coring (015), then break for lunch. Immediately after lunch we collect the grab (016) sample at target 007 and slowly proceed towards site 008. It is sunny with a stiff SW breeze producing moderate seas. At the site of target 008 we collect a grab (017), do camera stations (018 – 5 photographs) and a core (019). Then we do sites S1 to S5, located in a field of pockmarks. Site 1 is a reference site, site 2 is in a pockmark, and site 3 is on the lip of the pockmark. Sites 4 and 5 are located in a pockmark centre and lip respectively. Sampling finished at 21:40 UT and the vessel proceeds to the southwest towards the start of lines for the evening. When reviewing photographs it is noticed that photographs at

station 18 are out of focus – too close to the sea floor. We start the surveys with lines across a series of sunken ships.

Day 214 Wednesday 2 August

The day begins overcast with light winds and intermittent light rain. Gear is recovered at 09:00 UT and we proceed towards site 014. We commence with a grab sample (025), continue with the camera (026), and are ready for the core at 11:00 UT. We finish coring (027) and steam to Eastern Channel, on the east side of the bay. The day is now overcast with strong SSE winds and heavy rain at times. After a break for lunch we start the first grab sample at 15:00 (028) and follow with core 029 at the same site. Then we complete grab sample 030 and core 031 at the same site. The rain has eased by 18:00 UT but the wind and accompanying rough seas remain. We are steaming south to site 015 by 18:30 UT. Given the rough conditions, we have to steam very slowly while dismantling the previous cores and setting up the next, so when suppertime arrives, the core is brought aboard and put in the rack but not prepared for storage. Gear is deployed just after 21:00 UT and we run a line southwest along the outboard shipping channel. The swell remains heavy, causing poor quality in the Huntec external record. The lines trailing behind the ship are entangled at one point.

Day 215 Thursday 3 August

The morning is dull, with broken low cloud and light winds. The sea is slight. Gear is recovered at 09:00 UT. The line during the night crossed the shipping lanes and returned northeast along the inboard lane. We end lines due west of the tip of the Argentia Peninsula and proceed to target 013. We collect a grab, bottom photographs, and a piston core, in that order, and are en route south by 12:00 approximately. The weather improves – clear skies and light winds. We intend sampling a series of seven sites (1-7). We sample the sites in order, except we cannot proceed from site 4 to site 5 due to traffic. We sample at site 7, then finish at site 5. The camera has been functioning badly all day. No photographs are obtained at sites 3 and 4. However, quite good photos are obtained at site 7 and very good ones at site 5 (sample 047). Sampling finishes at 20:30 and we head towards St. Johns in moderate swell, calm seas, and sunny skies.

Day 216 Friday 4 August.

Hudson docks in St. John's (north side) at 10:00. Staff make preparations for the next cruise (Sonnichsen), including installation of an additional compressor on the flight deck. Shaw, Wile, Jiang and Brushett leave the vessel at 14:30 UT and travel to the airport. They catch a flight to Halifax at 13:30 local time. Shaw is back in Dartmouth about 15:00 local time.

TECHNICAL SUMMARY

Navigation

Positioning aboard the vessel was done with navigation software *Regulus II* build 28620. The primary computer was placed in the GP lab (aft) and received differential GPS signals from a Thales ADU5 receiver and vertical reference unit, located in the navigation lab, adjacent to the bridge. All navigation strings were logged from the serial navigation distribution system. Navigation was backed up every morning on compact disks.

GIS setup

A laptop computer was set up, running GlobalMapper and using a navigation feed (ship's navigation). However, while changing the domain of the computer to allow a network connection, we lost the registration for the program. We were unable to re-establish the computer in the NRN domain, and had to leave a message at BIO asking for the GlobalMapper registration information to be forwarded. This was done on Monday.

Huntec deep-towed seismic reflection system

The system used was AGC #2. This uses the small Huntec fish with an internal hydrophone and an external streamer. The towed fish contained a boomer plate as sound source. The fish rested on a cradle at the stern of the vessel, and was raised and deployed using the 'A' frame and a winch. Data were displayed with both internal and external channels. With 10 lines across each record, then the spacing between lines was 12.5 ms.

Figure 4: Huntec DTS system in its cradle, with block and A-frame above.

Klein sidescan sonar system

This was a Klein 3000 system comprising a towfish, an electromechanical cable, a neutral buoyancy tow-package, and an Interocean winch with 1500 metres of wire mounted on the quarterdeck. A remote control unit for the winch was in the aft lab. Data logging was in XTF format. The display unit was a Klein 3000 deck console running Klein's proprietary acquisition software. Data were backed up daily on DVD's. Data can be viewed using either Klein's software (downloadable) or any software capable of reading XTF format.

Figure 5: Sidescan sonar flotation system – fish hidden from view.

Figure 6: Winch for the sidescan sonar system.

Airgun

The airgun used air produced with the GSCA Price W2 compressor, located on the flight deck, and constantly monitored throughout survey operations. Air was supplied at 1650 psi. The airgun used was a 10 cubic inch sleeve gun with 6 cubic inch inserts, firing every four seconds approximately. The airgun winch was located on the port side of the flight deck and the gun was towed from the port 'ironing board'. The gun was approximately 50 m behind the vessel and was fired using the AGC firing unit, controlled by the MITS.

The eel (hydrophone) was the newly-refurbished GSCA eel and was towed off the starboard side of the vessel. The records was displayed on an EPC 9600 graphics recorder and the signal was amplified using the eel amplifier, filtered through a Kronhite filter, and digital data were recorded on GSCA DIGS.

Figure 7: Compressor for the airgun, mounted on the flight deck.

Onboard core processing and subsampling

A total of 98.37 m of sediment was obtained from 26 cores (13 Piston (PC), and 13 Trigger Weight (TWC). All cores were processed according to the standard GSC Atlantic core procedures.

Each core was broken down from the bottom and the 10-ft. core barrels were transferred to the half height container where the core liner in each barrel was extruded out of the barrel and cut into sections of approximately 1.5 m. The section ends were carefully capped and the sections were labelled alphabetically (the base of the core is designated as A). The sections were taken into the GP Lab and stored horizontally on the benches. Each core, starting with the base section AB, was processed using the following procedure. End caps were removed if the sediment was not too fluid, and the section length was recorded. Undrained shear strength measurements and constant volume samples were taken at the top and base of each section. Inert packing was placed in the voids created by the constant volume sampling, and the ends of each core section were re-capped, taped and sealed with wax.

The sealed core sections were stored upright in the refrigerated reefer container and maintained at 4°C. All core cutter and catcher samples were labelled, placed in split liners, waxed and stored upright in buckets in the refrigerated container. All samples and subsamples were catalogued and their location information within the container was recorded in an excel spreadsheet.

Physical properties measurements

Undrained shear strength measurements and constant volume samples were taken at the ends of each piston if the condition of the sediment allowed (Table 1). The undrained shear strength measurement was taken prior to the constant volume sample being taken.

The undrained shear strength was measured using a hand-held Hoskin Scientific Torvane according to ASTM Test Method D2573-94 Standard Test Method for Field Vane Shear Test in Cohesive Soil. The Torvane dial reading ranges from 0 to 1 and reports values in kg-force/cm^2 units (1 kg/cm^2 = 98.07 kPa). The Torvane has three adapter vanes as described below:

L - Sensitive vane has a range of 0 to 0.2 Kg-force/cm^2

Su = dial reading * 0.2 Kg-force/cm^2
M - Regular vane has a range of 0 to 1.0 Kg-force/cm^2
Su = dial reading * 1 Kg-force/cm^2
S - High capacity vane has a range of 0 to 2.5 Kg-force/cm^2
Su = dial reading * 2.5 Kg-force/cm^2

Figure 8: Taking an undrained shear strength

The **L** - Sensitive vane and the **M** - Regular vane were used for a total of 52 undrained shear strength measurements taken during the cruise.

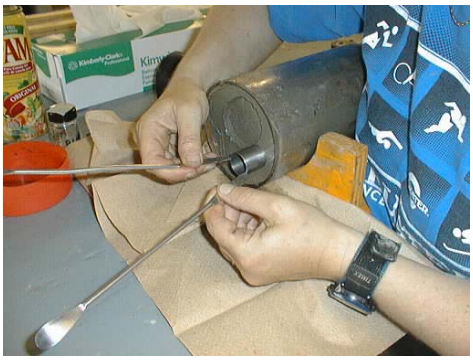

Figure 9: Inserting the constant volume sampler.

Constant volume samples for bulk density and water content determinations were taken by inserting stainless steel tubes of a known volume. Prior to insertion, the sampler was lightly sprayed with Pam cooking oil and gently wiped with a small Kimwipe. The bevelled edge of the sampler was placed on the flat sediment surface and the carefully inserted into the sediment at a constant rate (to minimize compression of the sediment within the sampler) using two flat headed spatulas (Fig. 2). The sampler was then carefully removed and the sediment was trimmed using a wire saw and extruded into a pre-weighed 1 oz screw-top glass bottle. The bottle cap was then labelled and sealed using electrical tape to

prevent the lid from loosening. A total of 70 constant volume samples were taken during the cruise. The sample will be weighed, dried at 105°C for 24 hours and re-weighed to determine bulk density, dry density and water content according to ASTM Test Method D 2216-90 (revision of 2216-63, 2216-80) Standard method for laboratory determination of water (moisture) content of soil and rock.

Station	Type	constant volume samples	Torvane Measurements
0005	TWC	0	0
0005	PC	5	4
0007	PC	6	5
0008	PC	3	2
0009	TWC	0	0
0009	PC	6	4
0010	TWC	0	0
0010	PC	3	3
0013	PC	9	7
0015	PC	5	4
0019	PC	8	7
0027	TWC	0	0
0027	PC	2	0
0029	PC	4	3
0031	TWC	0	0
0031	PC	5	3
0032	PC	9	8
0035	TWC	1	0
0035	PC	4	2

Table 1: Summary of Physical property sampling

Figure 10: van Veen grab sampler being recovered in the oceanographic winch room.

Bottom camera

The bottom camera consisted of an aluminum frame, with lights and Insite Scorpio digital camera mounted in pressure cases. The camera is triggered by a controller when a lead weight hanging below the camera hits the sea floor. A pinger used when lowering the camera enables the winch operator to ascertain close proximity to the sea floor. When the operator stops the winch the camera is then is 5 feet off the bottom. Between the pinger stop and the camera firing there is a variable delay (0.35 – 1.0 sec approximately). Photographs at the first two camera stations (012 and 014) were of acceptable quality, but photos as stations 018 and026 were poor. They were taken too close to the sea floor, commonly the lead weight was out of the frame, and images were out of focus. It was thought possible that there was excessive delay between the weight hitting the bottom, and the camera shooting. This delay could not be adjusted. The solution we tried was to have the winch go very slow. Subsequently we discovered the problem was that the camera had been set on autofocus. After two complete failures (samples 040 and 043) we set the focus and obtained acceptable photographs at the penultimate station (044), and good ones at the final station (047).

ACHIEVEMENTS

During the cruise a total of 44 samples was collected, consisting of 20 van Veen grab samples, 13 piston cores, and 11 sets of seafloor photographs. During three nights of surveys of just less than 12 hours duration we collected Huntec DTS data, Klein digital sidescan sonar data, and 10 cubic inch airgun data. Figure 13 shows the tracks of the Huntec surveys. Figure 14 shows sample locations.

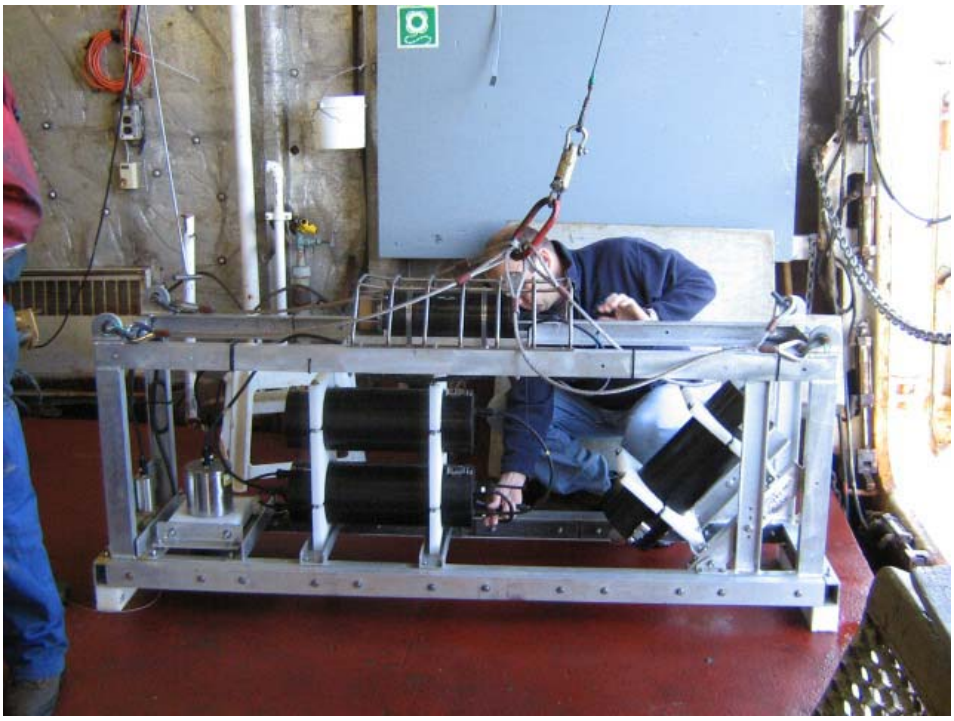

Figure 11: Close-up view of the bottom camera in the winch room.

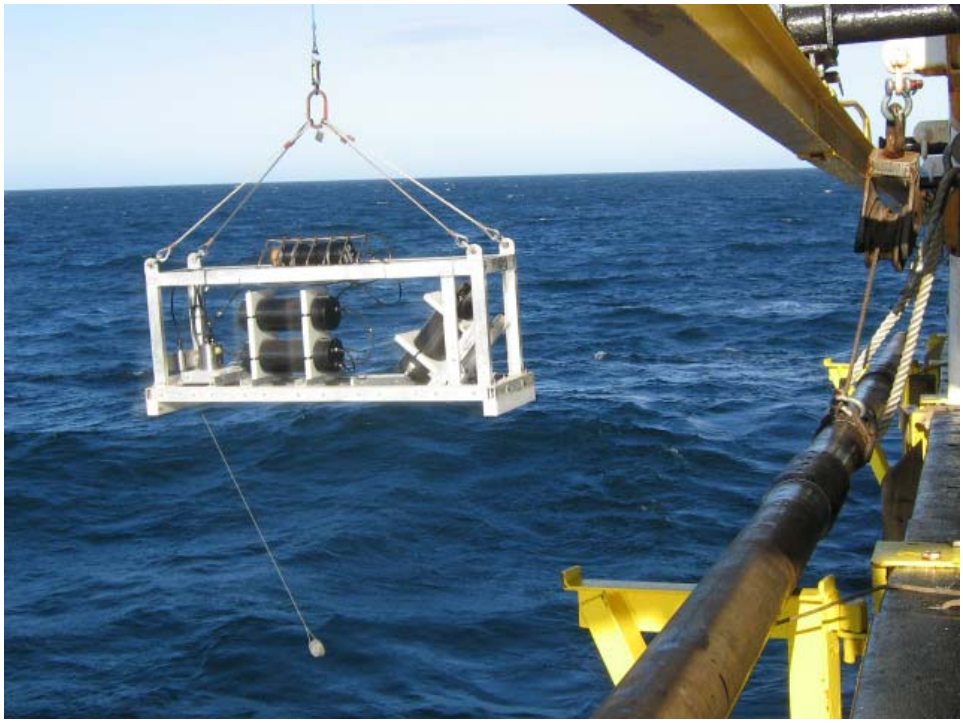

Figure 12: Bottom camera system being lowered from the winch room. Note the trigger weight swinging below the camera.

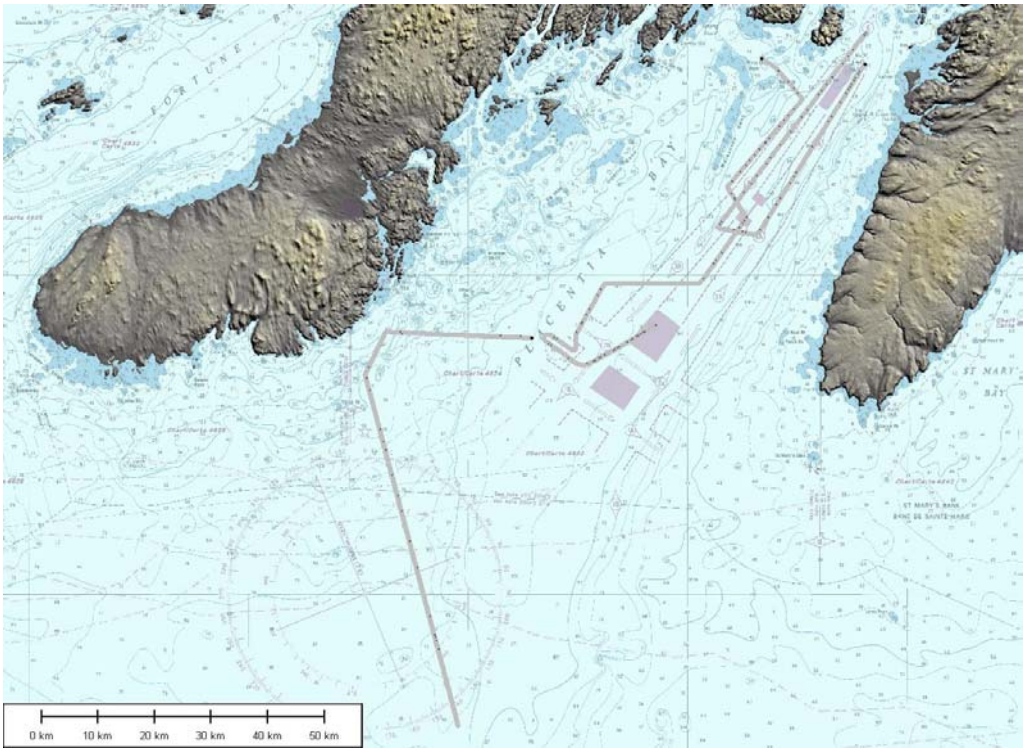

Figure 13: Huntec DTS tracks.

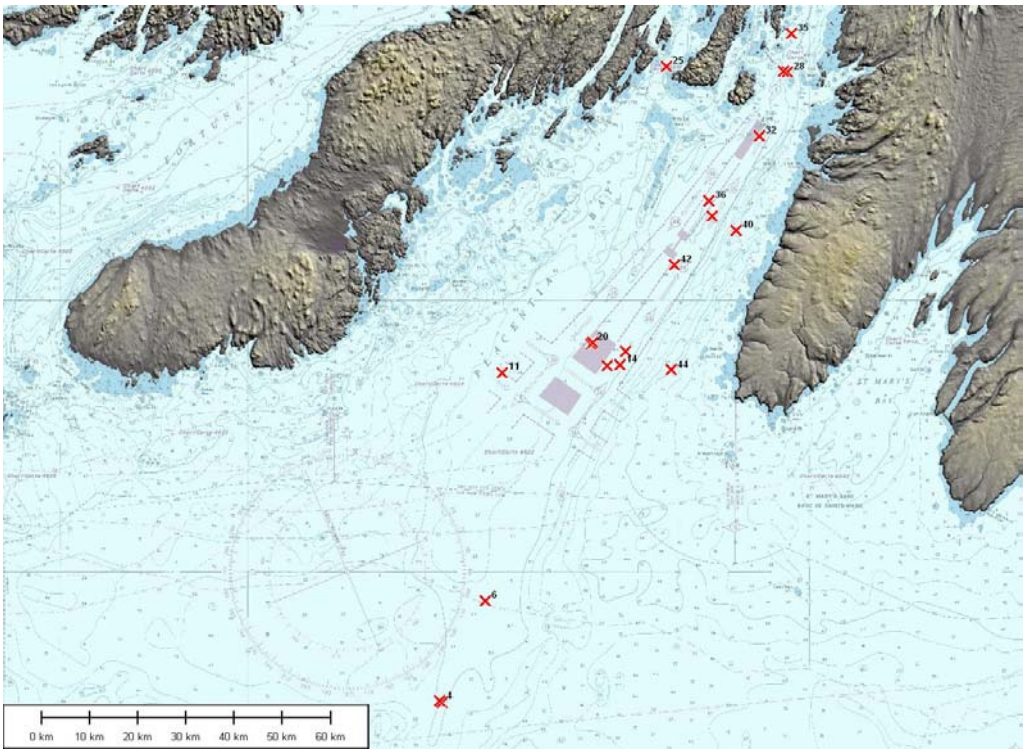

Figure 14: Sample locations.

PRELIMINARY SCIENTIFIC RESULTS

The science results are discussed within the context of the goals laid out in the introduction.

To date the retreat of glacier ice from Placentia Bay, and in particular, obtain new and more accurate dates for the Burin Moraine.

On the first day of coring, Monday 31 July (JD 212), the goal was to attempt to core stratified glaciomarine sediments interfingered with till tongues on the east flank of the Burin moraine (Fader et al., 1982), south of Placentia Bay. This attempt may have been partially successful, but we will have to wait for core analyses for confirmation. The cores collected were 005, 007, 008, 009, and 010 (see Table 1).

A cluster of four targets (Targets 1, 2, 3 and 4) was located on a Huntec DTS survey line, *Hudson* 78012, day 139, at 00:22, 00:23, 00:24 and 00:21 respectively. To ensure success we had to penetrate the Downing Silt Facies (Fader et al., 1982) at the seafloor and intersect a prominent reflection that marked the upper surface of the till tongue. The required penetration below the sea floor and the actual core lengths (brackets) are as follows:

Target #	Piston core #	Required penetration	Actual
1	005	5.7 m	5.40 m
2	008	6.8 m	4.29 m
3	009	6.2 m	5.66 m
4	010	4.7 m	4.87 m

Thus, we only reached the horizon with one core (010). However, core tops are generally truncated, and a complete stratigraphy is commonly obtained by including overlap with the trigger-weight cores, so penetration was probably greater than indicated here. All cores had good apparent penetration, suggesting that at some stage the pistons ceased to function, and the core barrels ploughed into the sediments without coring. We took grabs at only one site (Target 1) and found, as predicted, some gravel at the sea floor. The trigger-weight core (TWC) at target 4 (core 010) contained numerous sub-rounded gravel clasts at the top.

The remaining core (007) in this area (south of Placentia Bay proper) was aimed at Target 5, located north of Targets 1-4. At this location we had to penetrate 2 m of postglacial mud and a further 12.5 m of glaciomarine sediments to reach the top of the till tongue. We did not expect to reach the till tongue, and indeed, total penetration was only 6.48 m. However, more than 4 m of this core is the glaciomarine unit, and may yield some dates that will help constrain the age of ice retreat.

Finally, the core at Target 6, core 013, had a length of 930 cm. The Huntec DTS data from here show about 5 m of postglacial mud over the glaciomarine sediments. The TWC was empty, and the top of the plastic core liner was burst open, so we probably do not

have the upper part of the stratigraphy. Nevertheless, the core probably penetrated the upper part of the glaciomarine sediments: it bottomed in stiff, buttery glaciomarine clay.

To gain understanding of the formation of megaflutes in Placentia Bay.

The approach taken here was to collect two adjacent cores, one in a megaflute, and one immediately west of the megaflute zone in an area of unmodified postglacial mud. Core 015 was in the flute zone, and was 552 cm long. The TWC was empty, suggesting perhaps that it encountered a hard surface, and fell over. The grab sample yielded muddy fine sand, suggestive of winnowing of the muddy sediments. The core west of the fluted zone (019) had a length of 737 cm. Here the trigger-weight core also fell over, and, unexpectedly, the grab sample yielded muddy fine sand.

From these results, and also from a series of grab samples collected in a nearby pock mark field (020-024) that yielded sandy mud, it seems that the seafloor sediments in this area of low backscatter are somewhat sandy. Since the piston cores penetrated well, perhaps sediments are muddier with depth, and possibly this evidence - together with the presence of megaflutes - argues for an increase in energy at the sea floor, possibly caused by strengthening of the Labrador current.

Collect piston cores containing long Holocene sections that can be used to derive high-resolution records of oceanographic changes.

We aimed to collect long Holocene sections at Target sites 12, 13 and 14. Target 14 was located in the deeps of Western Channel. We collected core 027 at this location, in a water depth of 404 m. The core had a length of 12.25 m, and the TWC was 0.65 m long. The core contained gas, resulting in numerous cracks. It had a blackish colour, the grab sampler contained pungent black silty clay, and photos (026) showed an anoxic sea floor. Core 029 (Target site 12) had a length of 8.14 m (TWC empty) and core 35 (Target site 13) had a length of 7.88 m (TWC 0.77 m). Both these sites are located in Eastern Channel. While the cores remain unopened, there is every expectation that success was obtained with regard to this goal.

Collect piston cores to ascertain the age of submarine slides in Eastern Channel.

At Target site 015, on the west flank of Eastern Channel, we collected core 32 (depth 211 m). The goal was to penetrate ~5.5 m of postglacial mud in a submarine slide scar, and reach the underlying sediments. The core had a length of 6.66 m, but the TWC was empty. Hopefully, some dates will be obtained. At Target site 009, in Eastern Channel (depth 297 m) we collected core 031. This would, it was hoped, penetrate 2.5 m of postglacial mud and reach acoustically incoherent submarine slide deposits. The core had a length of 9.26 m (TWC 0.59 m) so there is every hope that we have achieved a success at this site. The thickness of postglacial sediments lends support to the hypothesis that mass failures occurred in the lateglacial period, when tectonism accompanied rapid glacio-isostatic crustal adjustments. However, there is evidence of

Holocene earthquake activity offshore from Newfoundland, so good radiocarbon dates will be vital before we date the submarine slides with confidence.

Collect grab samples and photographs to facilitate production of A-Series maps of interpreted backscatter and surficial geology.

This goal was made difficult by the sheer size of the bay, and the priority accorded to coring. As noted above, samples in the area of low backscatter in the southern bay tended to have a significant sand content. This implies that the low backscatter zones obtained from multibeam bathymetry data equate with both mud and sandy mud. A sample from a ridge with high backscatter on the east side of the bay, protruding through the surrounding postglacial mud, (sample 037 - photograph set 036) yielded gravelly sandy mud, probably a lag deposit.

Several samples were obtained from the east side of the bay, in areas of high backscatter. As expected, these show that as we proceed from deep water to shallow we encounter coarser materials. Sample 041 (photo set 040) comprised coarse shelly sand with gravel. Sample 045 (photo set 055) was shelly coarse sand.

Before creation of surficial geology maps, it will be necessary to collect more samples. Probably several cross-bay transects would be the best approach. In particular, little is known regarding seafloor texture on the west side of the bay. From shallow to deep we pass through a zone of drumlins (bouldery gravels at the seafloor?) into a zone of drumlins mantled by thin glaciomarine mud (sandy gravels?) to a zone of glaciomarine mud imprinted by icebergs furrows (gravelly mud?) to a zone of postglacial mud (sandy mud?). Sampling will be required to test these assumptions.

Collect surface samples for the Department of Fisheries and Oceans.

A group of samples (020-024) was obtained in the pockmark zone of the southern bay. Attempts were made to sample in the base of pockmarks and on the lips, and at a reference station. Samples were also collected a few other sites where the seafloor was muddy.

Other results.

Surveys in the southwest portion of the bay across a series of 5 multibeam targets (Figs. 15, 16) showed that these were, as expected, sunken fishing vessels (Figs. 17-21) , deliberately scuttled by Fisheries Products International, of Marystown.

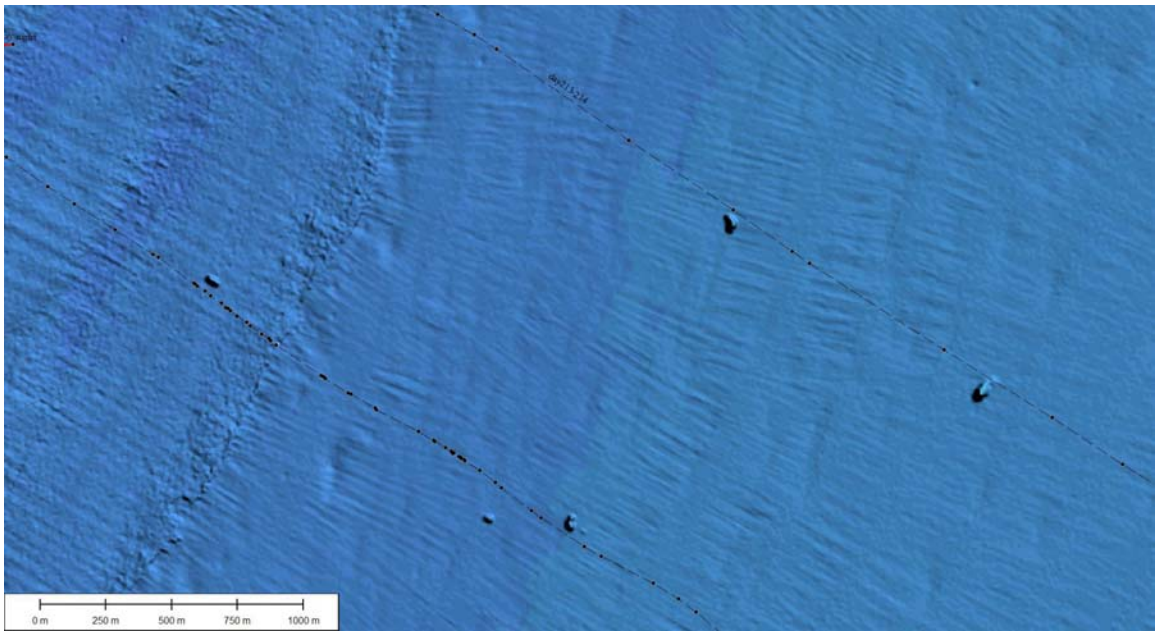

Fig. 15: Multibeam image of the wrecks. The wrecks are numbered 1-5, clockwise from the wreck at bottom right.

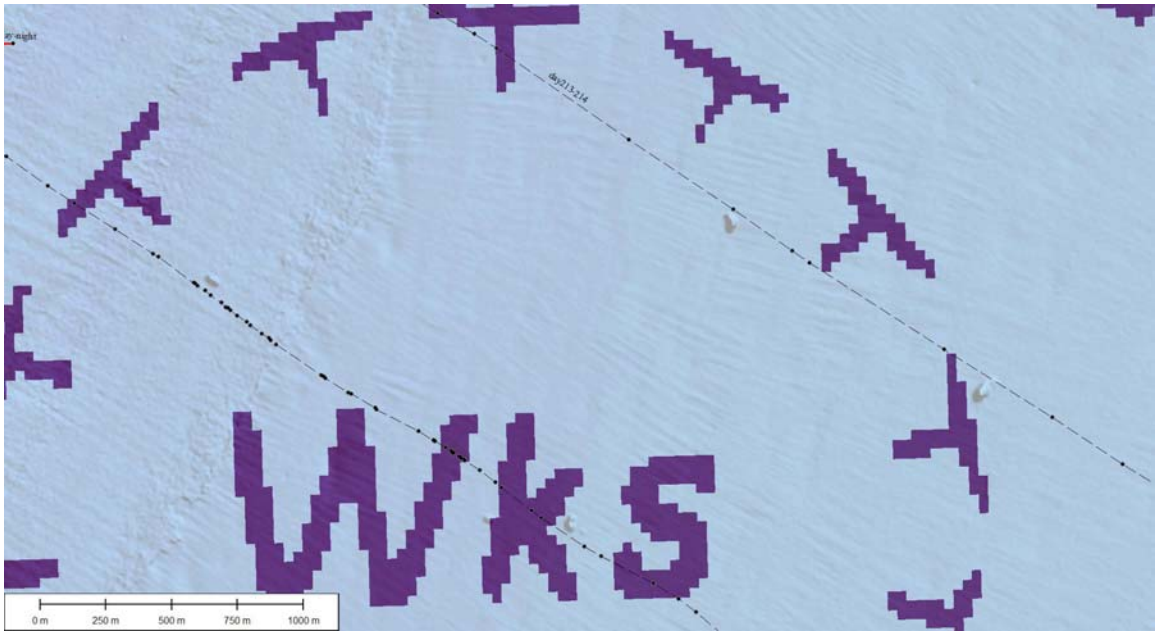

Fig. 16: Multibeam image of the wrecks with the chart superimposed.

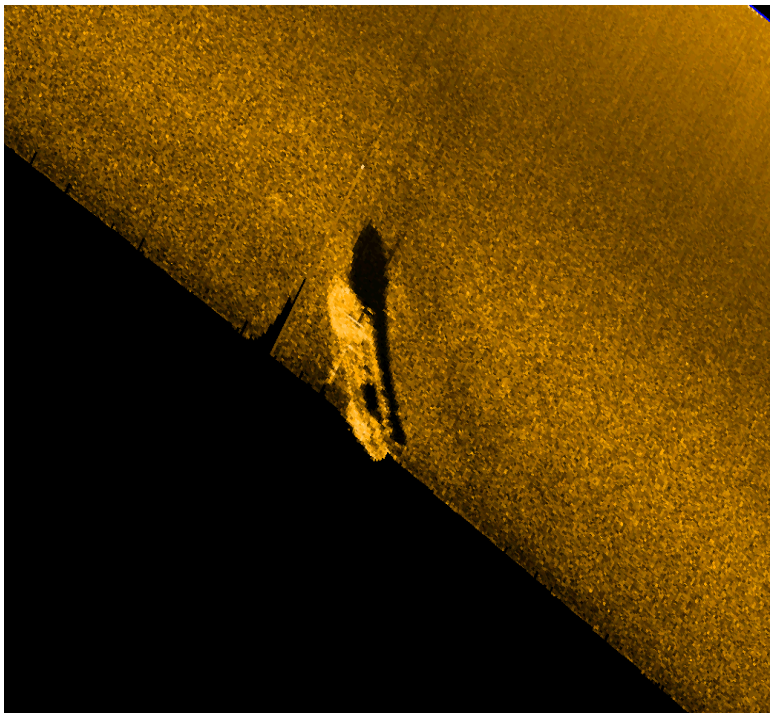

Fig. 17: Ship 1

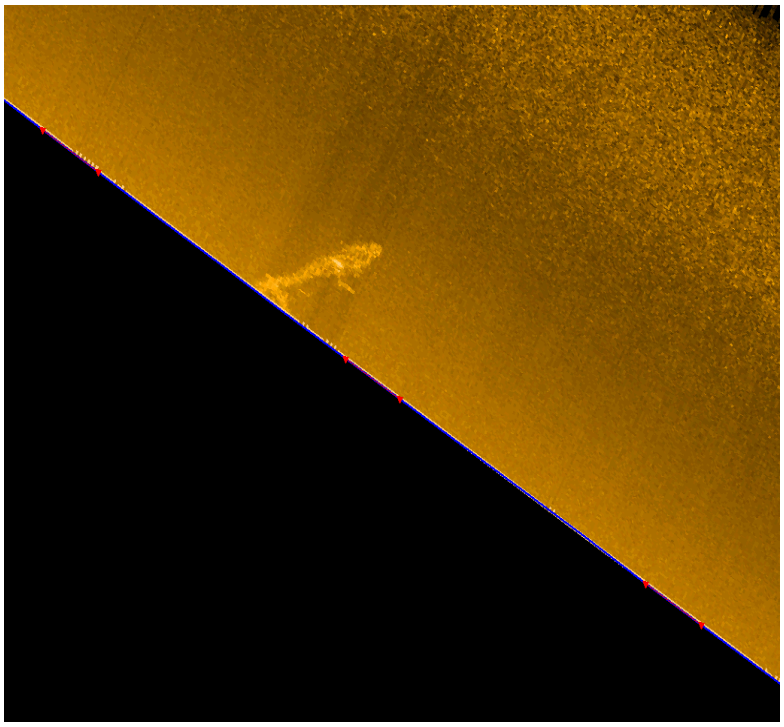

Fig. 18: Ship 2.

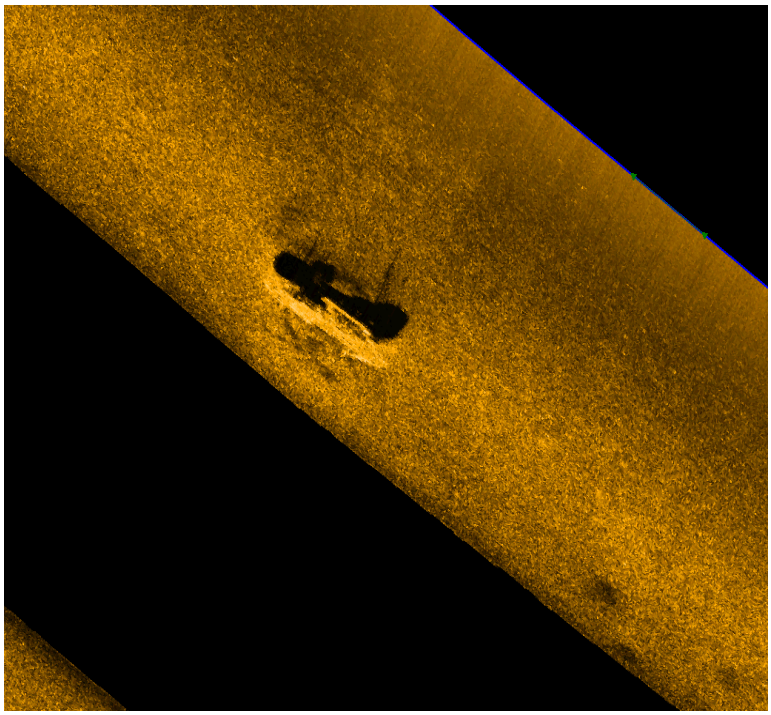

Fig. 19: Ship 3.

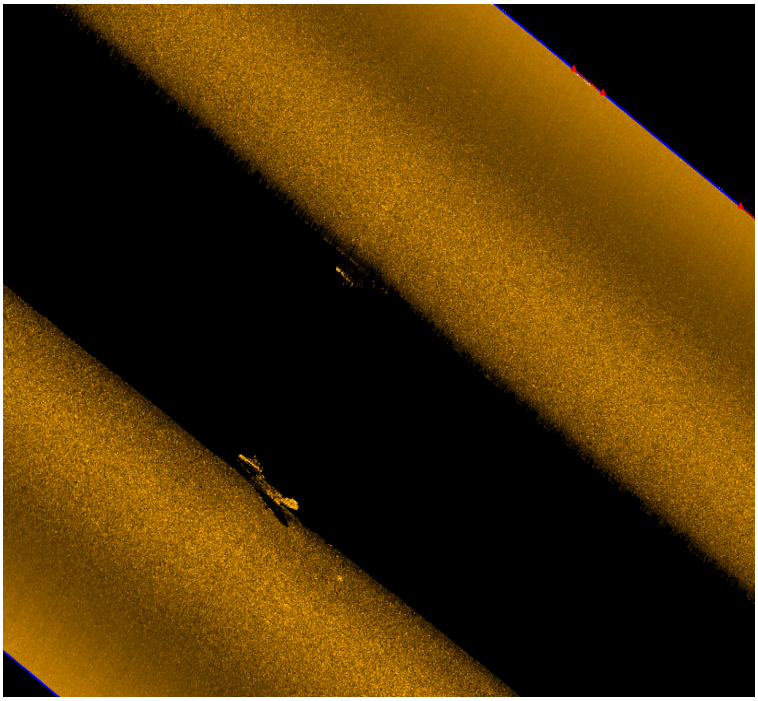

Fig. 20: Ship 4.

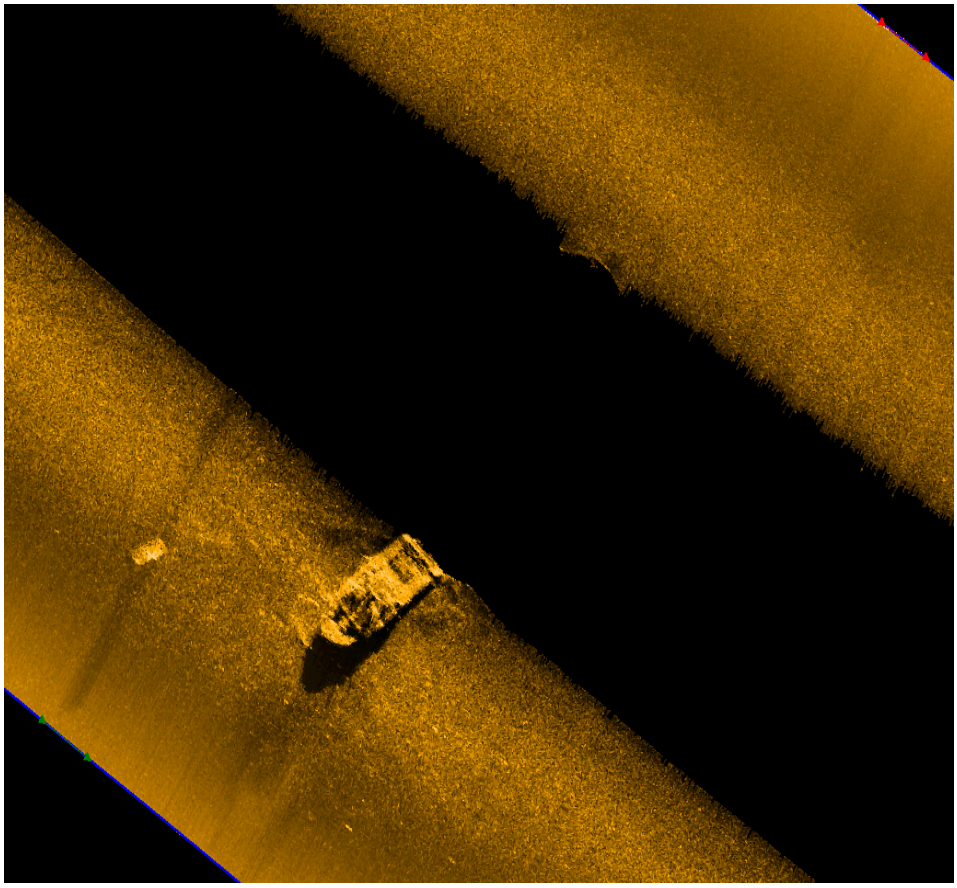

Fig. 21: Ship 5.

ACKNOWLEDGEMENTS

We thank Captain Todd Gilmore and his crew for their assistance and cooperation during the cruise. We thank support staff at BIO who assisted with various problems, including Wayne Prime and Cheryl Boyd. Russell Parrott reviewed this document.

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Appendix 1: Samples

#	Latitude	Longitude	Depth (draft corr.)	Type	Seismic daytime	Description
001	43 58.9605	-58 59.0258	1220.0 *	OBS	-	Axis of The Gully
002	43 55.5962	-58 59.6504	1400.0 *	OBS	-	Axis of The Gully
003	43 50.9159	-58 55.0828	1770.0 *	OBS	-	Axis of The Gully
004	46 15.5997	-54 58.9288	184.0	G	78012-1390022	Olive gray gravelly sandy mud. Surface veneer of sub-rounded and sub-angular pebbles, up to 12 cm diameter, embedded in sandy mud. Pebbles mainly bare except for a few small attached sponges. 2 vials and one bag. Same site as core 005. Target 1.
005	46 15.6122	-54 58.9238	184.0	PC	78012-1390022	Cutter reddish gray clay. Same site as grab 004. Target 1. 540 cm TWC 149 cm
006	46 26.7592	-54 51.7118	231.0	G	78012-1380850	Dark olive gray silty mud; stiff; scattered small shell fragments. 2 vials and one bag. Same site as core 007. Target 5.
007	46 26.7530	-54 51.7316	231.0	PC	78012-1380850	Cutter stiff, buttery, red clay. Same site as grab 006. Target 5. 648 cm TWC empty
008	46 15.5389	-54 58.8045	185.0	PC	78012-1390023	No grab. Cutter buttery, reddish gray clay. Target 2. 429 cm TWC empty
009	46 15.4799	-54 58.7161	184.0	PC	78012-1390024	No grab. Target 3. Nose of cutter has buttery red clay. 566 cm. TWC 123 cm
010	46 15.6571	-54 59.0286	183.0	PC	78012-1390021	No grab. Target 4 on list. 487 cm. TWC empty.
011	46 52.0293	-54 49.0447	243.0	G	78012-1362047	Very dark gray silty mud, a few worm tubes, one large sub-rounded pebble, one ornate brittlestar. Target 06. Same location as camera 012 and core 013. 2 vials, one bag, and a sample for Environment Canada. Target 6 on list – same location as camera 012 and core 013.
012	46 52.0171	-54 49.0243	243	C	78012-1362047	All photographs at Target 6 on list – same location as grab sample 011 and core 013. Photo 1.
012	46 52.0146	-54 49.0195	243	C	78012-1362047	Photo 2.
012	46 52.0121	-54 49.0143	242	C	78012-1362047	Photo 3.
012	46 52.0136	-54 49.0105	242	C	78012-1362047	Photo 4.
012	46 52.0155	-54 49.0131	243	C	78012-1362047	Photo 5.
013	46 52.0187	-54 48.9949	243	PC	78012-1362047	Same location as camera 011 and grab 012. 930 cm TWC empty. Target 6.
014	46 52.8716	-54 30.1645	188	C	78012-1361818	Eleven camera stations – drifting north from the SDT location. Target site 007. Photo 1.
014	46 52.8764	-54 30.1640	188	C	78012-1361818	Photo 2.

014	46 52.8780	-54 30.1565	188	C	78012-1361818	Photo 3.
014	46 52.8835	-54 30.1562	187	C	78012-.1572136 1818	Photo 4.
014	46 52.8967	-54 30.1572	189	C	78012-1361818	Photo 5.
014	46 52.9050	-54 30.1546	188	C	78012-1361818	Photo 6.
014	46 52.9114	-54 30.1438	188	C	78012-1361818	Photo 7.
014	46 52.9159	-54 30.1278	188	C	78012-1361818	Photo 8.
014	46 52.9201	-54 30.1968	186	C	78012-1361818	Photo 9.
014	46 52.9216	-54 30.0877	189	C	78012-1361818	Photo 10.
014	46 52.9163	-54 30.0782	189	C	78012-1361818	Photo 11.
015	46 52.8722	-54 30.1719	189.0	PC	78012-1361818	Target site 007 – same as camera station 014 and grab station 016. 552 cm TWC empty
016	46 52.8510	-54 30.1761	191.0	G	78012-1361818	Dark olive gray muddy fine sand. Target site 007 – same location as camera 014 and core 015. 2 vials, 1 bag, and 1 sample for Environment Canada.
017	46 52.7721	-54 32.2030	196.0	G	78012-1361832	Olive gray muddy fine sand. Target 008 – same location as camera 018 and core 019. 2 vials, 1 bag, and Environment Canada sample.
018	46 52.7793	-54 32.1847	199.0	C	78012-1361832	Photo 1 – part of a series of 5 photos, same site as grab 017 and core 019.
018	46 52.7777	-54 32.1880	199.0	C	78012-1361832	Photo 2
018	46 52.7716	-54 42.1927	199.0	C	78012-1361832	Photo 3
018	46 52.7713	-54 32.1979	199.0	C	78012-1361832	Photo 4
018	46 52.7789	-54 32.1940	199.0	C	78012-1361832	Photo 5
019	46 52.7649	-54 32.1889	199.0	PC	78012-1361832	737 cm TWC empty Target 8.
020	46 55.3692	-54 34.7772	206.0	G	-	S1-reference station – EC sample and DFO sample, 2 vials and 1 bag.
021	46 55.2067	-54 34.8062	207.0	G	-	S2- pock mark centre – EC sample and DFO sample, 2 vials and 1 bag.
022	46 55.1916	-54 34.7592	206.0	G	-	S3-pock mark lip – DFO sample, 2 vials, 1 bag.
023	46 55.3422	-54 34.5410	203.0	G	-	S4-pock mark centre – DFO sample, 2 vials, 1 bag.
024	46 55.3566	-54 34.5234	204.0	G	-	S5-pock mark lip – DFO sample, 2 vials, 1 bag.
025	47 25.5279	-54 22.7270	403.0	G	2005051-3021750	Pungent black silty clay – EC sample, 2 vials and 1 bag.
026	47 25.5263	-54 22.7418	403.0	C	2005051-	Photo 1

					3021750	
026	47 25.5255	-54 22.7408	403.0	C	2005051-3021750	Photo 2
026	47 25.5282	-54 22.7435	403.0	C	2005051-3021750	Photo 3
026	47 25.5321	-54 22.7435	403.0	C	2005051-3021750	Photo 4
026	47 25.5313	-54 22.7447	403.0	C	2005051-3021750	Photo 5
027	47 25.5237	-54 22.7331	404.0	PC	2005051-3021750	Western Channel. Same location as 025 and 026. 1225 cm TWC 65 cm.
028	47 24.9839	-54 03.2545	221.0	G	2005051-3051652	Eastern Channel – target site 012. Dark olive gray silty clay; a few shell fragments.
029	47 24.9756	-54 03.2844	224.0	PC	2005051-3051652	Eastern Channel – same site at grab 028. Target site 012. 814 cm TWC empty
030	47 25.0636	-54 03.9323	298.0	G	99020-1852029	Eastern Channel. Target site 009. Gravelly sandy mud. Dark olive gray mud with some sand and a surficial veneer of sub-angular to sub-rounded gravel (see deck photos) with attached fauna. 2 vials, I bag, 1 EC sample. Same site as core 031.
031	47 25.0545	-54 03.8777	297	PC	99020-1852029	Eastern Channel. Target site 009 – same site as grab 030. 926 cm TWC 59 cm
032	47 17.9275	54 07.7828	211	PC	2005051-3051443:30	Eastern Channel-site of old submarine slide. 666 cm TWC empty
033	47 29.1594	54 02.6368	212.0	G	2005051-3051756	Dark olive gray silty mud; light brown on surface; trace of very fine sand. 2 vials, 1 bag, 1 EC sample, 1 DFO sample.
034	47 29.1691	-54 02.6429	204.7	C	2005051-3051756	Photo 1 – poor quality.
034	47 29.1720	-54 02.6479	204.7	C	2005051-3051756	Photo 2– poor quality.
034	47 29.1709	-54 02.6517	210.0	C	2005051-3051756	Photo 3– poor quality.
034	47 29.1703	-54 02.6509	203.8	C	2005051-3051756	Photo 4– poor quality.
034	47 29.1698	-54 02.6487	201.9	C	2005051-3051756	Photo 5– poor quality.
035	47 29.1602	-54 02.6435	212.0	PC	2005051-3051756	Same site as camera 034 and grab 033. Target site 013. 788 cm TWC 77 cm
036	47 10.9049	54 15.8849	184.0*	C	2005051-298170450	* Depth may be too deep. Photo 1. Site 1 on Thursday list.
036	47 10.9054	54 15.8822	175.0	C	2005051-298170450	Photo 2.
036	47 10.9046	54 15.8812	177.0	C	2005051-298170450	Photo 3.
036	47 10.9056	54 15.8838	174.0	C	2005051-298170450	Photo 4.
036	47 10.9040	54 15.8856	172.0	C	2005051-	No photo taken

					2981704 50	
037	47 10.9102	54 15.8932	184.0	G	2005051-2981704 50	Same location as camera 036 – ridge of high backscatter – site 1 in the Thursday list. Gravelly sandy mud.
038	47 09.2019	-54 15.3400	201.0	G		Same location as camera 039. Deep channel with low backscatter. Dark olive gray muddy very fine sand, light brown on surface. Site 2 on list.
039	47 09.2023	-54 15.3211	202.0	C	2006039-	Same location as 038. Photo 1. Site 2 on list.
039	47 09.2026	-54 15.3207	196.0	C	2006039-	Photo 2.
039	47 09.2067	-54 15.3196	196.0	C	2006039-	Photo 3.
039	47 09.2030	-54 15.3229	196.8	C	2006039-	Photo 4.
039	47 09.2085	-54 15.3238	202.0	C	2006039-	Photo 5.
040	47 07.6141	-54 11.5562	83.7	C	2005051-2981307 50	Photo 1. Site 3 on list. No photo obtained.
040	47 07.6144	-54 11.5541	84.9	C	2005051-2981307 50	Photo 2. No photo obtained.
040	47 07.6109	-54 11.5565	84.9	C	2005051-2981307 50	Photo 3. No photo obtained.
040	47 07.6163	-54 11.5487	84.9	C	2005051-2981307 50	Photo 4. No photo obtained.
040	47 07.6130	-54 11.5561	83.9	C	2005051-2981307 50	Photo 5. No photo obtained.
041	47 07.6111	-54 11.5527	84.9	G	2005051-2981307 50	Site 3 on Thursday's sample list. Same location as camera 040. Morainal area in shallow water. Gravelly sand: poorly-sorted coarse shelly sand with fine, sub-rounded gravel clasts, bivalves. Yellow brown colour. 2 vials and one bag.
042	47 03.8347	-54 21.3833	200.8	G	2006039-	Site 4 on the list – 'scalloped' sea floor. Olive gray muddy fine sand. EC sample, 2 vials, one bag.
043	47 03.8364	-54 21.4051	201.0	C	2006039-	Site 4 on list. Photo 1. No photo obtained.
043	47 03.8389	-54 21.4156	200.0	C	2006039-	Photo 2. No photo obtained.
043	47 03.8385	-54 21.4044	199.9	C	2006039-	Photo 3. No photo obtained.
043	47 03.8331	-54 21.4003	199.9	C	2006039-	Photo 4. No photo obtained.
043	47 03.8337	-54 21.4073	200.8	C	2006039-	Photo 5. No photo obtained.
044	46 52.2897	-54 21.9380	92.9	C	78012-1361717	Site 7 on list. Hard sea floor close to coast. Photo 1.
044	46 52.2858	-54 21.9164	90.7	C	78012-1361717	Photo 2.
044	46 52.2863	-54 21.9250	92.0	C	78012-1361717	Photo 3.
044	46 52.2897	-54 21.9397	92.0	C	78012-1361717	Photo 4.
044	46 52.2914	-54 21.9467	92.0	C	78012-1361717	Photo 5.

045	45 52.2955	-54 21.9554	88.0	G	-	Site 7 on list. Hard sea floor close to coast. Light brownish gray shelly coarse sand;
046	46 54.3277	-54 29.2336	199.0	G	-	Site 5 in list, in megaflute. Dark olive gray fine sand with some mud; a few small shrimps. 2 vials and 1 bag.
047	46 54.3239	-54 29.2143	198.0	C		Photo 1
047	46 54.3212	-54 29.2162	198.0	C		Photo 2
047	46 54.3252	-54 29.2167	198.0	C		Photo 3
047	46 54.3273	-54 29.2219	192.0	C		Photo 4
047	46 54.3286	-54 29.2205	191.0	C		Photo 5
047	46 54.3273	-54 29.2195	195.0	C		Photo 6
047	46 54.3242	-54 29.2146	191.0	C		Photo 7
047	46 54.3297	-54 29.2183	196.8	C		Photo 8
047	?	?	?	C		Photo 9 missed the event...
047	46 54.3268	-54 29.2280	191.0	C		Photo 10
047	46 54.3207	-54 29.2362	196.8	C		Photo 11
047	46 54.3136	-54 29.2423	192.0	C		Photo 12
047	46 54.3079	-54 29.2489	192.0	C		Photo 13
047	46 54.3022	-54 29.2582	196.0	C		Photo 14
047	46 54.2968	-54 29.2704	196.0	C		Photo 15

- Estimated depth based on chart: all other depths are draft corrected.

Appendix 2: Summary of grab samples

Station Number	Sample Type	surface subsample	Mixed subsample	Bulk	Foil subsample Environment Canada	Other DFO	**Total**
0004	VV Grab	1	1	1			**3**
0006	VV Grab	1	1	1			**3**
0011	VV Grab	1	1	1	1		**4**
0016	VV Grab	1	1	1	1		**4**
0017	VV Grab	1	1	1	1		**4**
0020	VV Grab	1	1	1	1	1	**5**
0021	VV Grab	1	1	1	1	1	**5**
0022	VV Grab	1	1	1		1	**4**
0023	VV Grab	1	1	1		1	**4**
0024	VV Grab	1	1	1		1	**4**
0025	VV Grab	1	1	1	1		**4**
0028	VV Grab	1	1	1	1	1	**5**
0030	VV Grab	1	1	1	1		**4**
0033	VV Grab	1	1	1	1	1	**5**
0037	VV Grab	1	1	1	1		**4**
0038	VV Grab	1	1	1	1		**4**
0041	VV Grab		1	1			**2**
0042	VV Grab	1	1	1	1		**4**
0045	VV Grab	1	1	1			**3**
0046	VV Grab	1	1	1			**3**
	Total	**19**	**20**	**20**	**12**	**7**	**78**

Appendix 3: Deck photographs of grab samples

Sample 2006039-004.

Sample 2006039-006.

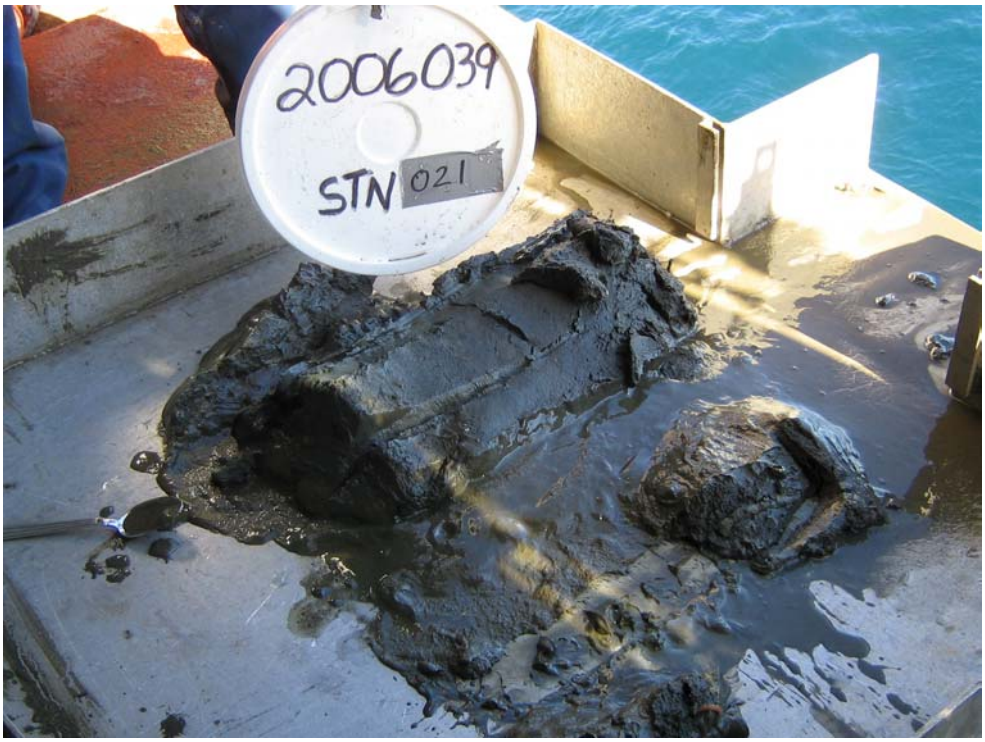
Sample 2006039-011.

Sample 2006039-011 – enlarged view of a brittlestar.

Sample 2006039-016.

Sample 2006039-017.

Starfish in sample 2006039-020



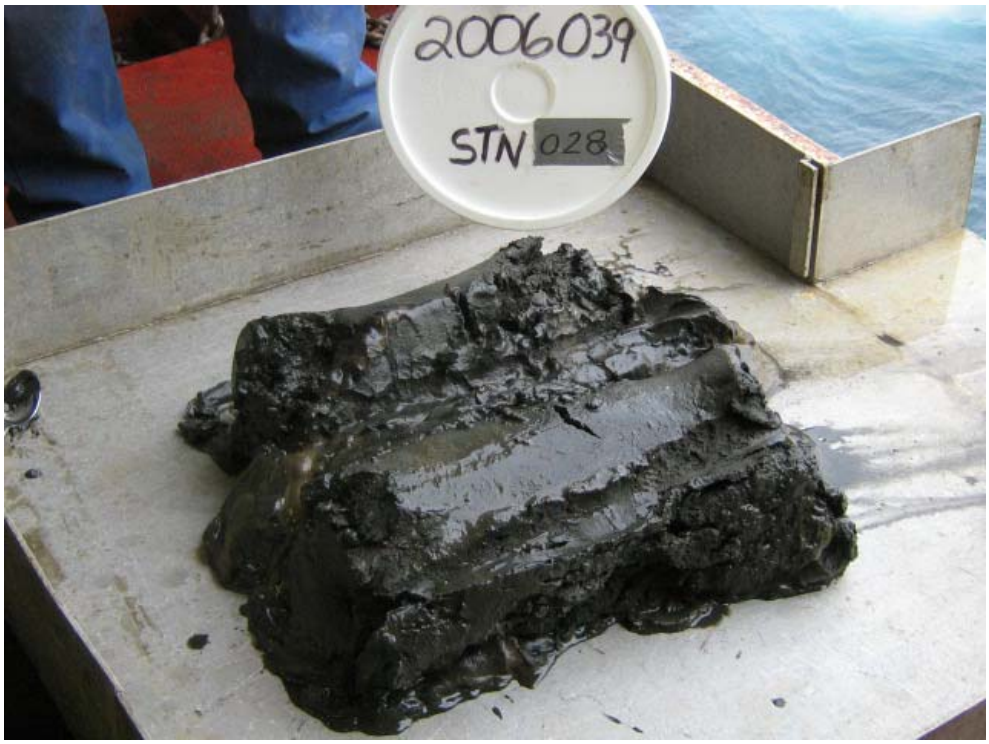
Sample 2006039-021.

Sample 2006039-022.

Sample 2006039-023.

Sample 2006039-024.

Sample 2006039-025.



Sample 2006039-028.

Sample 2006039-030.

Sample 2006039-030 - gravel clasts with attached biota.

Sample 2006039-030 - gravel clasts with attached biota.

Sample 2006039-033

Sample 2006039-037.

Sample 2006039-038.

Sample 2006039-041.

Sample 2006039-042.

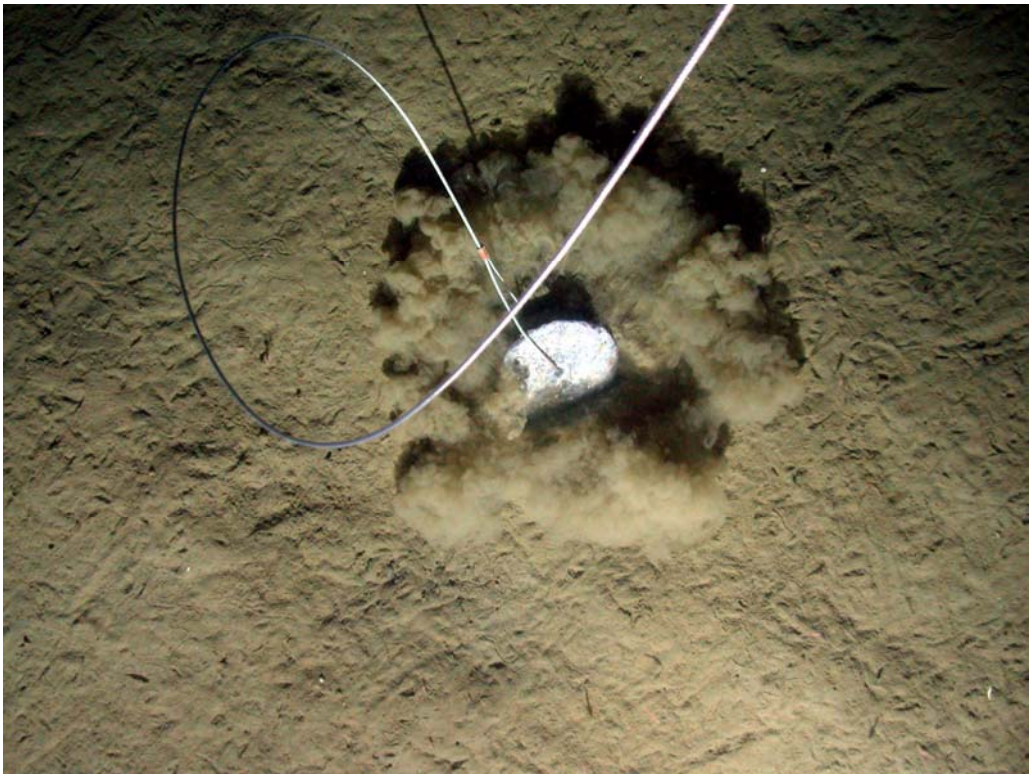
Sample 2006039-045.

Sample 2006039-046.

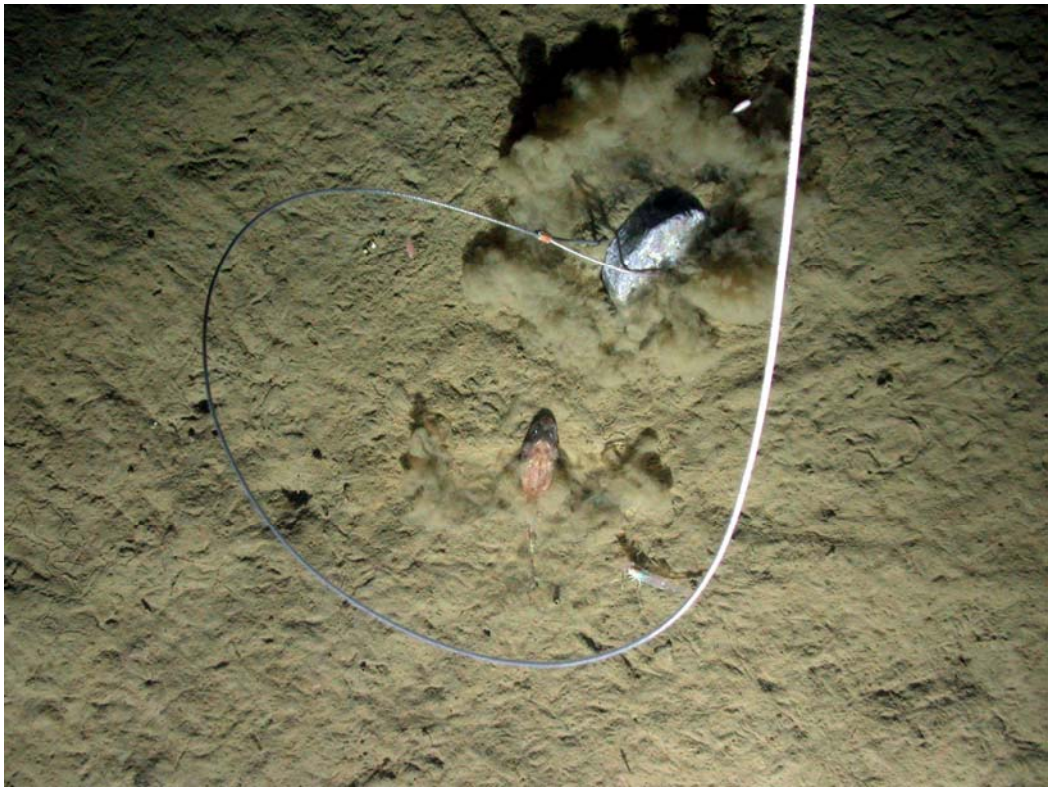
Appendix 4: Sea floor photographs

2006039-012-photo 1 A muddy sea floor heavily imprinted with animal tracks and burrows. A few shrimp can be seen. **Depth 243 m.**

2006039-012-photo 2 A muddy sea floor heavily imprinted with animal tracks and burrows. **Depth 243 m.**



2006039-012-photo 3 A muddy sea floor heavily imprinted with animal tracks and burrows. **Depth 242 m.**



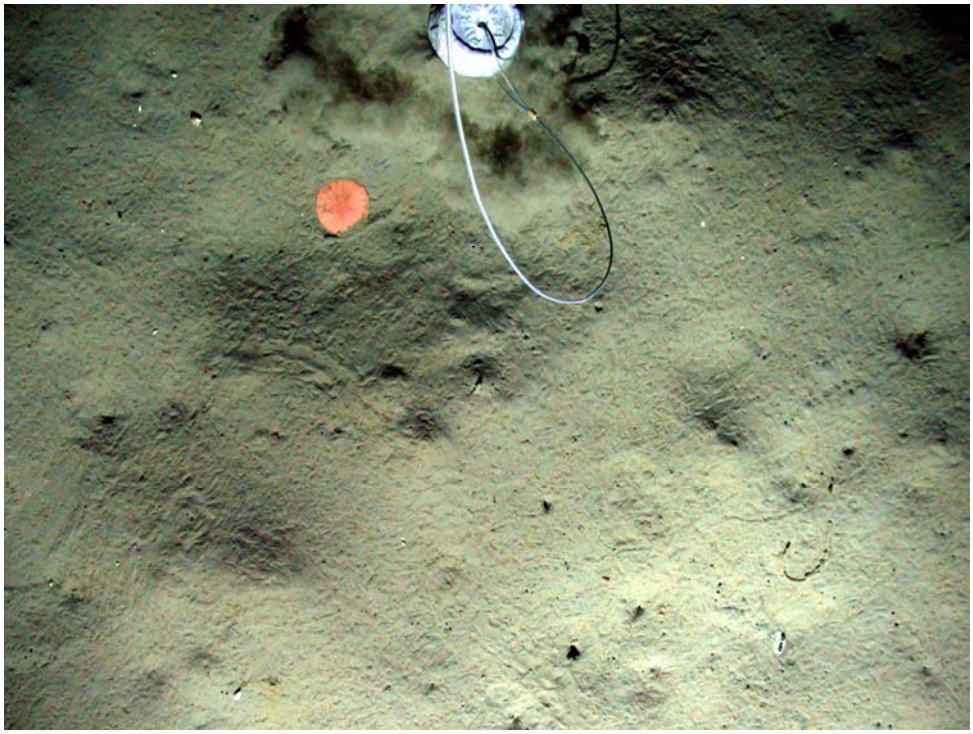
2006039-012-photo 4 A muddy sea floor heavily imprinted with animal tracks and burrows. Also showing a fish (sculpin?) and a large shrimp. **Depth 242 m.**

2006039-012-photo 5 A muddy sea floor heavily imprinted with animal tracks and burrows. **Depth 243 m.**

2006039-014-photo 1 Muddy fine sand imprinted with animal tracks and burrows. **Depth 188 m.**

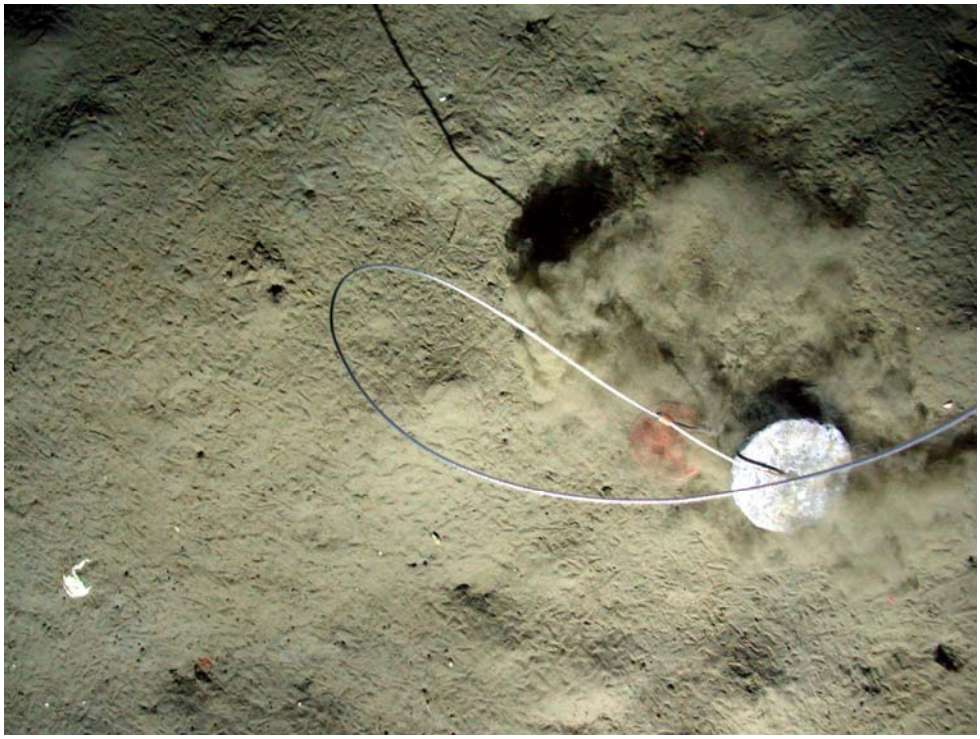
2006039-014-photo 2 Muddy fine sand animal tracks, burrows, sand dollar. **Depth 188 m.**

2006039-014-photo 3 Muddy fine sand, animal tracks, burrows, sand dollar, crabs, gastropod. **Depth 188 m.**



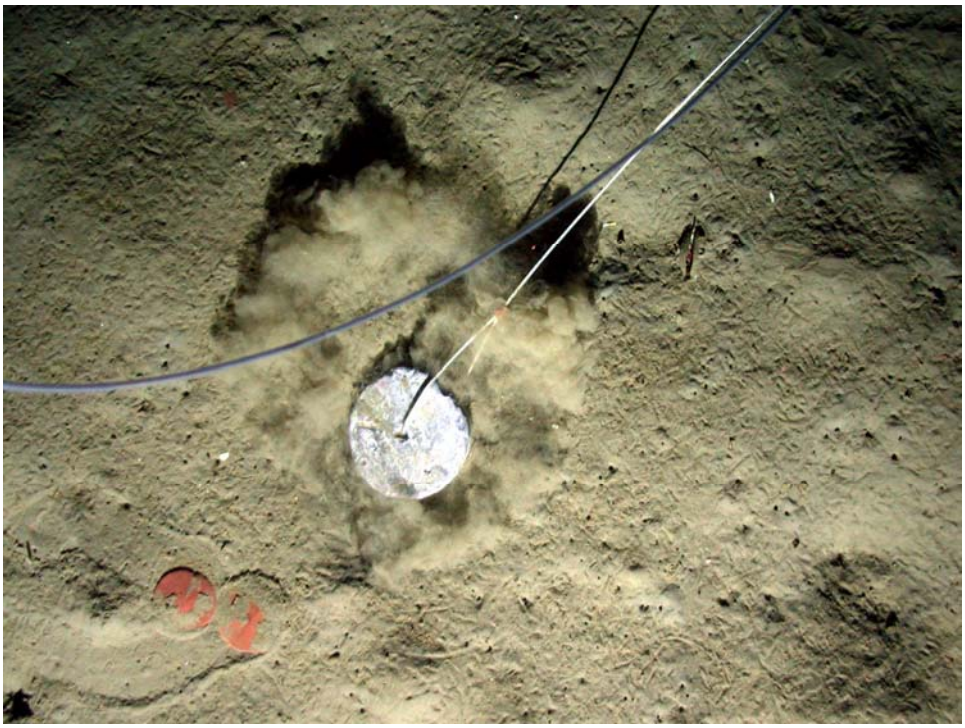
2006039-014-photo 4 Muddy fine sand, animal tracks, burrows, sand dollar. **Depth 187 m.**

2006039-014-photo 5 Muddy fine sand, animal tracks, burrows. **Depth 189 m.**



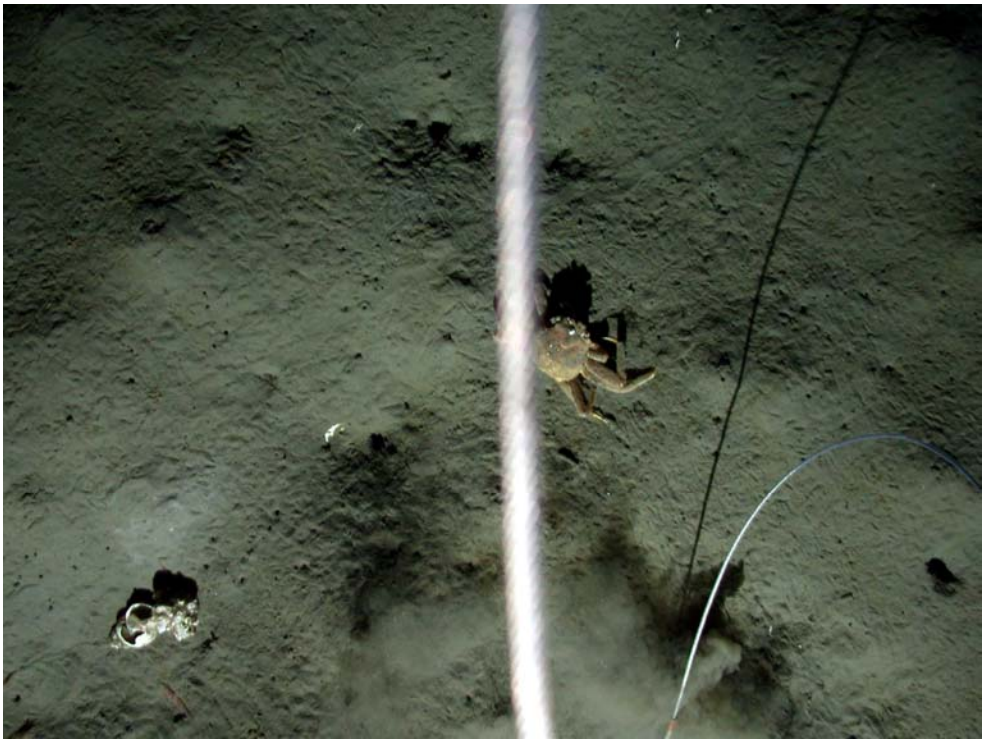
2006039-014-photo 6 Muddy fine sand, animal tracks, burrows, sand dollar.
Depth 188 m.

2006039-014-photo 7 Muddy fine sand, animal tracks, burrows, crabs, gastropod.
Depth 188 m.

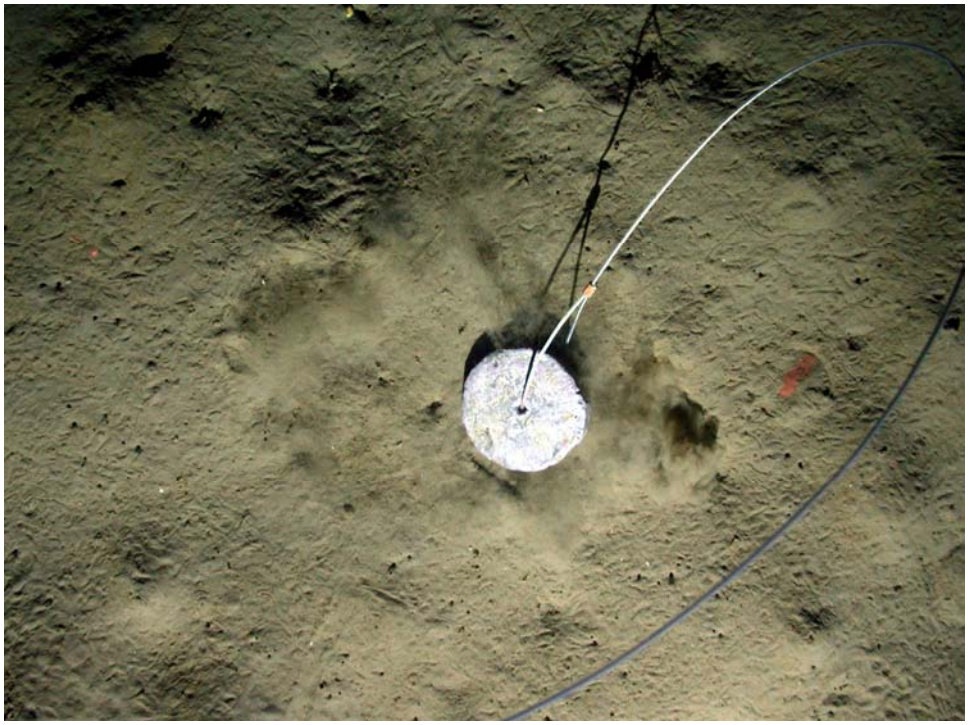


2006039-014-photo 8 Muddy fine sand, animal tracks, burrows, bivalve, sand dollars. **Depth 188 m.**

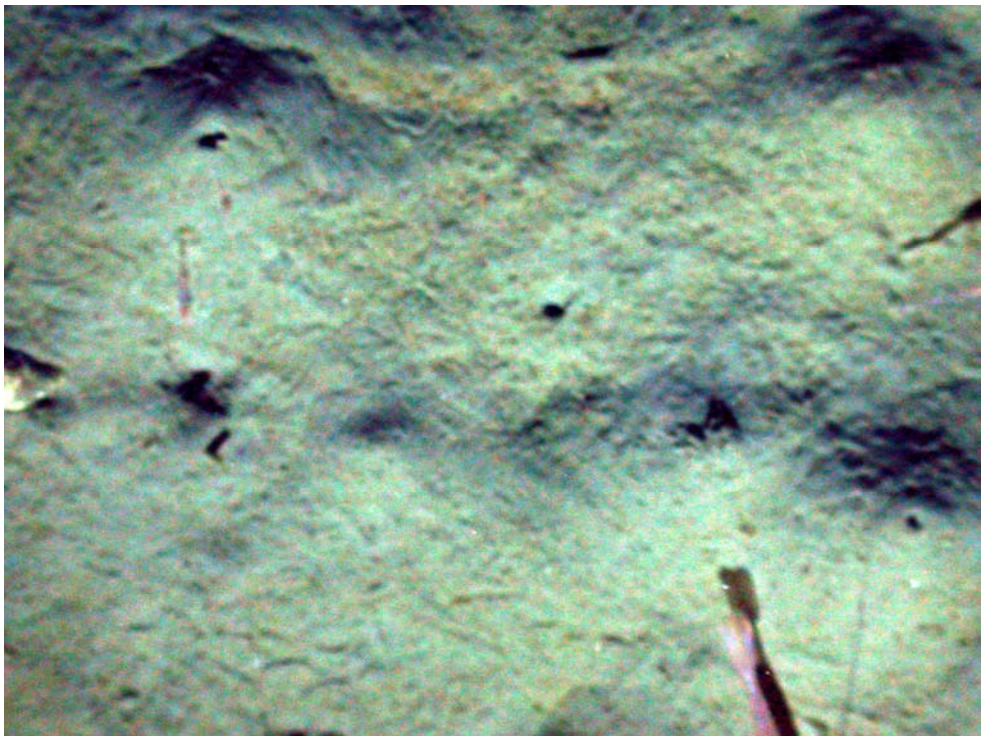
2006039-014-photo 9 Muddy fine sand, animal tracks, burrows, bivalve tubes. **Depth 186 m.**



2006039-014-photo 10 Muddy fine sand, animal tracks, burrows, crab.
Depth 189 m.



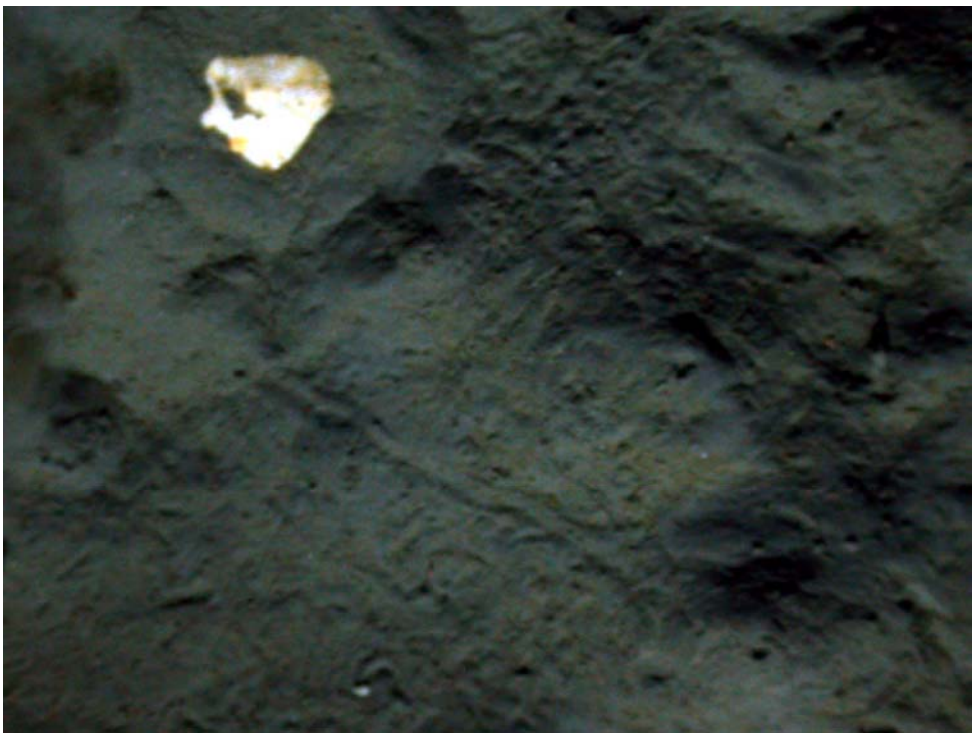
2006039-014-photo 11 Muddy fine sand, animal tracks, burrows, sand dollar.
Depth 189 m.



2006039-018-photo 1 Muddy fine sand, animal tracks, burrows. Photo out of focus. **Depth 199 m.**

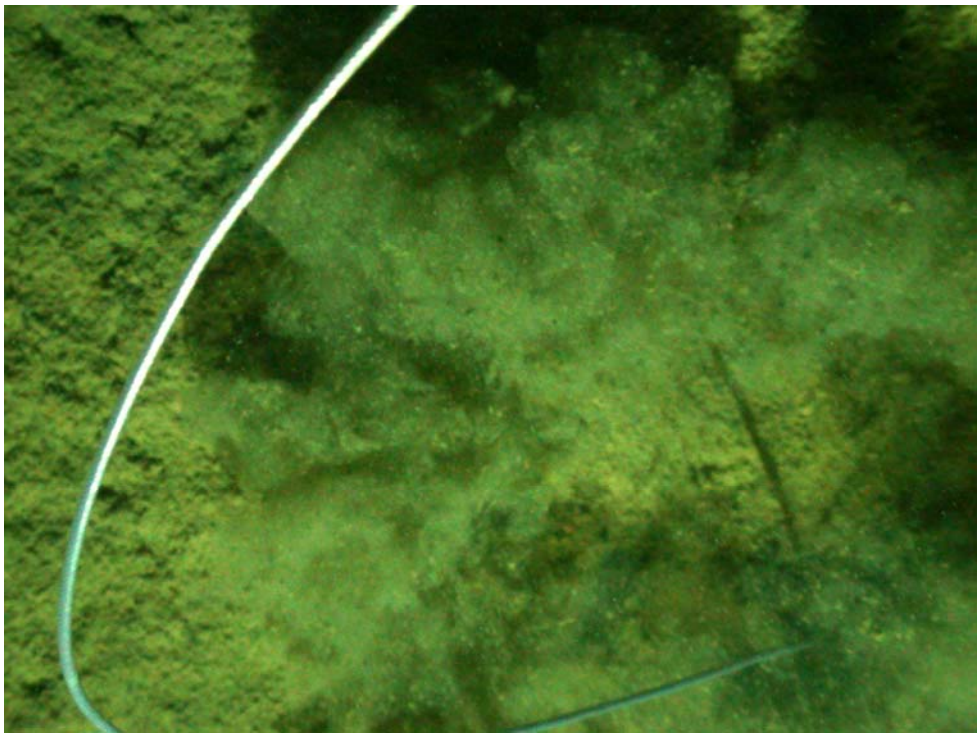
2006039-018-photo 2 Muddy fine sand – photo out of focus. **Depth 199 m.**

2006039-018-photo 3 Muddy fine sand – photo out of focus. **Depth 199 m.**

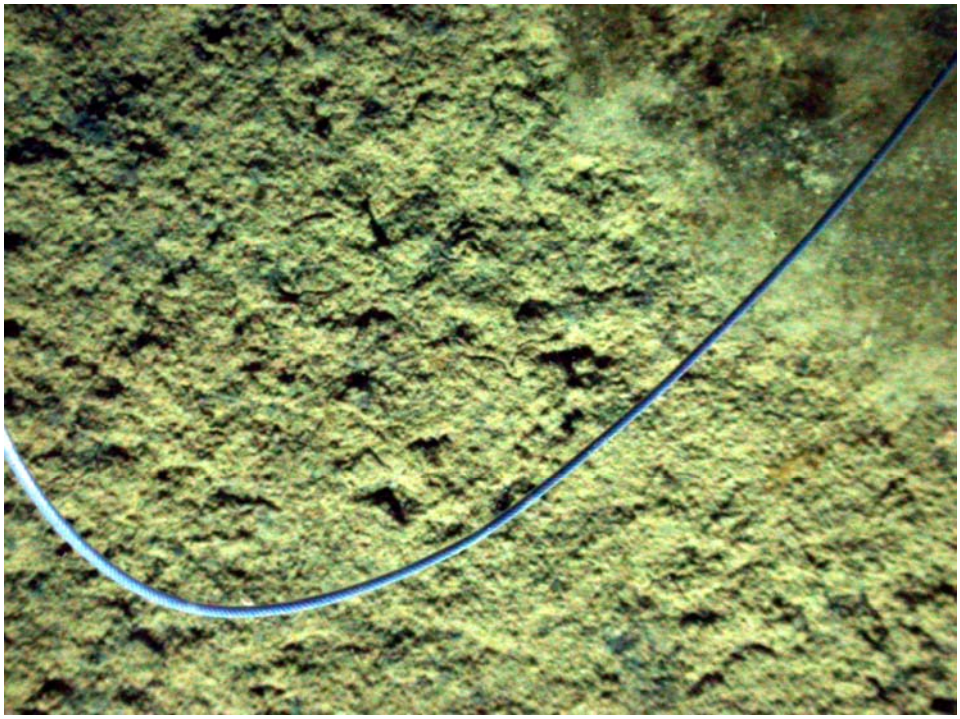


2006039-018-photo 4 Muddy fine sand , animal tracks – photo out of focus. **Depth 199 m.**

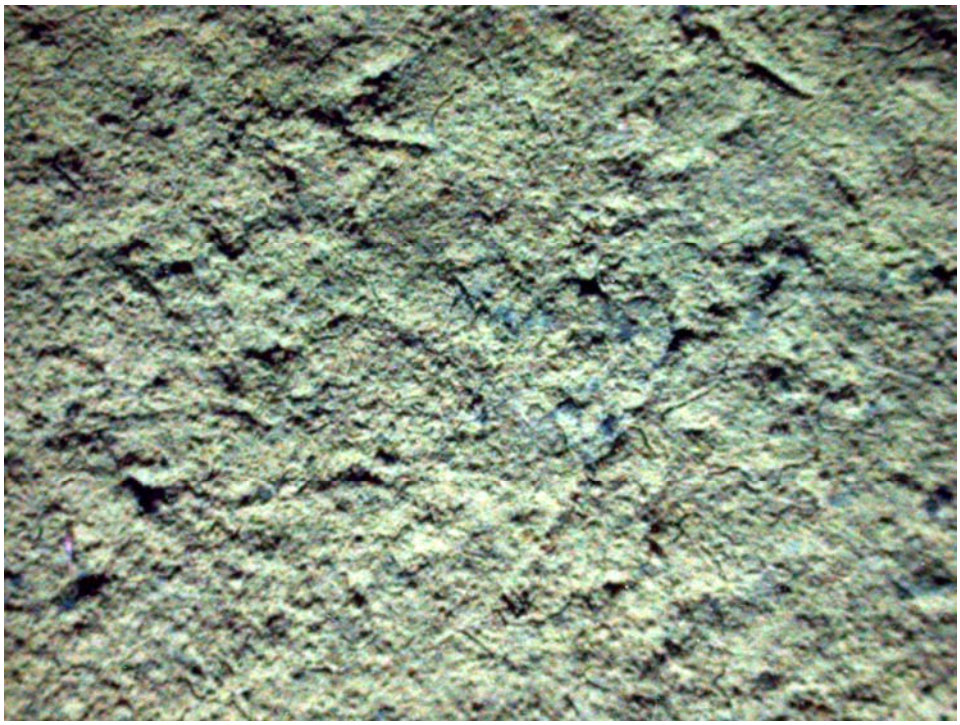
2006039-018-photo 5 Muddy fine sand, animal tracks, burrows – photo out of focus. **Depth 199 m.**



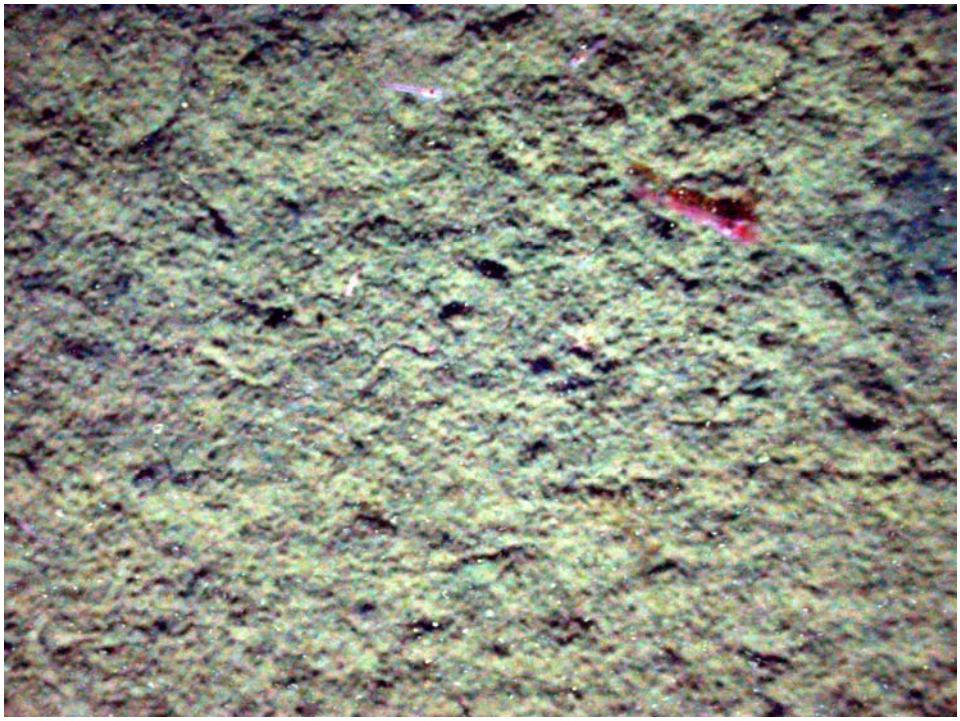
2006039-026-photo 1 Black pungent mud in the deeps of Eastern Channel. Camera malfunctioned – out of focus. **Depth 403 m.**



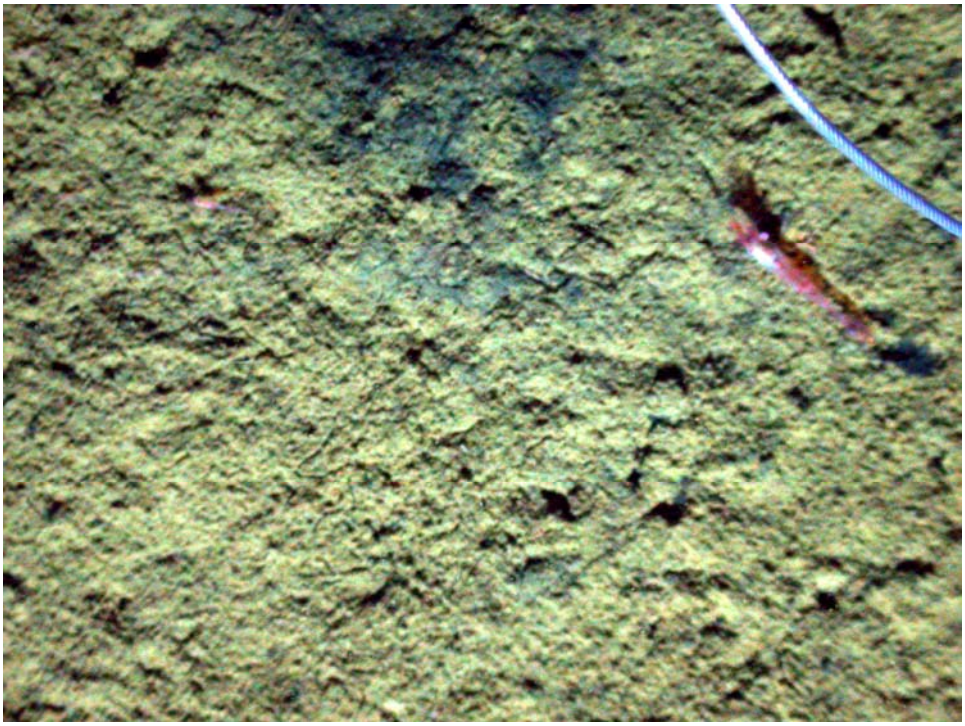
2006039-026-photo 2 Black pungent mud in the deeps of Western Channel. Camera malfunctioned – out of focus. Irregular surface- animal tracks.



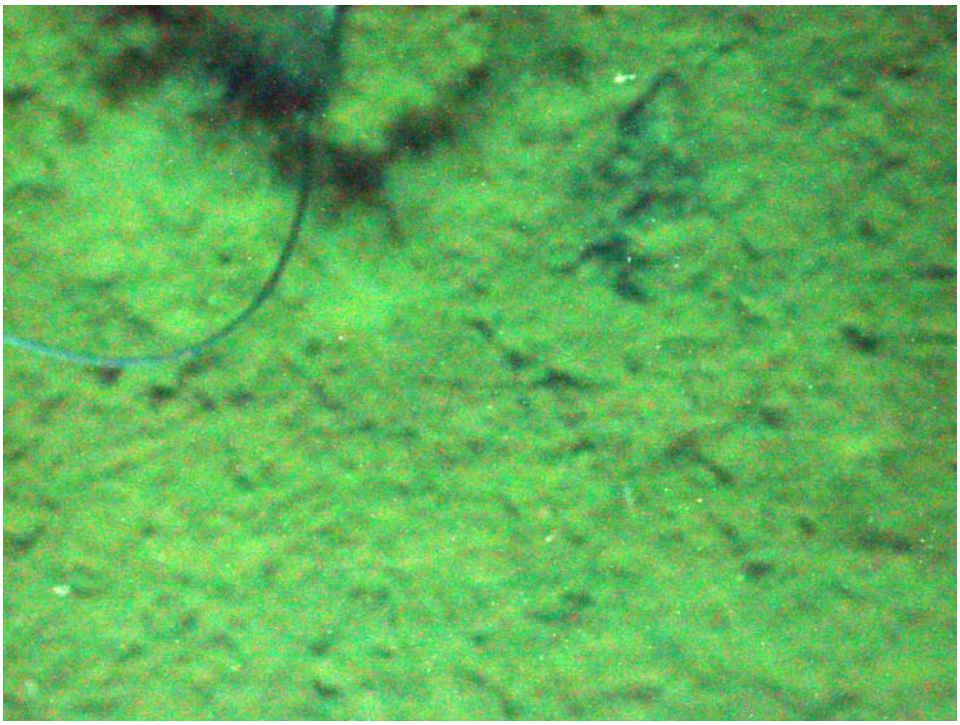
2006039-026-photo 3 Black pungent mud in the deeps of Western Channel. Camera malfunctioned – out of focus. Irregular surface- animal tracks.



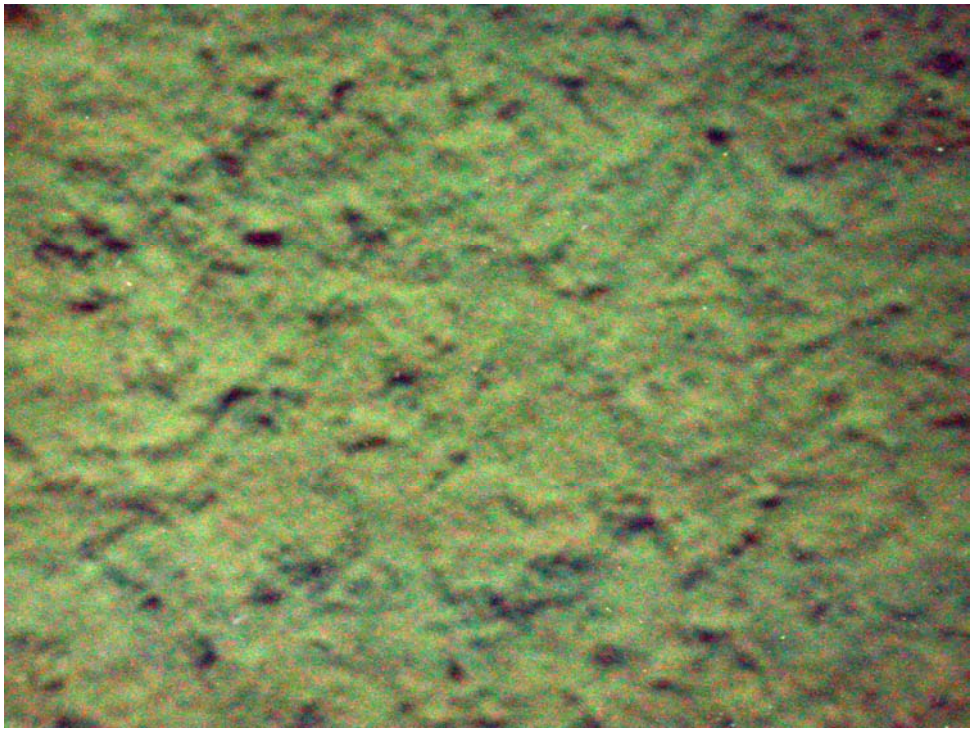
2006039-026-photo 4 Black pungent mud in the deeps of Western Channel. Camera malfunctioned – out of focus. Irregular surface- animal tracks.



2006039-026-photo 5 Black pungent mud in the deeps of Western Channel. Camera malfunctioned – out of focus. Irregular surface- animal tracks. Blue colouration in places may indicate anoxia.

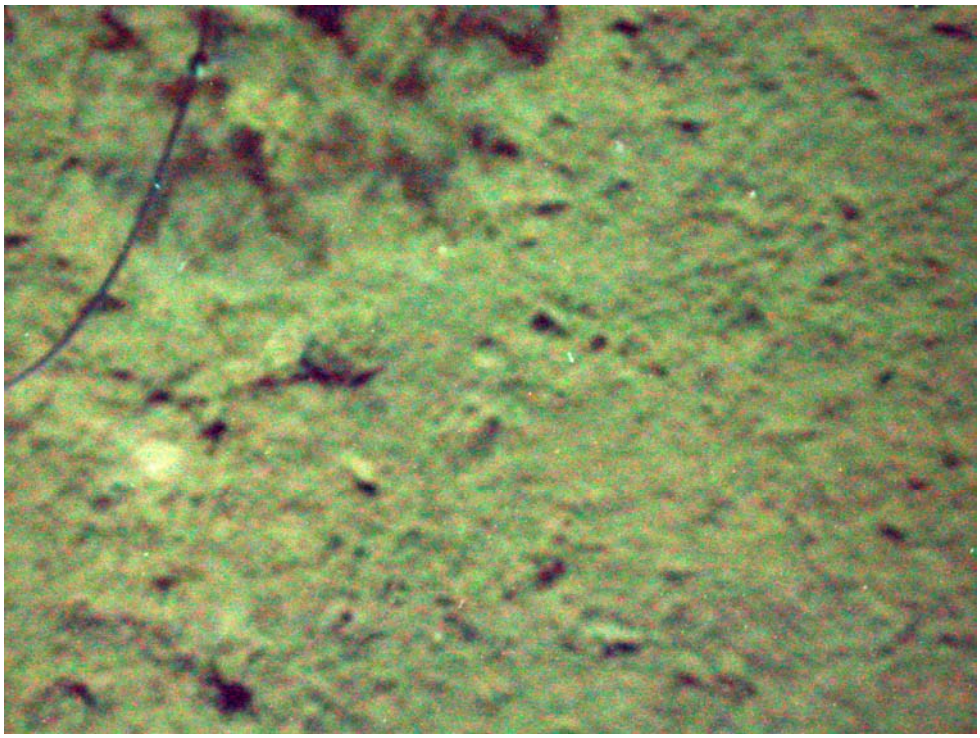


2006039-034-photo 1 Silty mud, Eastern Channel. Camera malfunctioned – out of focus. Irregular surface with animal tracks.

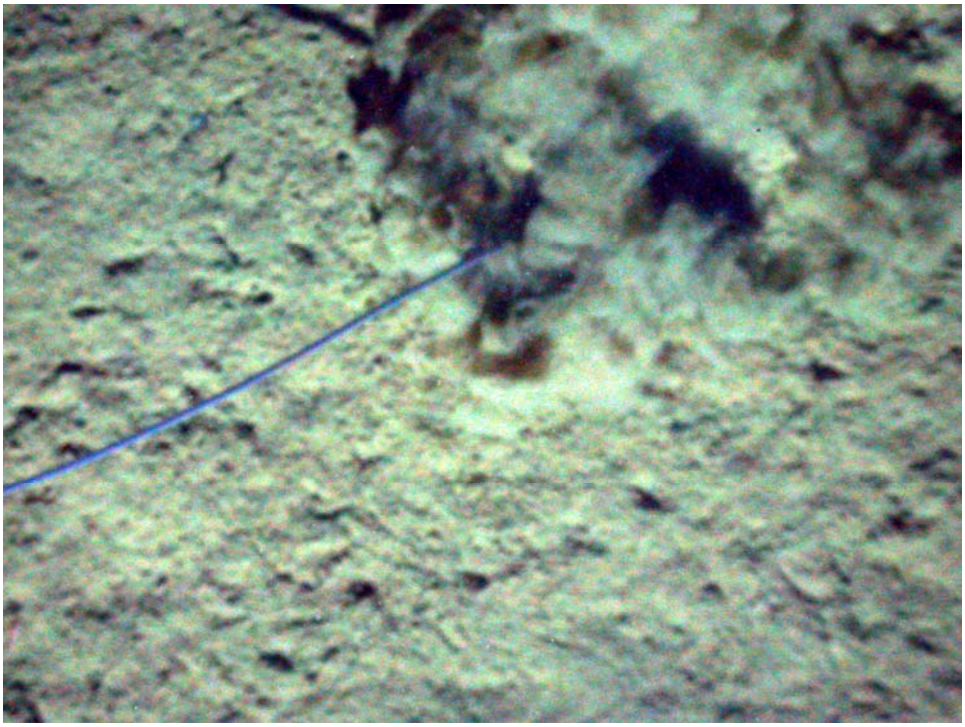


2006039-034-photo 2 Silty mud, Eastern Channel. Camera malfunctioned – out of focus. Irregular surface with animal tracks.

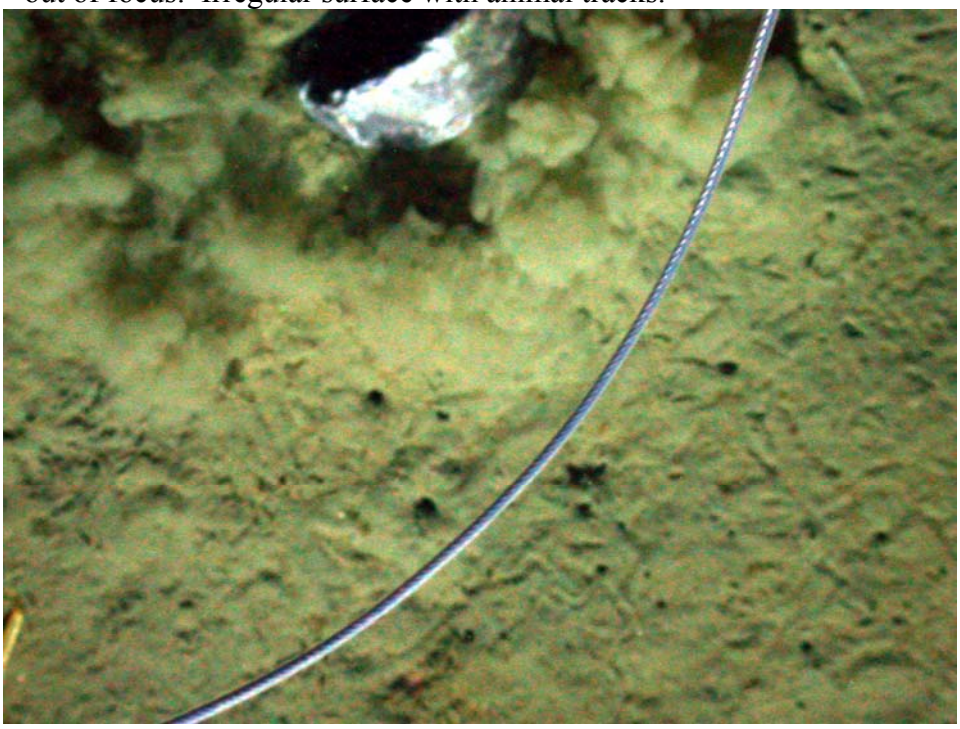
2006039-034-photo 3 Silty mud, Eastern Channel. Camera malfunctioned – out of focus. Irregular surface with animal tracks.



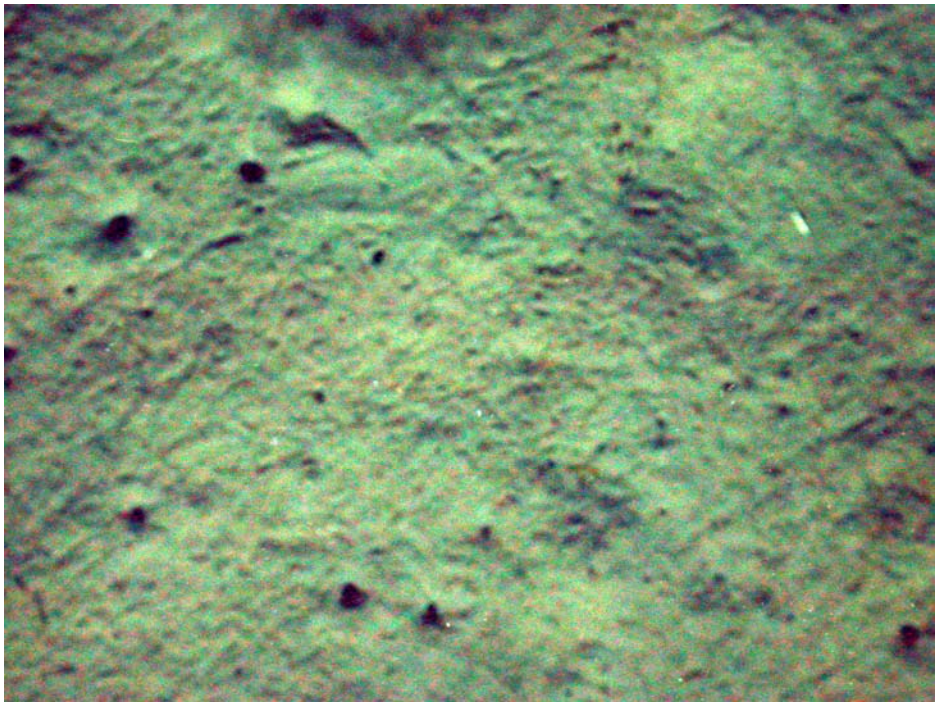
2006039-034-photo 4 Silty mud, Eastern Channel. Camera malfunctioned – out of focus. Irregular surface with animal tracks.



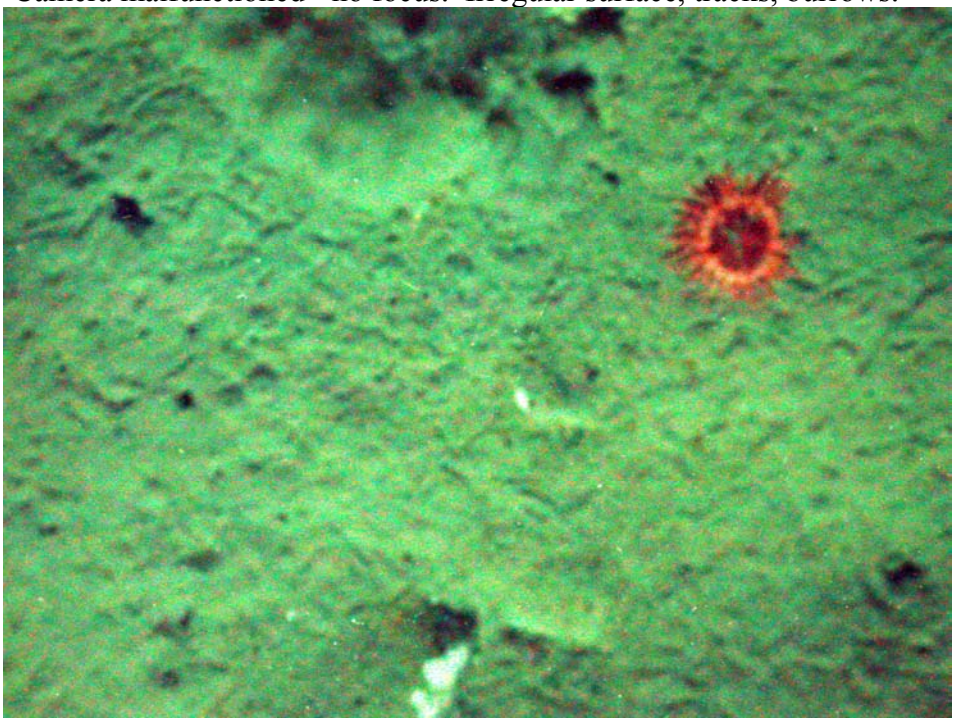
2006039-034-photo 5 Silty mud, Eastern Channel. Camera malfunctioned – out of focus. Irregular surface with animal tracks.



2006039-036-photo 1 Muddy fine sand on high-backscatter ridge. Camera malfunctioned, no focus. Irregular surface, animal tracks, burrows.

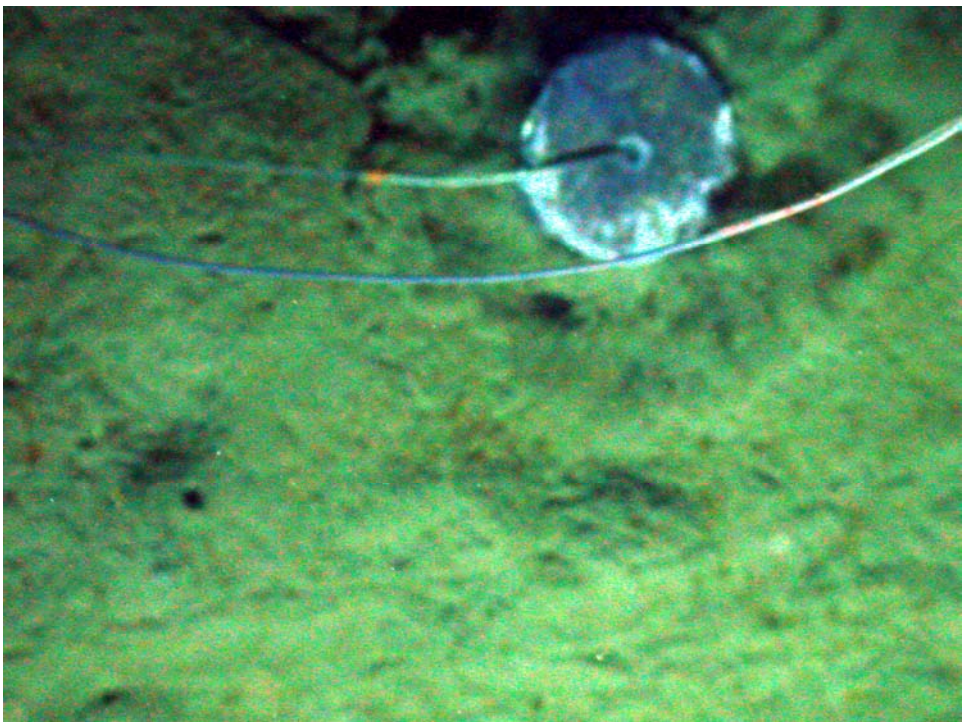


2006039-036-photo 2 Muddy fine sand on high-backscatter ridge. Camera malfunctioned - no focus. Irregular surface, tracks, burrows.

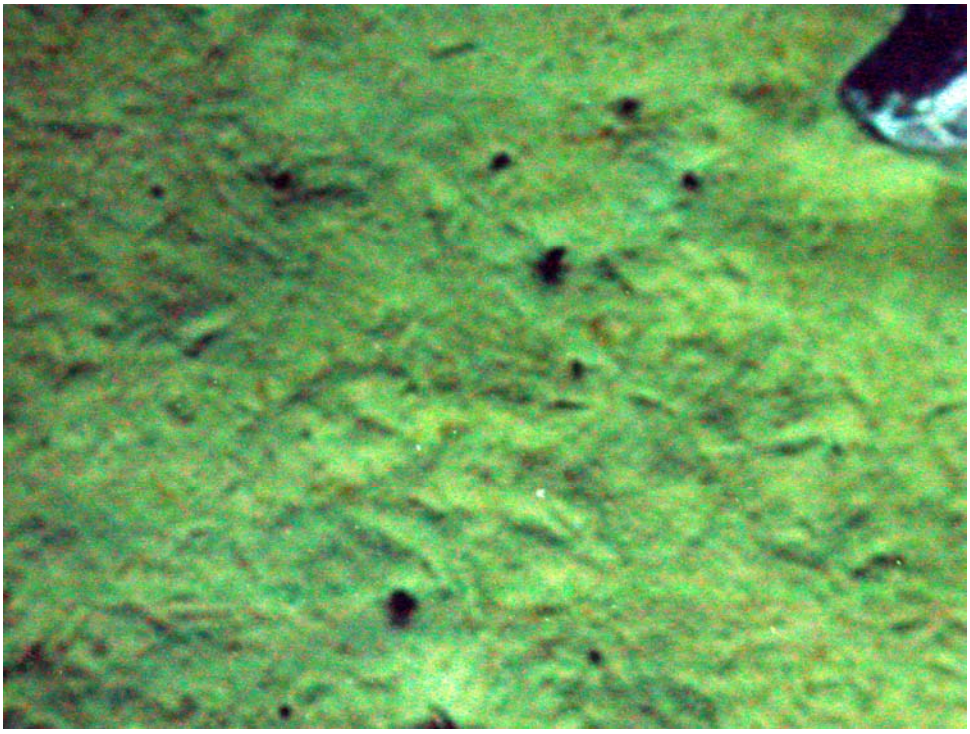


2006039-036-photo 3 Muddy fine sand on high-backscatter ridge. Camera malfunctioned - no focus. Animal tracks, anemone - probably attached to a gravel clast, burrows.

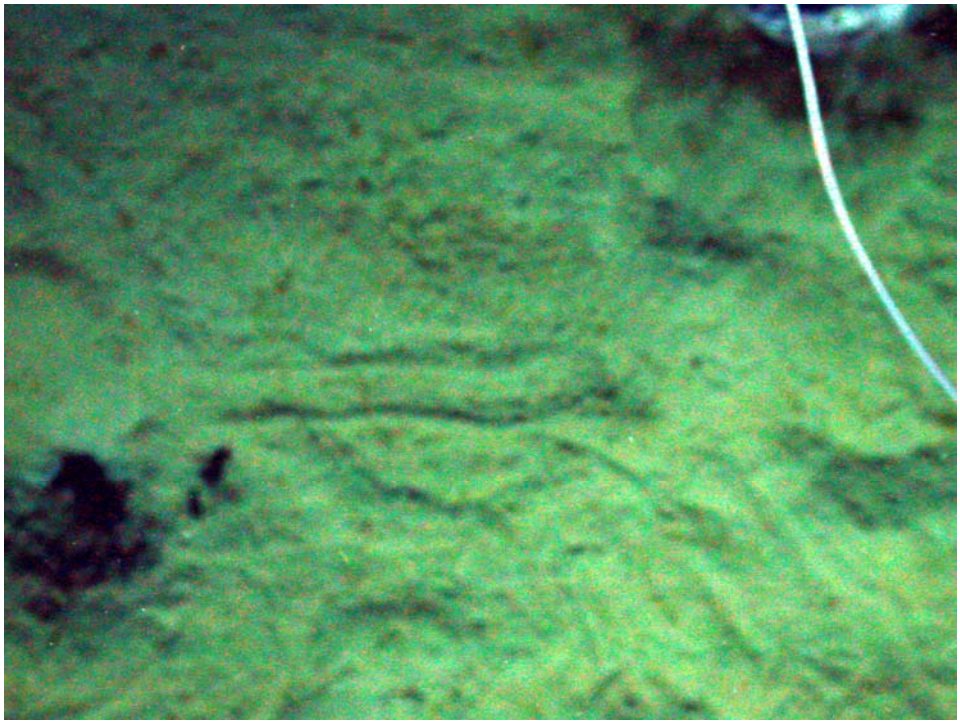
2006039-036-photo 4 Muddy fine sand on high-backscatter ridge. Camera didn't focus. Animal tracks, sea urchin, gravel clasts, burrows.



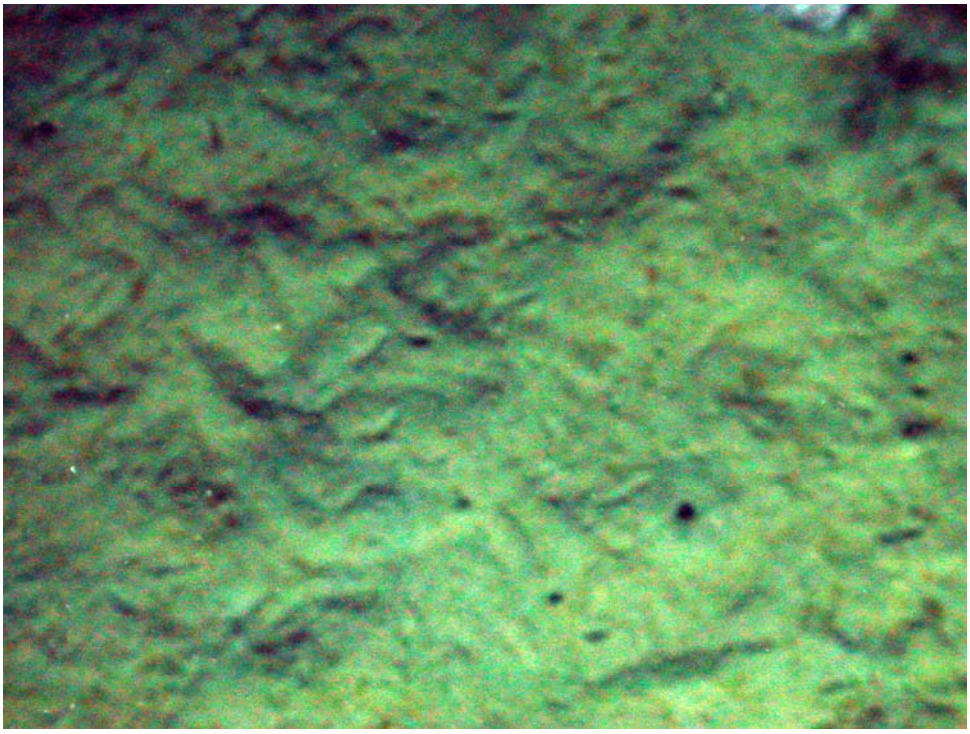
2006039-039-photo 1 Muddy fine sand. Camera malfunctioned - no focus. Animal tracks, burrows.



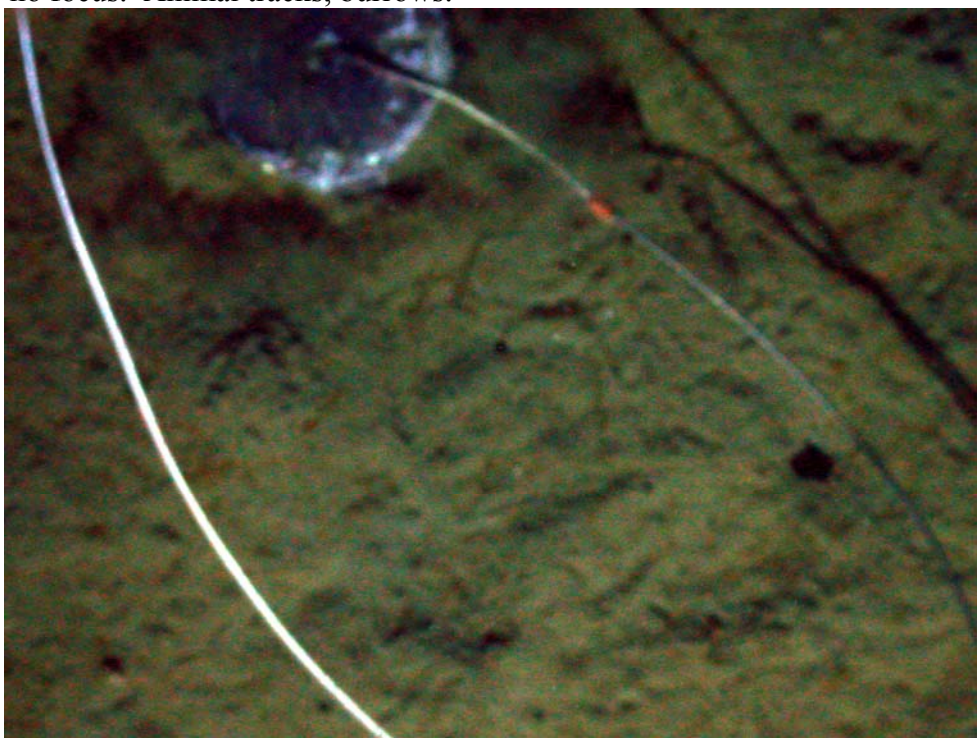
2006039-039-photo 2 Muddy fine sand. Camera malfunctioned - no focus. Animal tracks, burrows.



2006039-039-photo 3 Muddy fine sand. Camera malfunctioned - no focus. Animal tracks.



2006039-039-photo 4 Muddy fine sand. Camera malfunctioned - no focus. Animal tracks, burrows.



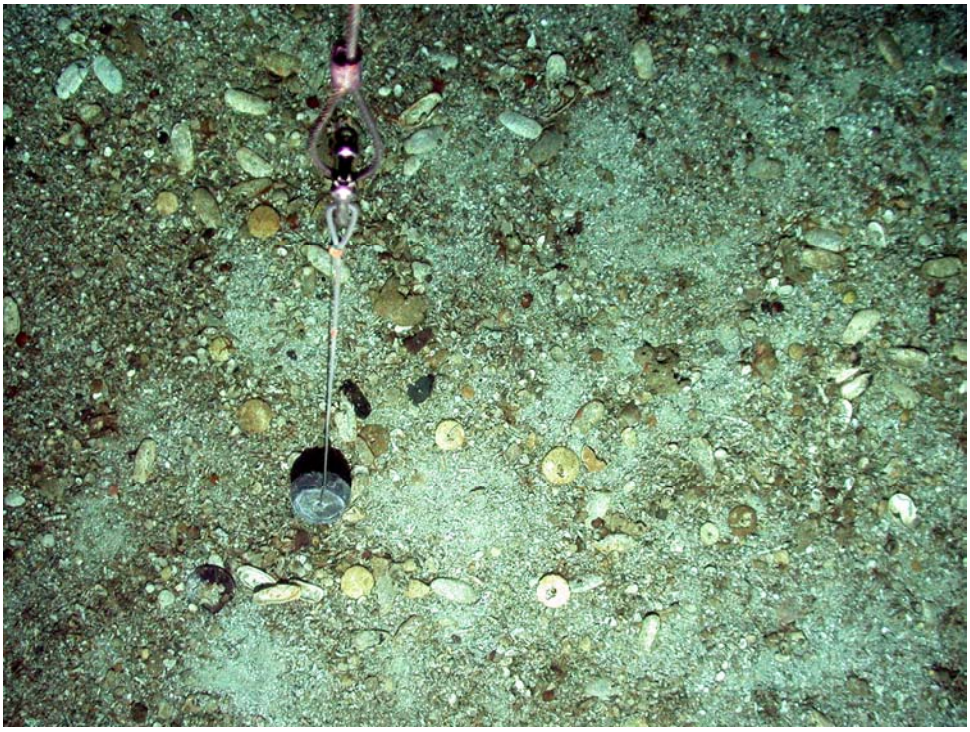
2006039-039-photo 5 Muddy fine sand. Camera malfunctioned - no focus. Animal tracks.

2006039-044-photo 1 Gravelly shelly sand. Photo overexposed. Much shelly debris at sea floor, including scallop shells.

2006039-044-photo 2 Gravelly shelly sand. Photo overexposed. Much shelly debris at sea floor, including scallop shells.

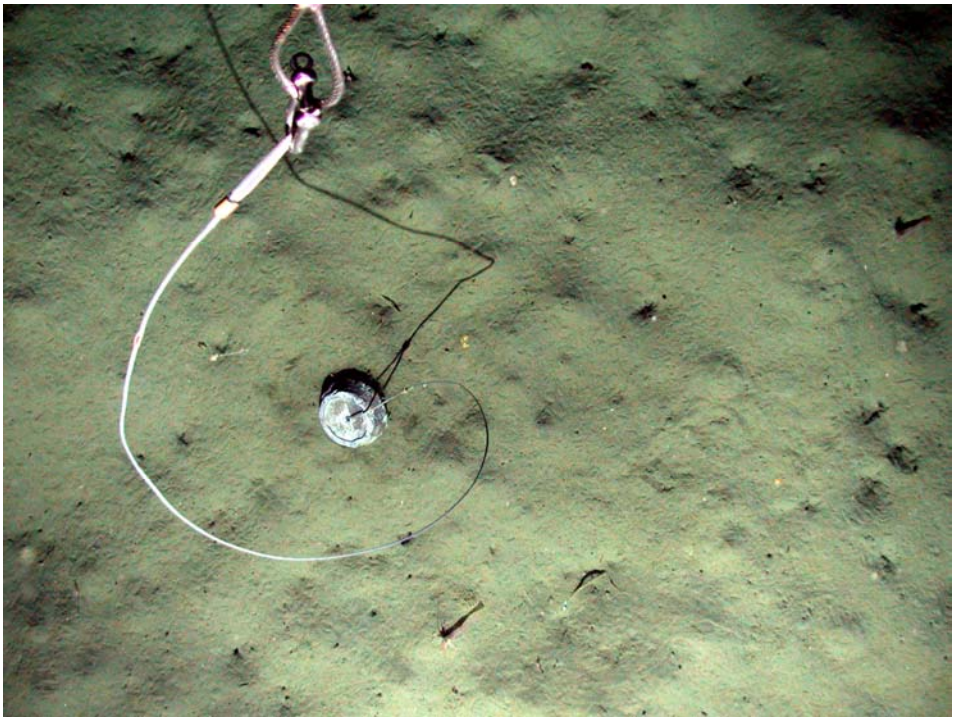
2006039-044-photo 3 Gravelly shelly sand. Photo overexposed. Much shelly debris at sea floor, including scallop shells.

2006039-044-photo 4 Gravelly shelly sand. Photo overexposed. Gravel ripples - coarse shelly debris in troughs.



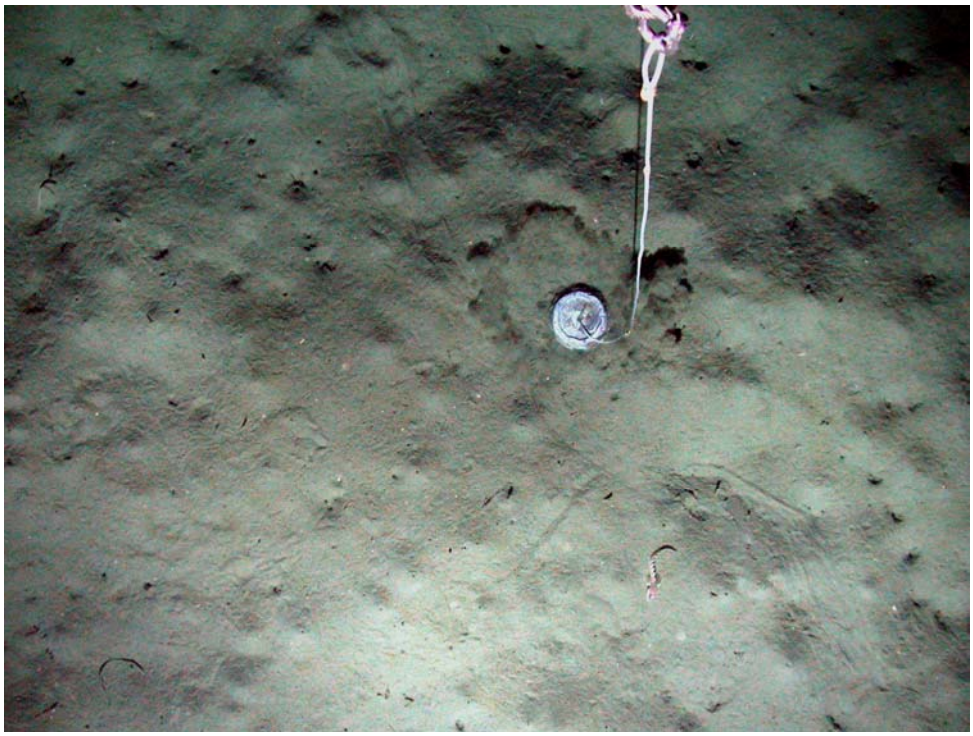
2006039-044-photo 5 Gravelly shelly sand. Photo overexposed.

2006039-047-photo 1 Muddy fine sand, burrows and mounds, sculpin? crab, small starfish leaving track. Inside megaflute.

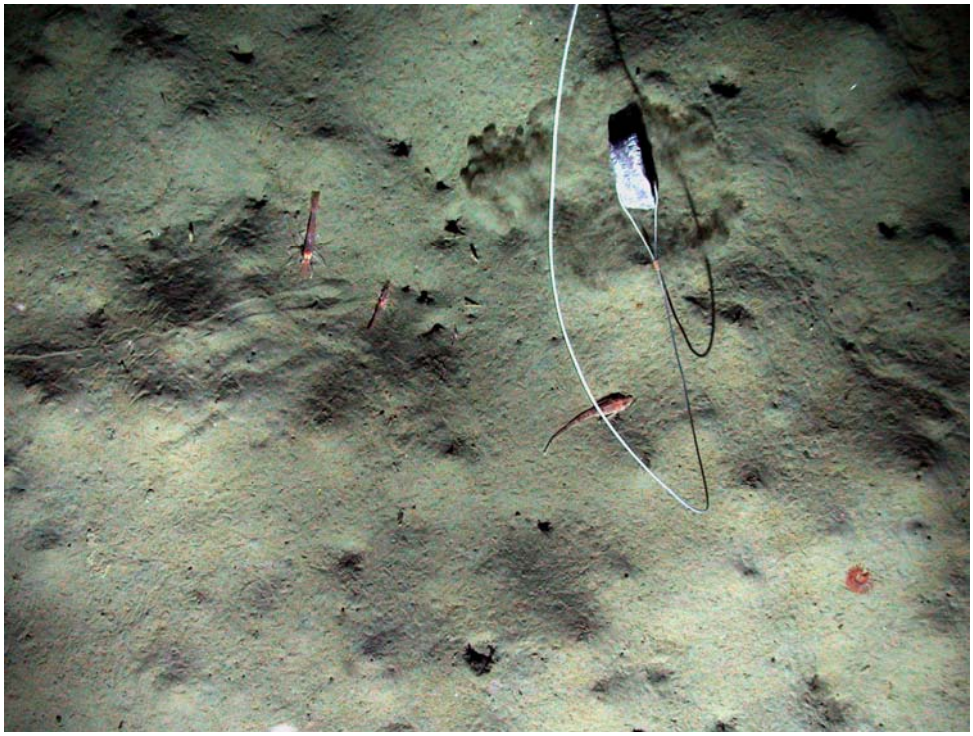


2006039-047-photo 2 Muddy fine sand, burrows and mounds, shrimps, crab. Inside megaflute.

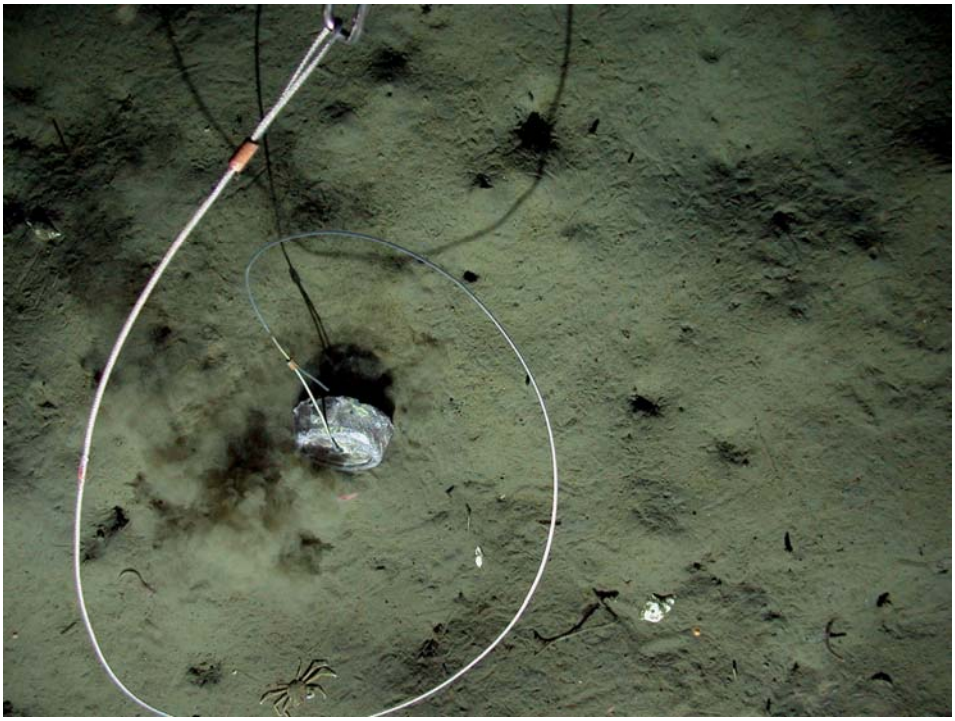
2006039-047-photo 3 Muddy fine sand, burrows and mounds, dead gastropod. Inside megaflute.



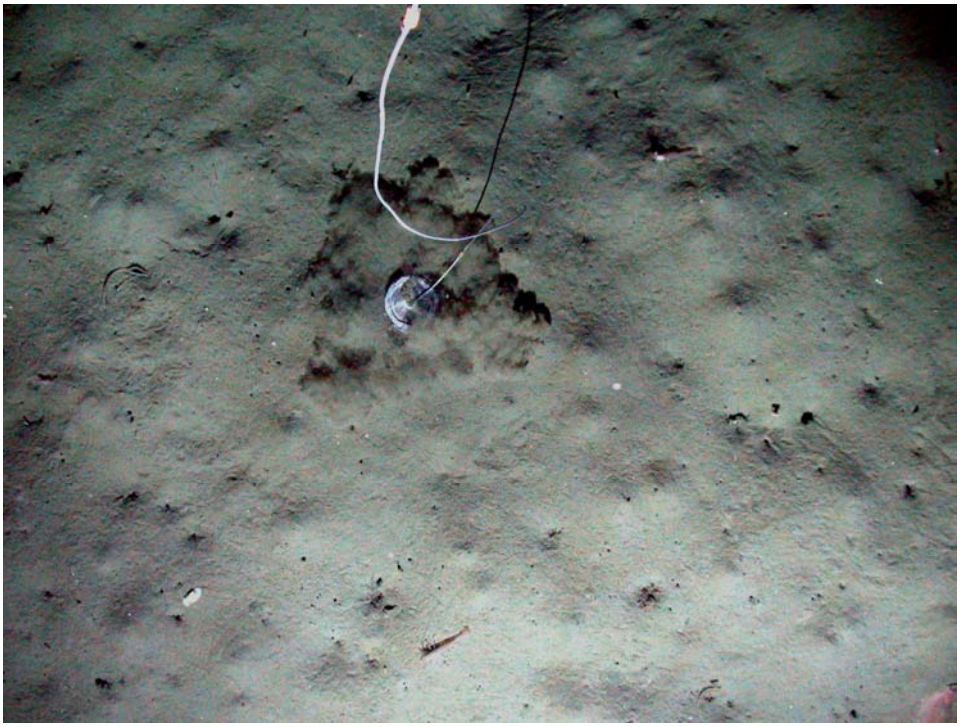
2006039-047-photo 4 Muddy fine sand, burrows and mounds, small sculpin Inside megaflute.



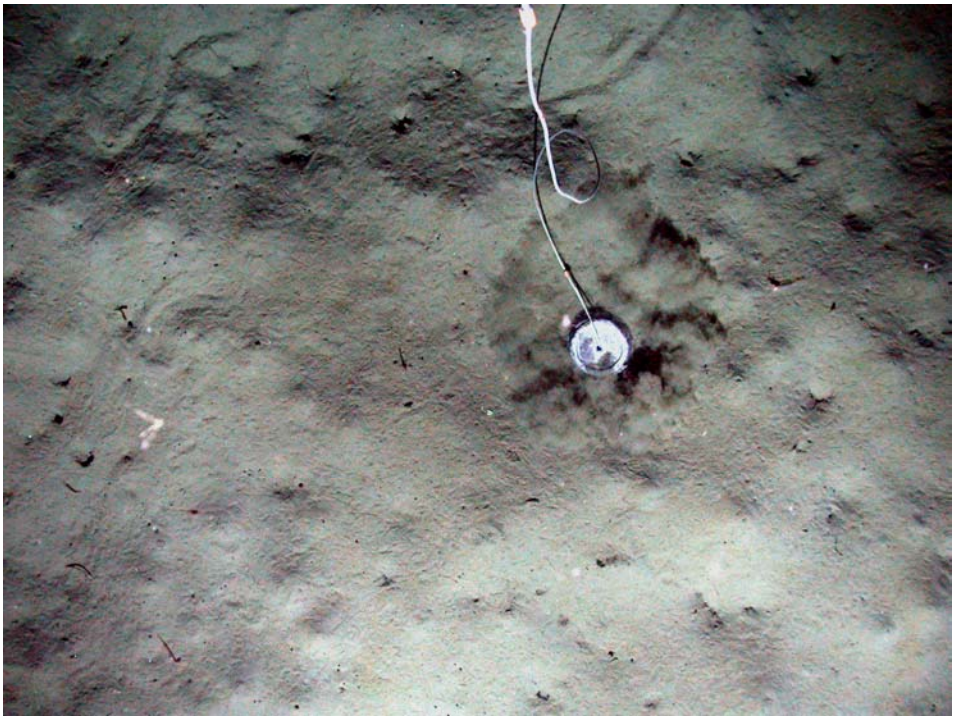
2006039-047-photo 5 Muddy fine sand, burrows and mounds, shrimps, small fish, anemone. Inside megaflute.



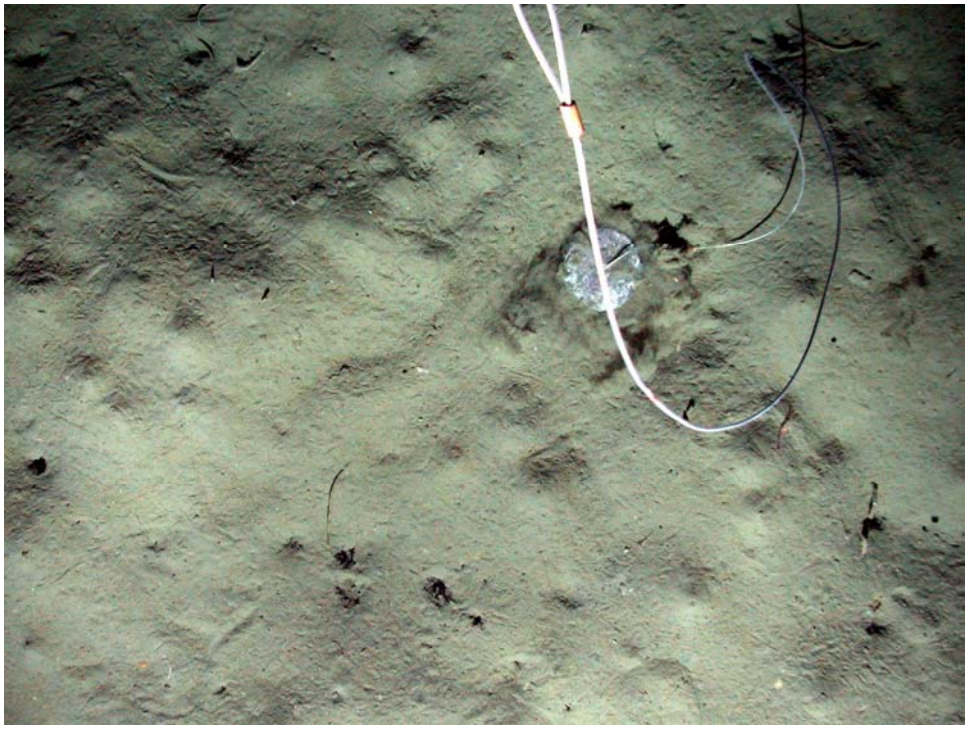
2006039-047-photo 6 Muddy fine sand, burrows and mounds, gastropods, crab. Inside megaflute.



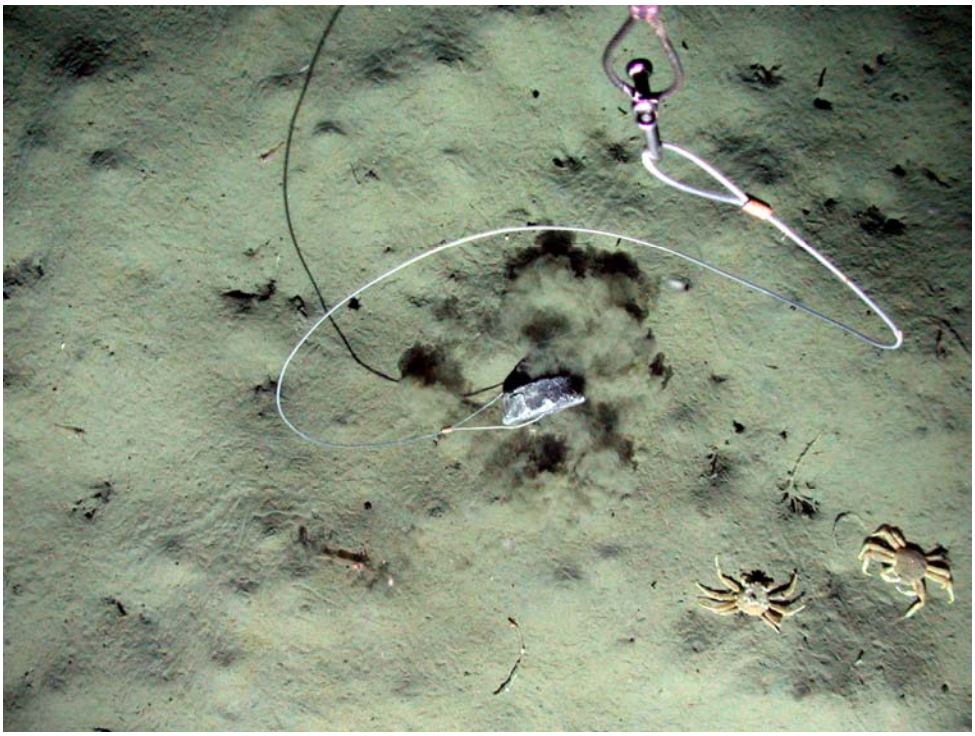
2006039-047-photo 7 Muddy fine sand, burrows and mounds, shrimps. Inside megaflute.



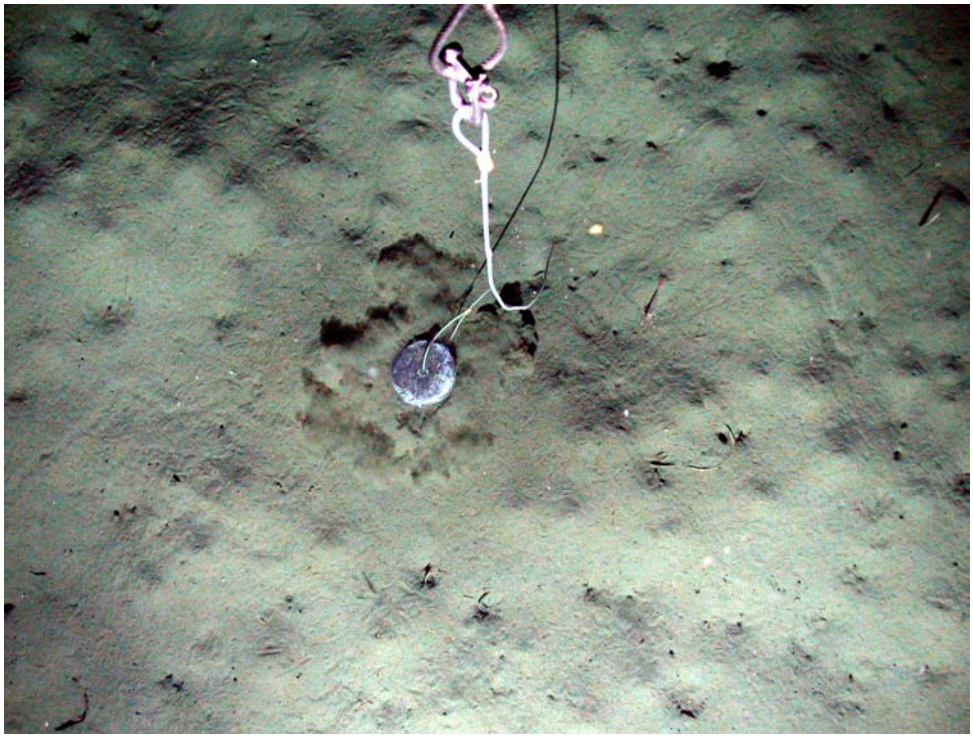
2006039-047-photo 8 Muddy fine sand, burrows and mounds. Inside megaflute.



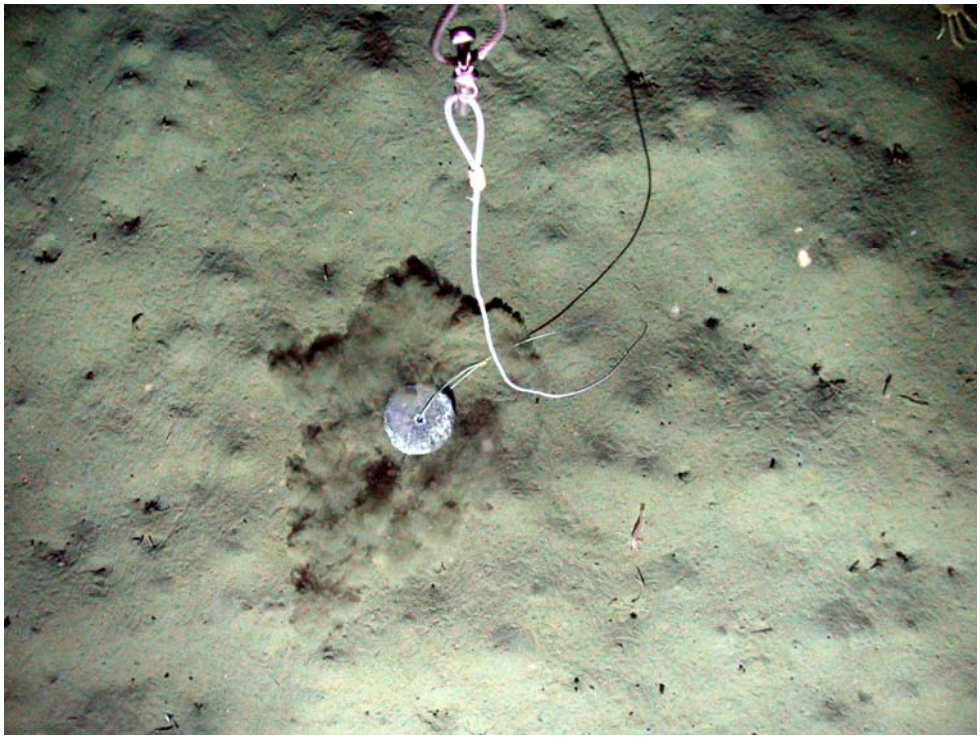
2006039-047-photo 9 Muddy fine sand, burrows and mounds. Inside megaflute.



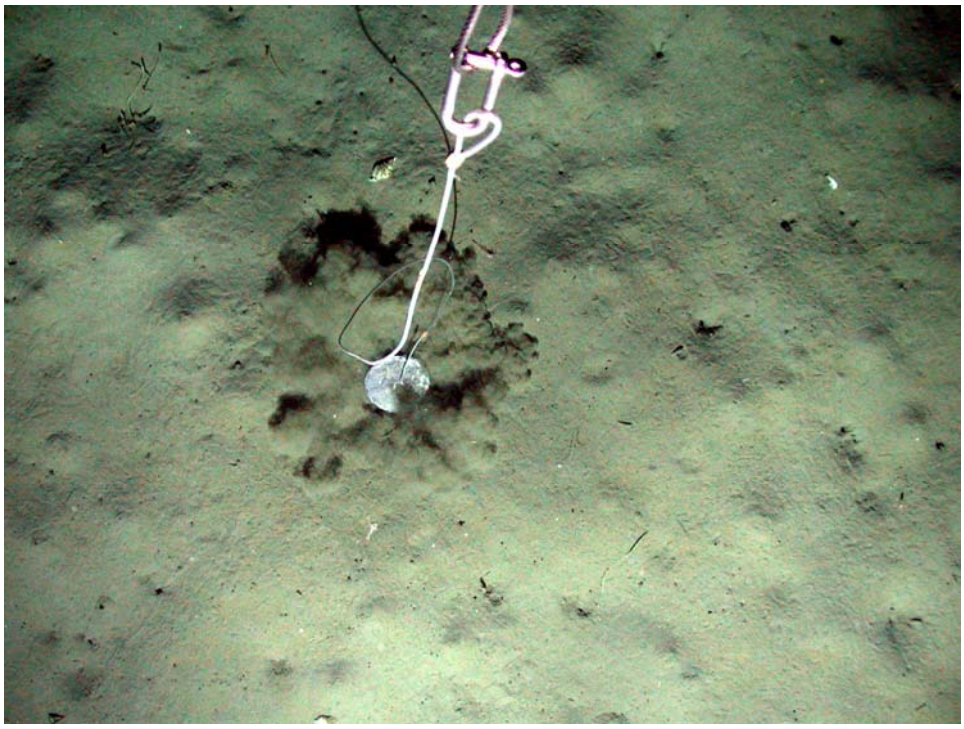
2006039-047-photo 10 Muddy fine sand, burrows and mounds, shrimp, crab. Inside megaflute.



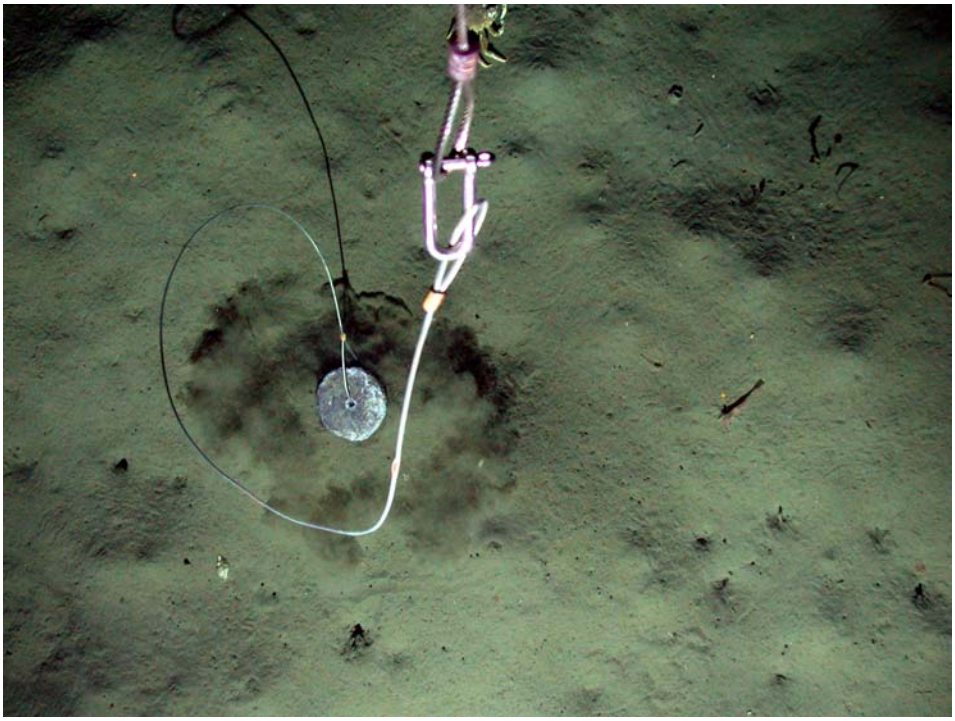
2006039-047-photo 11 Muddy fine sand, burrows and mounds, shrimp. Inside megaflute.



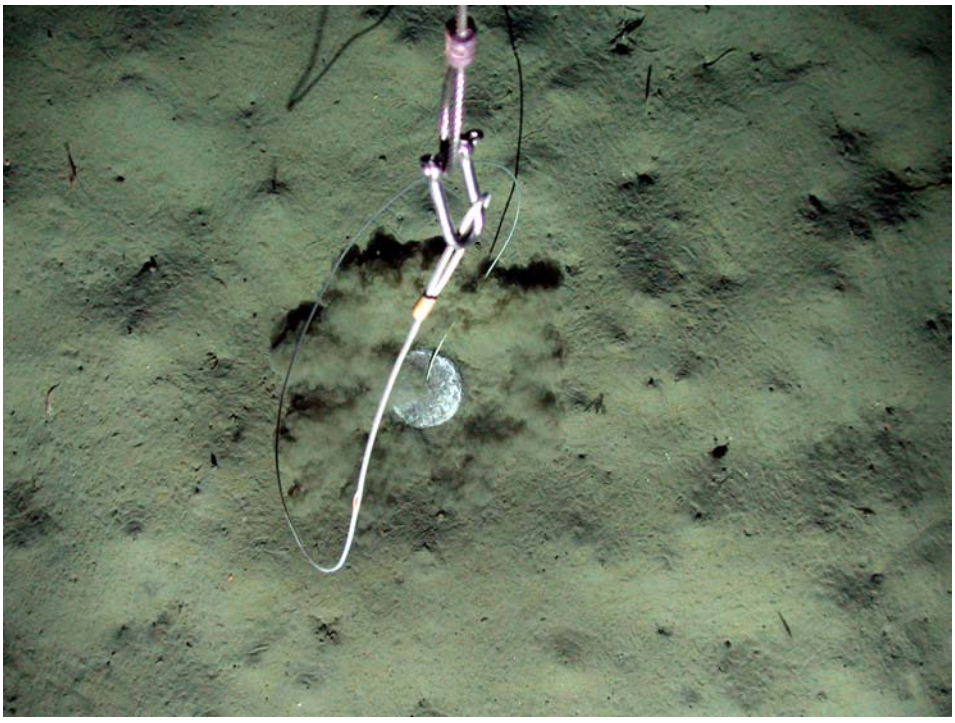
2006039-047-photo 12 Muddy fine sand, burrows and mounds, shrimps. Inside megaflute.



2006039-047-photo 13 Muddy fine sand, burrows and mounds, gastropod. Inside megaflute.

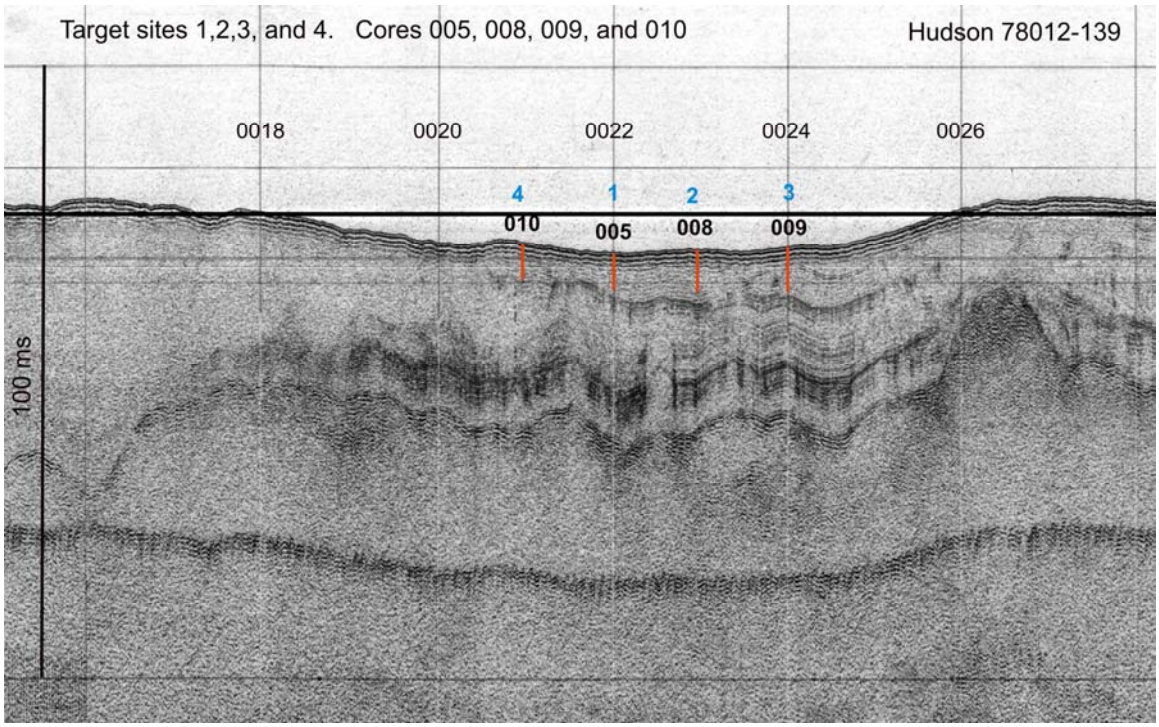


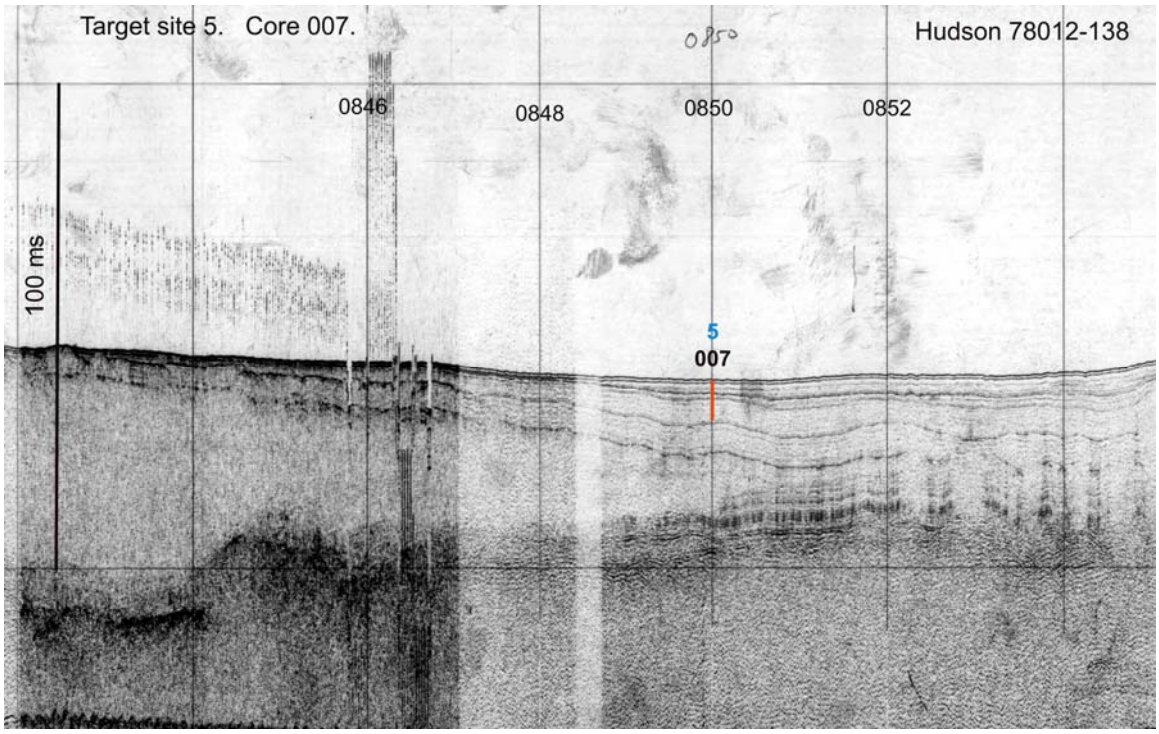
2006039-047-photo 14 Muddy fine sand, burrows and mounds, shrimp, gastropod. Inside megaflute.

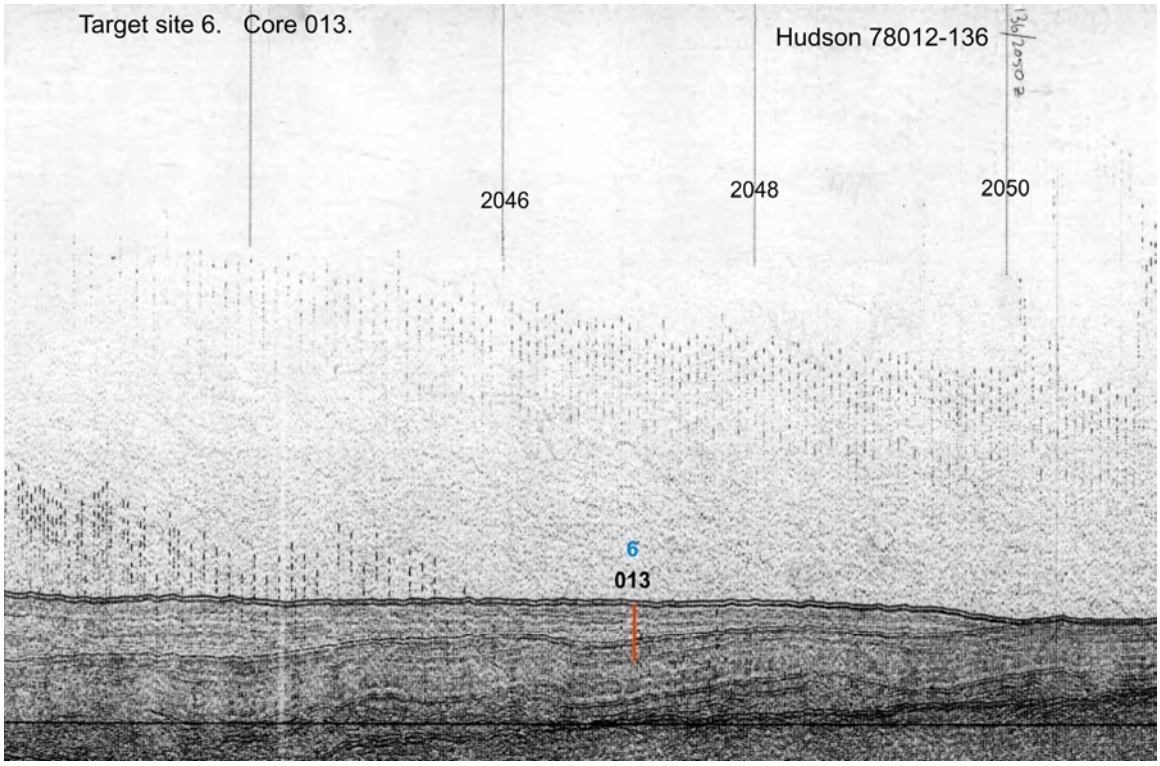


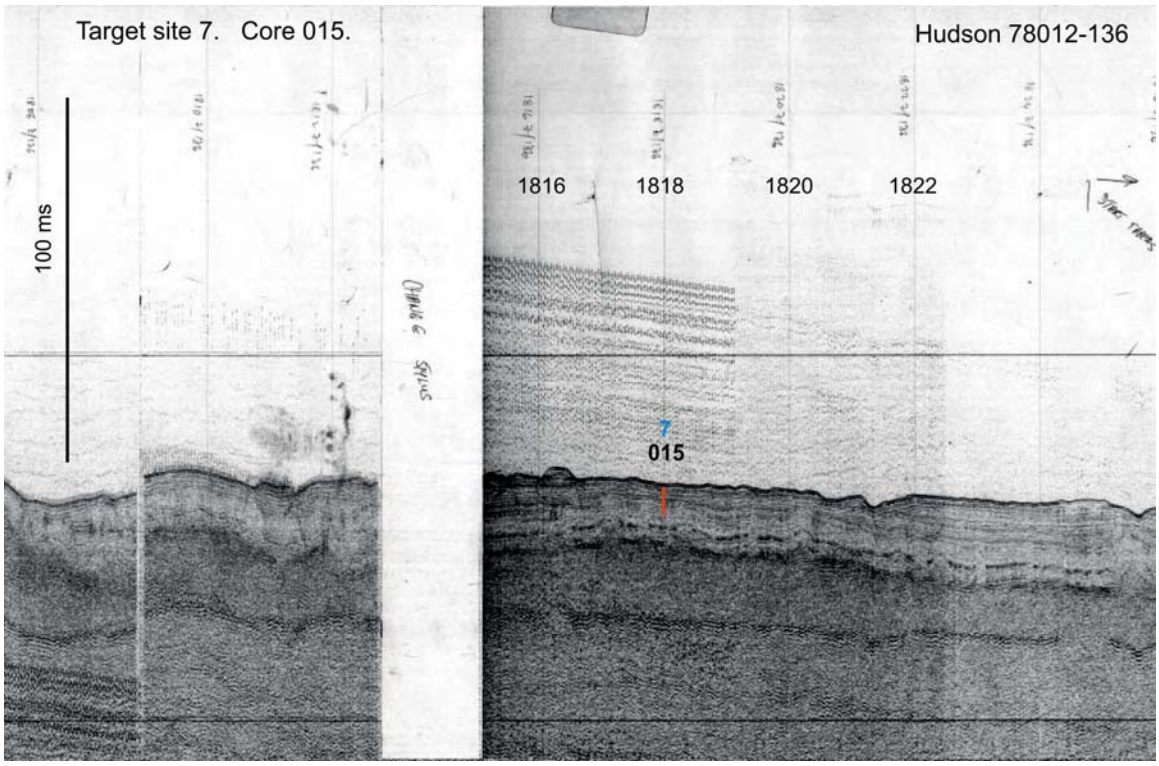
2006039-047-photo 15 Muddy fine sand, burrows and mounds, shrimp. Inside megaflute.

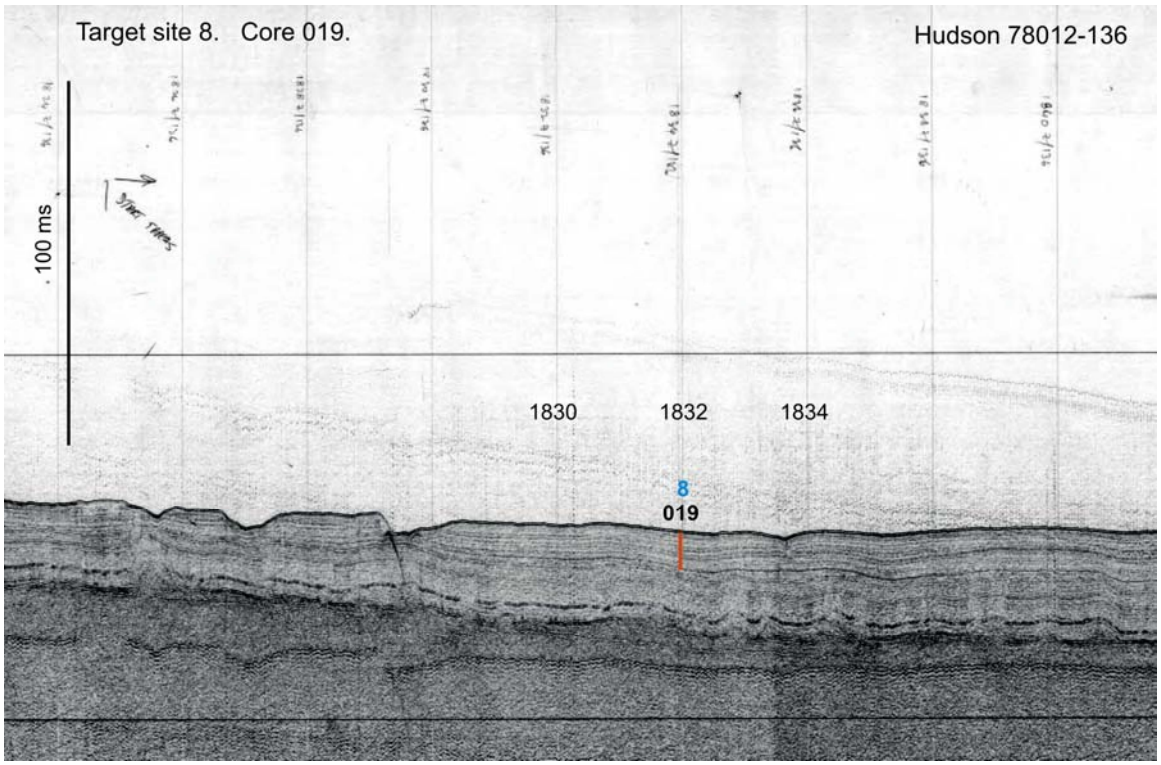
Appendix 5: Seismic targets

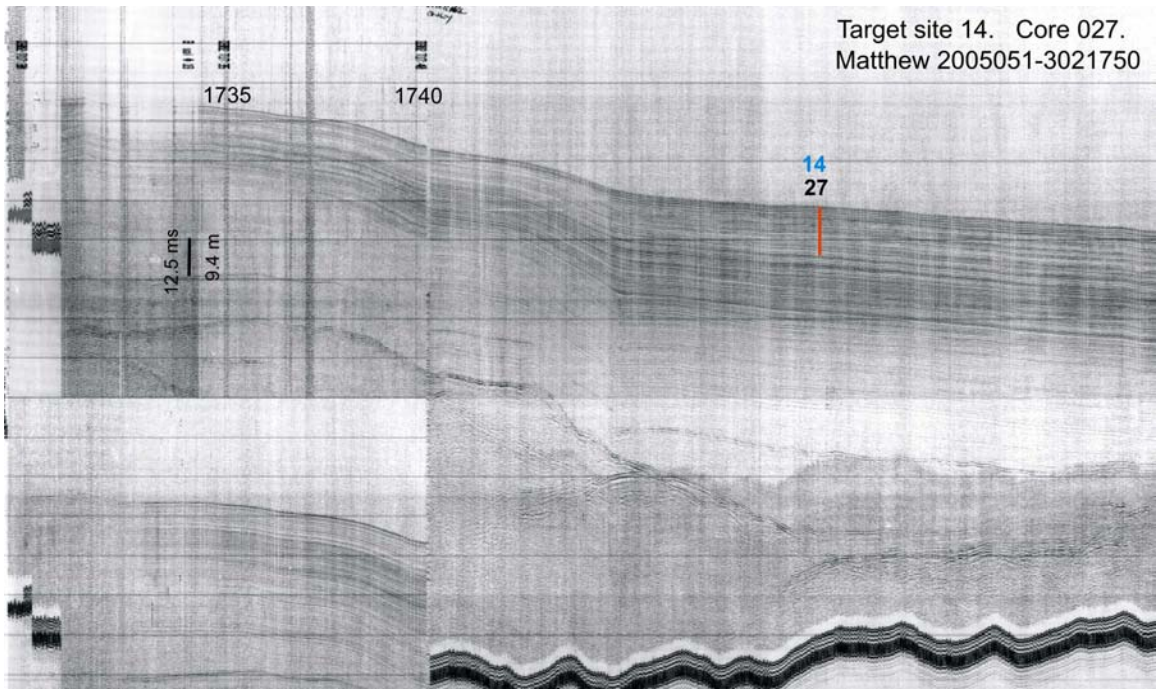


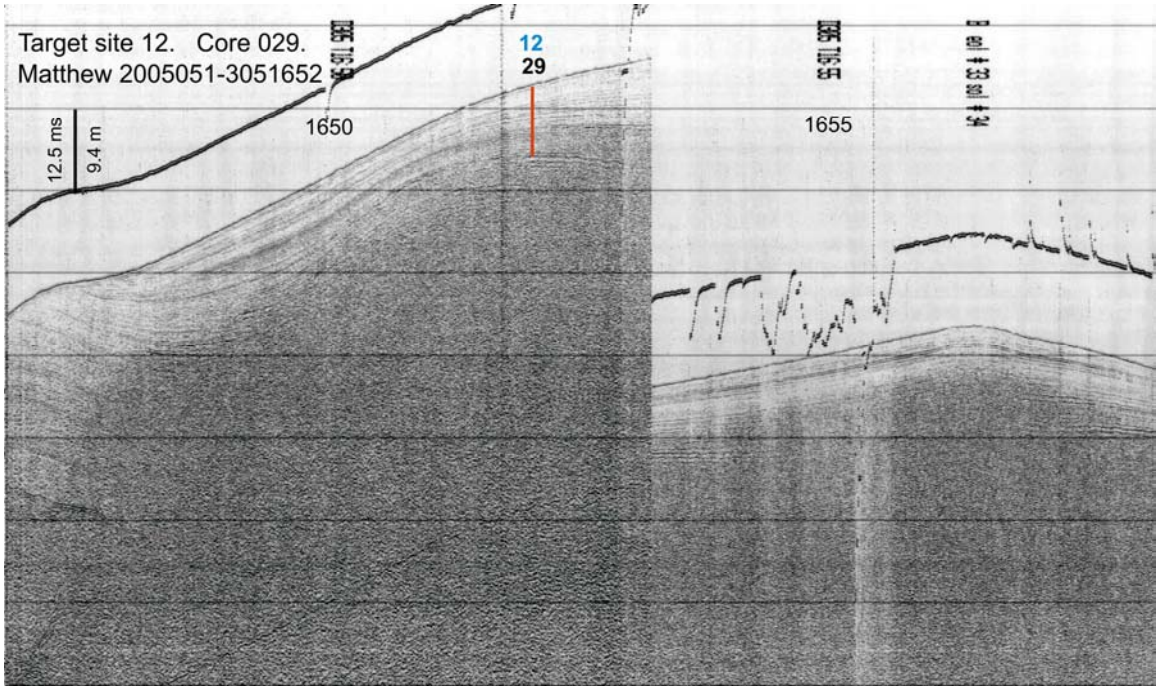


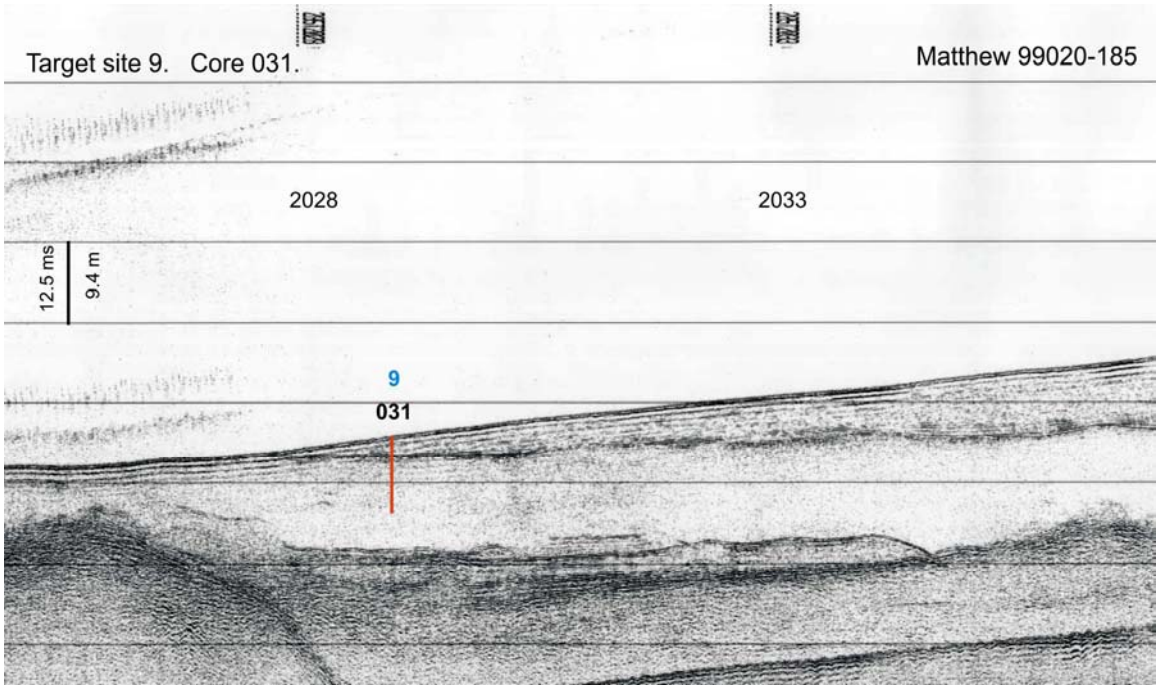

Target site 6. Core 013.
Hudson 78012-136
2046
2048
2050
6
013

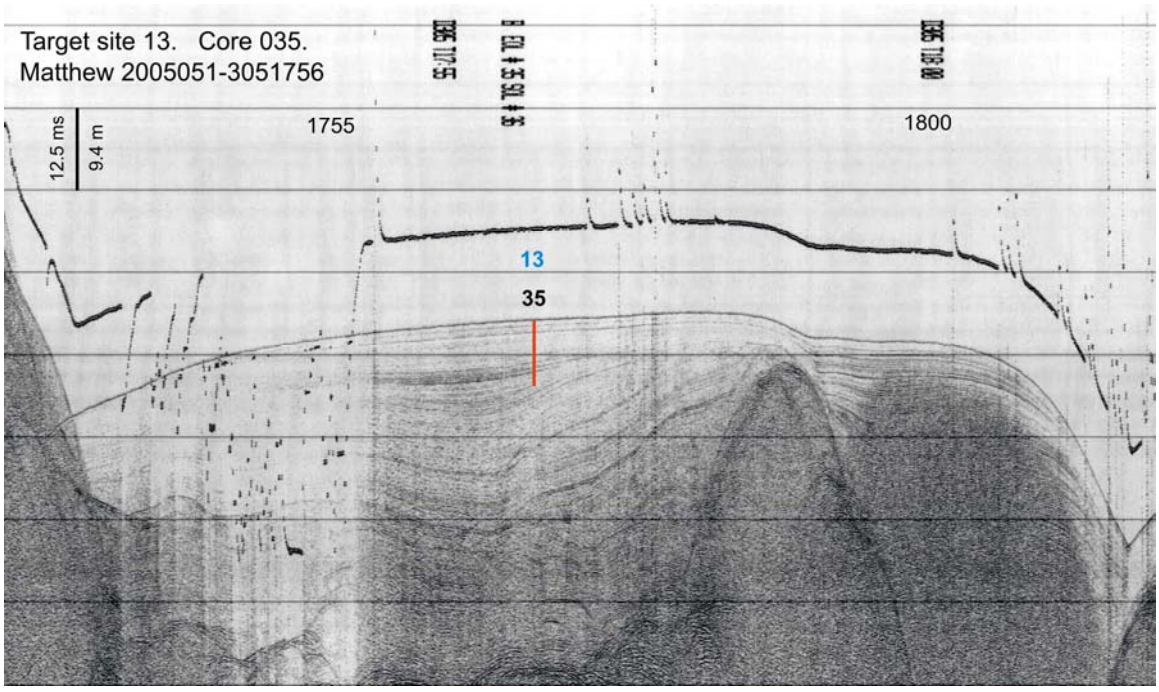

Target site 7. Core 015.
Hudson 78012-136
100 ms
1816
1818
1820
1822
7
015

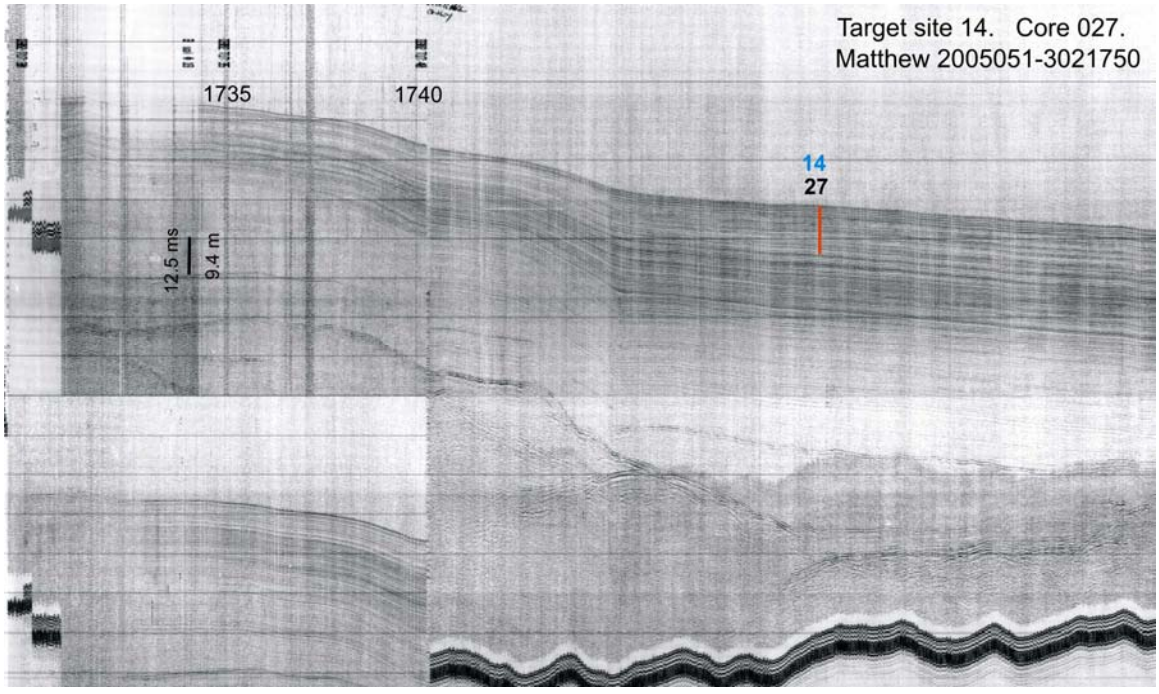

Target site 8. Core 019.
Hudson 78012-136
100 ms
1830
1832
1834
8
019

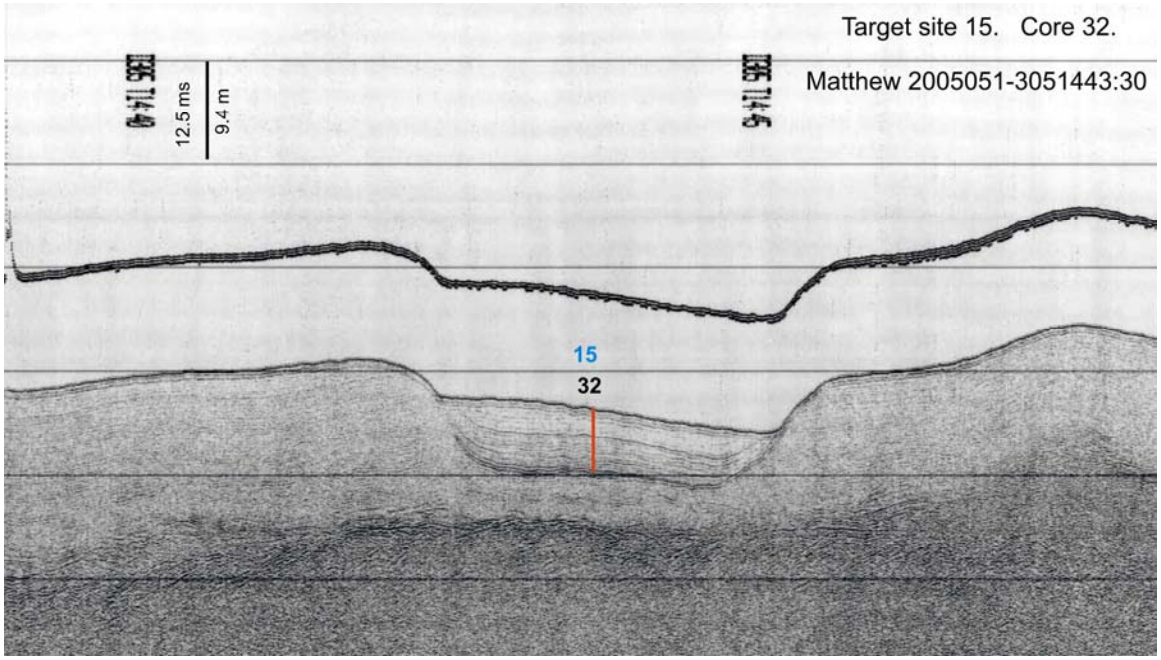

Target site 14. Core 027.
Matthew 2005051-3021750
1735
1740
14
27
12.5 ms
9.4 m


Target site 12. Core 029.
Matthew 2005051-3051652
12
29
1650
1655
12.5 ms
9.4 m


Target site 9. Core 031.
Matthew 99020-185
2028
2033
12.5 ms
9.4 m
9
031


Target site 13. Core 035.
Matthew 2005051-3051756
1755
1800
12.5 ms
9.4 m
13
35


Target site 14. Core 027.
Matthew 2005051-3021750
1735
1740
12.5 ms
9.4 m
14
27


Target site 15. Core 32.
Matthew 2005051-3051443:30
1335 1149
12.5 ms
9.4 m
1335 1145
15
32

Appendix 6: Stations Report

Station Number	Station Type	Station Day / Time (UTC)	Latitude	Longitude	Water Depth (M)	Geographic Location
0001	Ocean Bottom Seismometer	211 / 1002	43.982675	-58.983763	1220.00	Scotian Shelf - The Gully
0002	Ocean Bottom Seismometer	211 / 1032	43.926603	-58.994173	1400.00	Scotian Shelf - The Gully
0003	Ocean Bottom Seismometer	211 / 1110	43.848598	-58.918046	1770.00	Scotian Shelf - The Gully
0004	Grab	212 / 950	46.259995	-54.982146	176.80	Grand Banks of Newfoundland -
0005	Piston	212 / 1026	46.260203	-54.982063	183.00	Grand Banks of Newfoundland -
0006	Grab	212 / 1218	46.445986	-54.861863	231.00	Grand Banks of Newfoundland -
0007	Piston	212 / 1258	46.445883	-54.862193	231.00	Grand Banks of Newfoundland -
0008	Piston	212 / 1539	46.258981	-54.980075	185.00	Grand Banks of Newfoundland -
0009	Piston	212 / 1717	46.257915	-54.978601	184.00	Grand Banks of Newfoundland -
0010	Piston	212 / 1912	46.260951	-54.983810	183.00	Grand Banks of Newfoundland -
0011	Grab	213 / 950	46.867160	-54.817400	236.80	Grand Banks of Newfoundland -
0012	Camera	213 / 1045	46.866951	-54.817071	242.00	Grand Banks of Newfoundland - Placentia Bay
0013	Piston	213 / 1128	46.866978	-54.816581	243.00	Grand Banks of Newfoundland - Placentia Bay
0014	Camera	213 / 1359	46.881193	-54.502741	188.00	Grand Banks of Newfoundland - Placentia Bay
0015	Piston	213 / 1439	46.881203	-54.502865	189.00	Grand Banks of Newfoundland - Placentia Bay
0016	Grab	213 / 1553	46.880850	-54.502935	191.00	Grand Banks of Newfoundland - Placentia Bay
0017	Grab	213 / 1713	46.879535	-54.536716	198.90	Grand Banks of Newfoundland - Placentia Bay
0018	Camera	213 / 1732	46.879655	-54.536411	198.90	Grand Banks of Newfoundland - Placentia Bay
0019	Piston	213 / 1804	46.879415	-54.536481	198.00	Grand Banks of Newfoundland - Placentia Bay
0020	Grab	213 / 1918	46.922820	-54.579620	206.00	Grand Banks of Newfoundland - Placentia Bay
0021	Grab	213 / 1942	46.920111	-54.580103	207.00	Grand Banks of Newfoundland - Placentia Bay
0022	Grab	213 / 1957	46.919860	-54.579320	206.00	Grand Banks of Newfoundland - Placentia Bay
0023	Grab	213 / 2016	46.922370	-54.575683	203.00	Grand Banks of Newfoundland - Placentia Bay
0024	Grab	213 / 2032	46.922610	-54.575390	204.00	Grand Banks of Newfoundland - Placentia Bay
0025	Grab	214 / 1024	47.425465	-54.378783	403.00	Grand Banks of Newfoundland - Placentia Bay
0026	Camera	214 / 1049	47.425438	-54.379030	402.80	Grand Banks of Newfoundland - Placentia Bay

0027	Piston	214 / 1128	47.425395	-54.378885	403.80	Grand Banks of Newfoundland - Placentia Bay Western Channel
0028	Grab	214 / 1505	47.416398	-54.054241	221.00	Grand Banks of Newfoundland - Placentia Bay Eastern Channel
0029	Piston	214 / 1544	47.416260	-54.054740	224.00	Grand Banks of Newfoundland - Placentia Bay Eastern Channel
0030	Grab	214 / 1712	47.417726	-54.065538	298.00	Grand Banks of Newfoundland - Placentia Bay Eastern Channel
0031	Piston	214 / 1747	47.417575	-54.064628	296.80	Grand Banks of Newfoundland - Placentia Bay Eastern Channel
0032	Piston	214 / 2026	47.298791	-54.129713	211.00	Grand Banks of Newfoundland - Placentia Bay Eastern Channel
0033	Grab	215 / 1046	47.485990	-54.043946	212.00	Grand Banks of Newfoundland - Placentia Bay
0034	Camera	215 / 1115	47.486151	-54.044048	204.70	Grand Banks of Newfoundland - Placentia Bay
0035	Piston	215/1146	47.486003	-54.044058	212.00	Grand Banks of Newfoundland - Placentia Bay
0036	Camera	215 / 1352	47.181748	-54.264748	184.00	Grand Banks of Newfoundland - Placentia Bay
0037	Grab	215 / 1411	47.181836	-54.264886	184.00	Grand Banks of Newfoundland - Placentia Bay
0038	Grab	215 / 1508	47.153365	-54.255666	201.00	Grand Banks of Newfoundland - Placentia Bay
0039	Camera	215 / 1527	47.153371	-54.255351	202.00	Grand Banks of Newfoundland - Placentia Bay
0040	Camera	215 / 1609	47.126901	-54.192603	83.70	Grand Banks of Newfoundland - Placentia Bay
0041	Grab	215 / 1623	47.126851	-54.192545	84.90	Grand Banks of Newfoundland - Placentia Bay
0042	Grab	215 / 1717	47.063911	-54.356388	200.80	Grand Banks of Newfoundland - Placentia Bay
0043	Camera	215 / 1733	47.063940	-54.356751	201.00	Grand Banks of Newfoundland - Placentia Bay
0044	Camera	215 / 1857	46.871495	-54.365633	92.00	Grand Banks of Newfoundland - Placentia Bay
0045	Grab	215 / 1911	46.871591	-54.365923	88.00	Grand Banks of Newfoundland - Placentia Bay
0046	Grab	215 / 1954	46.905462	-54.487227	199.00	Grand Banks of Newfoundland - Placentia Bay
0047	Camera	215 / 2008	46.905398	-54.486905	198.00	Grand Banks of Newfoundland - Placentia Bay