Hudson Expedition 2006040

Regional Geohazard Assessment of the Labrador Margin

St. John's to Halifax
August 5- September 1, 2006

Master- Capt. Gary Saunders
Chief Scientist- D. Calvin Campbell

Report by scientific staff of CCGS Hudson expedition 2006-040 and compiled by Calvin Campbell

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D. Calvin Campbell

2007

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Acknowledgments-

The work plan for Hudson 2006-040 was very ambitious, requiring a lot of area to be covered in the time available. As usual, the amount of work planned far exceeded the amount of time available, but that said, the highest priority objectives were met and, in most cases, exceeded. The success of this mission can be credited to a captain who was always willing to put the science objectives first; a deck crew who worked very efficiently and effectively, using a wide range of scientific equipment in various sea conditions; an engineering department who very quickly repaired or solved any equipment breakdowns; and the remainder of the ship's officers, crew and staff who went the extra mile to make for a very successful and comfortable scientific program.

On behalf of the scientific staff of Hudson 2006-040 and the Atlantic division of the Geological Survey of Canada at BIO, I would like to thank the Commanding Officer (Gary Saunders), those who contributed to the success of the mission, especially David Boyd and crew, Victor Parkes and William Sarty and the rest of the engineering staff, as well as the entire ship's complement, for continuous support in execution of the scientific objectives and flexibility in adapting to an ever-changing itinerary.

Scientific Staff

Name	*Affiliation*	*Responsibility*
Ken Asprey	NRCan	Manage geophysics, airgun maintenance
Gordon Cameron	NRCan	Planning, geophysics watch keeping
Calvin Campbell	NRCan	Chief scientist
Jade Chung	NRCan student	Core processing
Mark Deptuck	NRCan PDF	Planning (Aug 15-Sept 1)
David Fox	Waterloo volunteer	General watch keeping
Paul Fraser	NRCan	Navigation, geophysics watch keeping
Michael Giles	Dalhousie volunteer	Coring, seismic processing
Kate Jarrett	NRCan	Manage core processing
Fred Learning	GeoForce	Compressor maintenance
Susan Merchant	NRCan	Coring, record archival
Greg Middleton	NRCan	Coring, compressor maintenance
Bob Murphy	NRCan	Manage coring
Dwight Reimer	GeoForce	Seismics, sidescan operation
Gary Sonnichsen	NRCan	Second scientist (Aug 5-Aug 15)
Graham Standen	GeoForce	Manage Huntec DTS operation
Miriam Sutton	Armada volunteer	General watch keeping
Efthymios Tripsanas	NRCan PDF	Planning, geophysics watch keeping
Sean Yaehne	NRCan student	General watch keeping

1.0 Summary

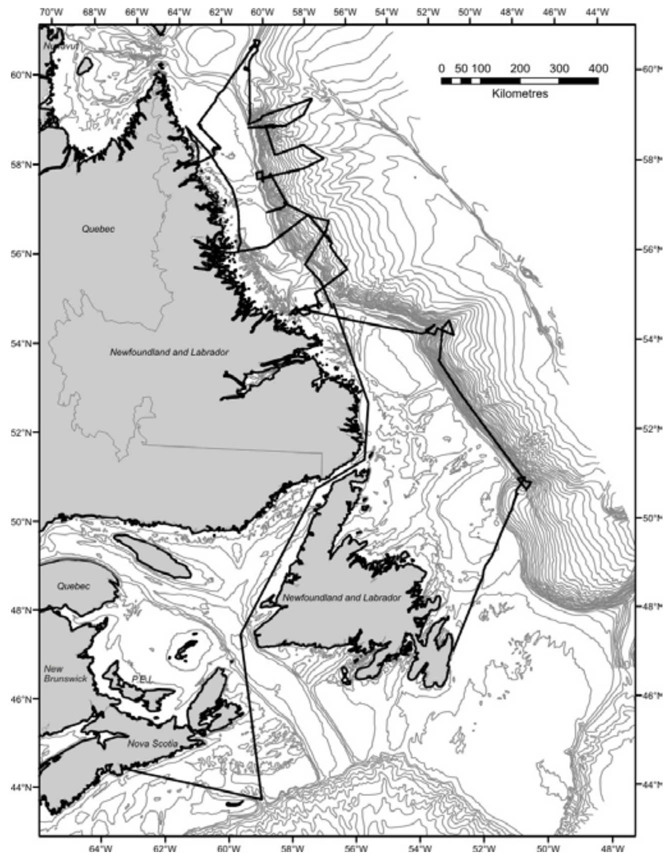

Figure 1.1- Regional track map for Hudson 2006-040

CCGS Hudson 2006-040 August 5th to September 1st, 2006
Master- Captain Gary Saunders
Chief Scientist- Calvin Campbell

Accomplishments:
31 piston cores
15 camera stations
14 grab samples
2542 line-km seismic reflection data (Huntec DTS and various volume airgun)
415 line-km sidescan sonar data

The primary purpose of this expedition was regional assessment of geohazards on the Labrador Margin. Regional seismic reflection surveys and sampling was conducted in deepwater areas off Labrador to assess sedimentation processes and physical properties of the shallow sub-surface. Repetitive mapping of the seabed on the Labrador Shelf was conducted to evaluate recurrence of iceberg impacts and to ground truth surveys of multibeam bathymetry data collected on Makkovik Bank and off Hudson Strait. As well, a new Huntec DTS console was field tested.

Table 1.1- Hudson 2006-040 activity summary.

HUDSON 2006-040 Summary of Activities				*Stations*			*Seismcs Lines*	
Date	*JD*	*Location*	*Purpose*	*Core*	*Grab*	*Camera*	*Airgun/ Huntec*	*Sidescan*
5-Aug	217	St. John's to Orphan Spur	Steaming to first work area, Orphan Spur.					
6-Aug	218	Orphan Spur	Coring on 2005-033B data in order to improve understanding of processes in Orphan Basin.	1-2			1-5	
7-Aug	219	Orphan Spur/Slope off Hamilton Bank	Complete regional strike line at 1500 mbsl.				6	
8-Aug	220	Hamilton Spur	Fill critical gaps in sesimic coverage and cores from 2005-033B survey.	3			7-10	
9-Aug	221			4-6				
10-Aug	222	Makkovik Bank	Ground truth of Matthew 2006-038 multibeam data.		7-21	8-23	10-17	10-17
11-Aug	223			36	24-35	25-34	18-26	18-26
12-Aug	224	Slope off Makkovik Bank	Collect regional dip line off Makkovik Bank, on southern margin of Hopedale Trough.				27-30	
13-Aug	225	Slope off Hopedale Trough	Too windy to core, collect regional dip line tying 2005 data and Amundsen multibeam data.				31-32	
14-Aug	226	Slope off southern Nain Bank	Regional dip line from rise to outer shelf. Cores to assess sedimentation patterns and sediment physical properties along depth transect.	37-39			33	33
15-Aug	227	Nain	Disembark Sonnichsen, embark Deptuck					
16-Aug	228	Saglek Bank	SAR call					
17-Aug	229	Saglek Bay to Saglek Bank	Finished SAR at 1100, transited to basin in Karlsefni Trough to take good Holocene core. Began Saglek mosaics.	40			34-41	34-41

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HUDSON 2006-040 Summary of Activities				*Stations*			*Seismcs Lines*	
Date	*JD*	*Location*	*Purpose*	*Core*	*Grab*	*Camera*	*Airgun/ Huntec*	*Sidescan*
18-Aug	230	Saglek Bank	Finished Saglek Bank Mosaics, then transit to slope off Hudson Strait				42-49	42-49
19-Aug	231	Slope off Hudson Strait	Ground truth of Amundsen multibeam data.	41-44			50-56	
20-Aug	232	Slope off Hudson Strait/Slope off Saglek Bank	Groundtruth of Amundsen multibeam data, begin work on Labrador Slope.	45			57-62	
21-Aug	233	Slope off Saglek Bank	Regional seismic reflection surveys to assess environmental conditions and geohazards.Cores to assess sedimentation patterns and sediment physical properties along depth transect.					
22-Aug	234			46-48			63-68	
23-Aug	235	Slope off Saglek Bank/ Slope off Okak Trough	Regional seismic reflection surveys to assess environmental conditions and geohazards.					
24-Aug	236	Slope off Okak Trough	Regional seismic reflection surveys to assess environmental conditions and geohazards.Cores to assess sedimentation patterns and sediment physical properties along depth transect.	49-51			69-72	
25-Aug	237	Slope off Okak Trough		52-55			73-75	
26-Aug	238	Slope off Northern Nain Bank		56-58			76-78	
27-Aug	239	Slope off Nain Bank		59-60			79-80	
28-Aug	240	Slope off Hopedale Trough.	Recover gear at 0700 and steam to the Gully					
29-Aug	241	On way to the Gully	Recover OBSs at Gully					
30-Aug	242	On way to the Gully	Recover OBSs at Gully					
31-Aug	243	The Gully	Recover OBSs at Gully					
1-Sep	244	BIO						

2.0 Daily Narrative

(all times in Atlantic Daylight Time except where noted, all positions are the planned positions, not necessarily the actual ship position)

Friday, Aug 4, JD 216- St. John's NL

Staff arrive in St. John's via air or onboard the ship. Coast Guard crew change. Plan is to sail next day at 10 am. Winch in the winch room deemed unsafe for use with camera. The clutch mechanism is not operating properly. MUN diesel compressor is loaded and welded down, some of the other gear on the aft deck has been moved and rewelded due to position problems discovered during the previous cruise. In the evening, discover that arrival of staff member Sutton is delayed and that she will not arrive until 1315 the next day.

Saturday, Aug 5, JD 217- St. John's NL / Orphan Spur

Ship familiarization performed by ship's crew for new staff. Confirm that Sutton's arrival will be 1315. New wire has been purchased for the pull winch on the forward deck. This will allow camera operation from the forward deck without the 40 minute delay in changing wire on the winch. Sutton arrives at 1500. Ship sailed at 1530 towards northern Orphan Basin.

Sunday, Aug 6, JD 218- Orphan Spur

Made good time overnight. Arrive at first core location near Orphan Spur at 0930.

Core 001- 12 m 50° 52.0615' N -50° 0.4415' W
Target- stratigraphic core into well-stratified sediment
Record- 212/1730 2005-033B Water depth 1107 m.

Problems encountered with the Pengo winch. At start of deployment, the brake malfunctioned. On recovery, the chain that drives the spooling gear came off its sprocket. Core up at 1115. Some difficulties again with the winch. Recovered about 9 m of silty grey mud. Implosion at top section. Total recovery was 9.5 m.

Core 002- 15 m 50° 49.0464' N -50° 4.4016' W
Target- mass transport deposit and over bank deposits from nearby channel
Record- 212/1625 2005-033B Water depth 1124 m

On site at 1300, changed to 15 m after penetration on previous core. Recovered 11.7 m of sediment.

Steamed to SOL 1 with purpose of imaging Bottom Simulating Reflector recognized in data from Hudson 2005-033B data. Huntec DTS and 2*210 cu. in. GI Guns deployed at 1715, out by 1800. Everything was operational within the lab by 1930. There was a small problem with the GI controller which gave various errors. At the end of line 01, it was discovered that only one gun was turned on. Once both guns were firing, the errors stopped. Ran lines 1-5:

Waypoint	latitude	longitude
Sol 1	50° 58.383'	-49° 59.766'
Sol 2	51° 13.180'	-49° 40.654'
Sol 3	51° 12.661'	-49° 56.885'
Sol 4	50° 56.509'	-49° 39.667'
Sol 5	51° 06.308'	-49° 28.032'
Eol 5*	51° 07.004'	-49° 36.261'

Monday, Aug 7, JD 219- Orphan Spur / Slope off Hamilton Bank

Survey to EOL 5 and recovered gear at 0645. During day, steamed to start of line 6 off Hamilton Bank. Purpose of line is to finish the regional strike profile along the 1500 m isobath from Hudson Strait to Orphan Basin. Arrived at start of line 6 at 2015 and deployed 2 GI guns and Huntec DTS.

Sol 6	53° 14.9622'	-51° 48.1248'
Eol 6	54° 15.9612'	-52° 45.7404'

All gear in the water by 2030. All online by 2045. The first hour of digital Huntec data was logged but was garbage because the input for the GSC DIGS (sigma/delta card) had come loose.

Tuesday, Aug 8, JD 220- Slope off Hamilton Bank / Hamilton Spur

Did not make the expected coverage overnight. Strong currents resulted in 5 kt through the water but only 4 over ground. Seismic data is seaward of a shelf-crossing trough, similar but smaller than Trinity Trough. Shows similar character with stacked amorphous bodies (MTDs), however, acoustic penetration is less than Orphan Basin. Recovered gear at 1000. After steaming 4 hours, arrived at core site 003 at 1400. Core over the side at 1415 and on bottom at 1445 (~2000 m water depth).

Piston Core 003-15 m 54° 47.7109'N -52° 19.2636'W
Target- stratigraphic secton.
Record- 225/2345 2005-033B Water depth 2002 m

After piston core 003, steam to SOL 7. At 2 nmi. before the line, slow to 2 kts to deploy gear. Purpose of survey was to fill critical data gaps in the 2005-033B survey data. Arrive at start of line at 1730. Deployed 2 GI guns and Huntec DTS. Everything in the water by 1800.

SOL 7	54º 54.1224	-52º 01.6238
SOL 8	54º 35.8412	-51º 53.8415
SOL 9	54º 46.7694	-52º 31.8596

SOL 10	54º 37.8450	-52º 39.1231
EOL 10	54º 44.2520	-52º 57.2974

Too much float was put on the eel at the start of the line which made it too buoyant for the bird to sink it. Also, the MUN compressor shutdown a few times overnight. The diesel overheated and shutdown. Apparently there is a cooling water problem.

Wednesday, Aug 9, JD 221- Hamilton Spur
Recovered gear at 0700, then steamed to core site 004.

Piston Core 004-15 m 54° 51.2915'N -52° 38.1102'W
Target- stratified sediment interbedded with thin debris flow deposits. Core will help date age of failures.
Record- 225/2033 2005-033B Water depth 1770m

Piston core had good penetration. Core cutter was damaged beyond repair. Recovered 12.5 m of sediment. Varied from the bottom up from silty clay to sandy mud. Coarse sand at top with minor implosion on the top section.

Piston Core 005 15 m 54° 42.8545'N -52° 54.7835'W
Target- Stratigraphic core that well help assess variations in sedimentation rates over Hamilton Spur.

Record- 228/0430 2005-033B Water depth 1148 m

Core recovered 9.9 m.

Piston Core 006- 12 m 54° 40.6661'N -53° 9.44274'W
Target- Stratigraphic core that well help assess variations in sedimentation rates over Hamilton Spur.
Record- 228/0633 2005-033B Water depth 736 m

Core recovered 8.1 m of sediment. After core on deck, steam to Makkovik Bank, running 3.5 kHz across outer shelf and bank top.

Thursday Aug 10, JD 222- Makkovik Bank
Arrive at station 007 on Makkovik Bank at 0720 ADT. Conducted ground truth sampling program for multibeam survey conducted by CCGS Matthew in July 2006 (2006-038) (for detailed description of sampling and seismic program, see Appendix X)

0007	VV Grab	222/1023	55.30211	-57.92821	99
0008	Camera	222/1058	55.30114	-57.92840	99
0009	VV Grab	222/1156	55.28022	-57.97870	147
0010	Camera	222/1215	55.27941	-57.97977	139
0011	VV Grab	222/1300	55.25592	-58.02930	282

0012	Camera	222/1323	55.25772	-58.03028	284
0013	VV Grab	222/1400	55.23840	-58.06346	261
0014	Camera	222/1429	55.23647	-58.06739	259
0015	VV Grab	222/1524	55.21689	-58.09074	249
0016	Camera	222/1553	55.21719	-58.09316	225
0017	VV Grab	222/1630	55.21512	-58.11765	274
0018	Camera	222/1701	55.21890	-58.12118	289
0019	VV Grab	222/1749	55.19414	-58.15180	272
0020	Camera	222/1816	55.19364	-58.15055	268
0021	VV Grab	222/1858	55.16171	-58.15195	230
0022	Camera	222/1924	55.16174	-58.15188	227
0023	Camera	222/2009	55.17331	-58.20465	120

At 1730, deployed Huntec DTS (boomer mode), 6 cu in sleeve gun and sidescan sonar. Small sleeve gun would not fire, so recovered and deployed the 10 cu in sleeve gun. Survey over area of multibeam data from Matthew 2006-038. Collected excellent quality data over bank top and small basins. Surface ghost in sleevegun data removed when processing data (low pass filter).

SOL 11	55 12.25	58 8.3
SOL 12	55 22.6	57 45.65
SOL 13	55 17.35	57 35.6
SOL 14	55 11.7	57 36.55
SOL 15	55 9.85	57 52.5
SOL 16	55 17.4	58 11.35
SOL 17	55 13	58 19
EOL 17	gear recovered on heading towards station 024	

Friday, Aug 11, JD 223- Makkovik Bank
Gear recovered at 0720, steamed to station 024.

0024	VV Grab	223/1105	55.19625	-58.27951	151
0025	Camera	223/1130	55.19708	-58.27961	149
0026	VV Grab	223/1200	55.20167	-58.30171	150
0027	Camera	223/1222	55.20164	-58.30200	150
0028	VV Grab	223/1307	55.21317	-58.25095	128
0029	Camera	223/1327	55.21312	-58.25035	127
0030	VV Grab	223/1411	55.24335	-58.27158	215
0031	Camera	223/1434	55.24319	-58.27159	216
0032	VV Grab	223/1545	55.26843	-58.22647	240
0033	Camera	223/1612	55.26751	-58.22710	263
0034	Camera	223/1726	55.34330	-58.13340	260
0035	VV Grab	223/1757	55.34466	-58.13330	248

At 1500, took piston core 036

Piston Core 036-12 m 55.30175 -58.14845
Target- Stratified sediment over possible glacial till.
Record- 217/0431 2005-033B Water depth 270m
Bolder stuck in cutter. Recovered 9.15 m of sediment.

After piston core, steamed to start of line 18. Arrived at 1920 ADT and deployed Huntec DTS (boomer), 10 cu in sleeve gun, and sidescan. Collected two small mosaics over good quality 79-019 data in order to quantify scour recurrence. Ran lines 18 to 26.

SOL 18	55° 23.0547'	-57° 22.9819'
SOL 19	55° 23.3033'	-57° 18.5359'
EOL 19	55° 19.2692'	-57° 15.5885'
SOL 20	55° 19.527'	-57° 14.5344'
EOL 20	55° 23.1711'	-57° 17.1869'
SOL 21	55° 23.0563'	-57° 17.728'
EOL 21	55° 19.4057'	-57° 15.0616'
SOL 22	55° 19.6636'	-57° 14.0206'
SOL 23	55° 24.0059'	-57° 17.1665'
SOL 24	55° 27.3124'	-57° 16.2936'
EOL 24	55° 22.2573'	-57° 06.6586'
SOL 25	55° 22.7479'	-57° 05.9305'
SOL 26	55° 27.7799'	-57° 15.5203'

Near midnight, lost sleevegun signal. Recovered gun and replaced blown hose, redeployed and continued surveying. Lost 1 hour of data.

Saturday, Aug 12, JD 224- Slope off Makkovik Bank

At 0700, recovered 10 cu in sleeve gun, Huntec DTS, and sidescan sonar. Switched over Huntec DTS to sparker mode, and prepared the 2 GI Gun rail. At 8 am, deployed Huntec DTS and 2 GI Gun. Everything operational at 0830. SOL 27. Collected regional dip line oriented in similar direction to industry multichannel data, then a strike line on the continental rise that tied into data from 2005-033B and mutibeam collected by the Amundsen in 2004.

Waypoint	latitude	longitude
SOL 27	55º 39.2002’	-57º 22.9819’
SOL 28	56° 12.5388’	-56° 04.2342’
SOL 29	56° 43.8858'	-56° 46.5366'
SOL 30	56° 48.6828'	-56° 42.1650'
EOL 30	57° 13.9362'	-57° 21.5064'

At 1930, near the end of line 27, recovered Huntec to trim the sparker tips, then redeployed. On line 28, at 2200, lost air to one GI Gun. Data quality was adequate with one gun and decided to carry on with the one gun. Weather blew up over night.

Sunday, Aug 13, JD 225- Slope off Hopedale Trough

Good data overnight despite 1 GI gun and weather. At 0700, recovered seismic gear with plans to take piston core. At 0800 blowing 40kts, made way over to core site to wait it out. Tried to hold station, with stern into the sea, but it was too rough to hold without risking damage to gear on the aft deck. Trolled around until 1030. At that time tried to hold again at the same station with similar result. Winds blowing 40 kts from the east. Decide to return to where line 30 ended and try to deploy seismic gear again. At 12 pm, deployed seismic gear and began surveying. Continued regional strike line, than ran line 32 up dip from the continental rise to the outer shelf.

SOL 31	56° 56.5445'	-56° 54.3549'
SOL 32	57° 27.3876'	-57° 42.2268'
EOL 32	56° 44.3076'	-59° 20.6832'

Monday, Aug 14, JD 226- Slope off Southern Nain Bank

Recovered Huntec DTS and GI Guns at 0700. Huntec dip profile along line 32 shows at least 2 shallow mtds with overlying sediment. Steamed to core site 037.

Piston Core 037- 15 m 57° 02.3415'N -58° 39.6884'W
Target- Upper section of a composite stratigraphy coring target. Well stratified sediments. Recovered 12.5 m.
Record- 226/0755 Water depth 1167m

Piston Core 038- 15 m 57° 01.2478'N -58° 42.1400'W
Target- Lower section of a composite stratigraphy coring target. Well stratified sediments. Recovered 11.1 m.
Record- 226/0817 Water depth 1104 m

Piston Core 039 15 m 57° 06.0882'N -58° 30.8920'W
Target- Stratified sediment over a shallow mass transport deposit. Recovered 11.9 m.
Record- 226/0635 Water depth 1446 m

Once core 39 was along side, we made our way over to SOL 33 at 1700. At 1830 deployed sidescan, Huntec Boomer, and 10 cu in sleeve gun. The purpose of the the line is to extend the dip line ran the previous night up onto the continental shelf. This will image subglacial deposits and determine their relationship to stratified deposits on the continental slope.

SOL 33 57° 00.3632' -58° 44.2160'

EOL 33 56° 32.0106' -59° 48.0402'

Ran until 2400, then recovered gear and steamed to Nain.

Tuesday, Aug 15, JD 227- Nain

Arrived in Nain at 830 for Sonnichsen to disembark. Deptuck embarks. Miscellaneous trips to shore for some equipment for ship, etc. Sutton baggage does not arrive. Sail from Nain at 1600 en route to Saglek Bank. At 1730, SAR call to disabled vessel on in a fjord inland of Saglek Bank. Commence steam to vessel.

Wednesday, Aug 16, JD 228- Saglek Bank, SAR call

Still on way to SAR call off Cape White Handkerchief. At 10 am FRC went up a small fjord to try to assist the disabled boat. At 1730 FRC returned with disabled fishing boat in tow. Hudson begins towing fishing boat 50 miles south to Saglek Bay.

Thursday, Aug 17, JD 229- Saglek Bay, SAR call

Arrive in Saglek Bay with fishing boat in tow at 0630. Ship's engineers try to get the boat going again but no luck. The boat was towed into a small fjord on the south side of the bay (St. John's Harbour). Back underway to core site at 1130. Arrive at basin in Karlsefni Trough at 1330. Run a 3.5 kHz transect across basin to find thick Holocene section. Took 40 ft Piston Core

Piston Core 040-12 m 58 45.5096 -61 52.1044
Target- Thick stratigraphic section to get good Holocene record. Core penetrated fully into soft sediment, although seabed looked hard in 3.5 records. Both trigger weight core and piston core had good quality top sections with preserved biology at the seafloor surface (brittle star, worm tubes).

Record, 2006-040 229/1711 3.5 kHz. Water depth- 200 m.

At 1600 deployed sidescan sonar, Huntec DTS in boomer mode, and mini-GI Gun. Ran sidescan mosaics over Saglek East and Caroline areas with transect between. Lines 34-41 on Saglek East mosaic, then ran regional lines 43 and 44 to Caroline mosaic with lines 45-49

Friday, Aug 18, JD 230- Saglek Bank

Continued sidescan mosaics over Saglek East (lines 34-42), then a survey line north (lines 43-44) to Caroline mosaic. Completed Caroline mosaic (lines 45-49) at 1900. Recovered gear and began steam to slope off Hudson Strait, running 3.5 kHz over banktop into deepwater.

Saturday, Aug 19, JD 231- Slope off Hudson Strait

Arrived at piston core site 41 at 0645.

Core 041- 15 m 61° 18.6131'N -60° 19.8635'W
Target- Stratigraphic section on a ridge off Hudson Strait based on multibeam bathymetry. Trigger weight core penetrated 123 cm. Piston core penetrated about 8 m. Trigger weight core consisted of olive grey gravelly and sandy mud. Piston core had gravelly sandy mud at the top, then silt and silty mud down core. Cutter had firm gravelly mud.

Record- 231/2310 Water depth- 1684 m

Core 42- 9 m 61°20.8791'N -60°20.4435'W
Target- A broad low lying canyon floor based on multibeam. Trigger weight core penetrated completely, but contained only ~50 cm of gravelly sandy mud. Piston core penetrated about 4 m. Piston core recovered about 180 cm of sandy mud with a 4 cm thick gravel bed ~60 cm down core.
Record- 231/2334 Water depth 1720 m

Core 43- 9 m 61°16.3551'N -60°24.6820' W
Target- A typical canyon floor from the multibeam data. Trigger weight core recovered 11.5 cm of muddy sand. Piston core recovered 3 m of medium to coarse gravel over muddy sand.
Record 231/2236 Water depth 1725 m

Core 44- 9 m 61° 16.9890'N -60° 11.3158'W
Target- Broad, flat intercanyon ridge. Trigger weight core tipped over. Core recovered 3.9 m of stiif, grey sediment.
Record 232/0257 Water depth 1862 m

Core on deck by 1630. Steamed to start of line 50. At 1830, deployed 2 GI Gun rail, and Huntec DTS. Ran lines 50-56 in order to ground truth Amundsen data.

SOL 50	61° 14.3412'	-60° 29.0394'
SOL 51	61° 18.9480'	-60° 19.2918'
SOL 52	61° 24.2712'	-60° 22.4466'
SOL 53	61° 23.4696'	-60° 5.36160'
SOL 54	60° 54.3402'	-60° 32.6382'
SOL 55	60° 42.0504'	-60° 33.2064'
SOL 56	60° 43.9542'	-60° 45.8214'
EOL 56	60° 58.5726'	-60° 32.0808'

Made it to small ridge at start of line 56. Had to divert course on line 54 to steer clear of a ship in our path that would not respond to our request to move.

Sunday, Aug 20, JD 232- Slope off Hudson Strait / Slope off Saglek Bank

Surveyed until 0800. Recovered gear then steamed to piston core site 045-

Core 045- 12 m 60 43.5537 -60 33.1186
Target- Well stratified ridge adjacent to a broad channel with a central thalweg. Core has a condensed seismic stratigraphy compared to nearby channel.
Record- 232/0920 Water depth 1589 m

Core on deck at 1030. Began steam to slope off Saglek Bank to begin 36 hour seismic survey on lines-

SOL 57	59° 29.6557'	-60° 21.4456'
SOL 58	59° 36.5713'	-59° 53.5129'
SOL 59	59° 40.9082'	-59° 49.0331'
SOL 60	60° 06.613'	-57° 35.619'
SOL 61	59° 44.4095'	-57° 57.3128'
SOL 62	59° 28.5098'	-58° 46.3963'
EOL 62	59° 24.7906'	-60° 15.2716'

Monday, Aug 21, JD 233- Slope off Saglek Bank

Continued running regional dip lines off Saglek Bank. Brought Huntec DTS onboard at 0730 and 1700 to trim sparker. At 1700 compressors shut down because fuel was depleted. Some problems with the MUN compressor overheating and issues with seaweed plugging the cooling hoses. Collected good quality data. Imaged large sediment wave complex in deep water which may be related to adjacent canyon.

Tuesday, Aug 22, JD 234- Slope off Saglek Bank

Finished line 62 at 0630. Recovered gear (on board at 0700). Asprey and Middleton to disassemble and inspect the heat exchanger on the MUN compressor. Steamed to piston core site 046. Arrived at core site at 0830. Core on bottom at 0915.

Piston Core 046- 15 m 59° 25.7097'N -59° 53.1506'W
Target- Smooth stratified sediment. Damage to liner in upper barrels and implosion on some lower barrels. Required disassembly of the top barrel to dislodge the piston. Took remainder of the morning to break corer down.
Record- 234/0700 Water depth ~1214 m

Piston Core 047- 12 m 59° 27.0199'N -59° 22.2078'W

Target- Smooth stratified sediment. While core was going down, was informed by the captain that we would have to shut down the port shaft to repair a leak in the tunnel manifold supply valve for the cooling water for the compressor. It was decided to proceed to the next core site and begin repairs once the corer was over the side.
Record- 234/0410 Water depth 2055 m

Piston Core 048 15 m 59° 27.6171'N -59° 07.6739'W
Target- Shallow widespread mass transport deposit. Recovered 6.5 m.
Record- 234/0250 Water depth 2275 m

Repair of leak on supply mainifold resulted in the failure of the primary motor for pump. Took some time to find another pump, repair made by 2130. Gear in water and surveying by 2200. Began 36 hour survey of lines off Saglek Bank.

SOL 63	59° 29.4318'	-59° 20.1276'
SOL 64	59° 27.4902'	-59° 39.8862'
SOL 65	58° 47.9832'	-59° 11.8722'
SOL 66	59° 02.9922'	-57° 57.5202'
SOL 67	58° 44.4924'	-57° 02.9340'
SOL 68	58° 30.6054'	-57° 55.4316'
EOL 68	58° 18.3798'	-59° 25.2192'

Wednesday, Aug 23, JD 235- Slope off Saglek Bank / Slope off Okak Trough

Continued 36 hour seismic survey.

Thursday, Aug 24, JD 235- Slope off Okak Trough

Recovered seismic gear at 0630. Arrived at core site 49 at 0800.

Core 49- 15 m 58° 26.6321'N -58° 24.6900'W
Target- thin mtd over stratified. Twc corer recovered silty/sandy mud with granules. Piston core recovered brown sandy mud over grey silty mud with granules
Record- 236/0801 Water depth 2360 m

Core 50- 12 m 58° 28.8749'N -58° 08.1579'W
Target- stratified sediment. TWC recovered full penetration, nice sample. Piston core penetrated ~34'. Recovered good sample with minor damage to top section.
Record- 236/0621 Water depth 2544 m

Core 51- 15 m 58° 28.1819'N -58° 13.2936' W
Target- eroded stratified. TWC toppled over. Piston corer penetrated ~15'. Recovered 4 m.
Record- 236/0652 Water depth 2493 m

Steamed to start of line 69. Deployed gear at 1700. Discovered exposed shield wires on the eel cable when deploying, fixed quickly. Ran lines-

SOL 69	58° 25.2184'	-58° 35.7971'
SOL 70	58° 13.8534'	-59° 55.644'
SOL 71	58° 23.0315'	-59° 58.8574'
SOL 72	58° 24.8377'	-59° 43.499'
EOL 72	58° 06.7572'	-59° 40.1247'

Friday, Aug 25, JD 237- Slope off Okak Trough

Surveyed until half way down line 72. Recovered seismic gear at 0700. Steamed to core site 052.

Core 52- 9 m 58° 15.5996'N -59° 43.3702'W
Target- thin mtd over stratified. Twc had no recovery. Piston core recovered about 1.8m. Gravelly base with sandy/gravelly lag at top of the core.
Record- 237/0331 Water depth- ~690 m

Cores 53 and 54- 9 m 58° 18.4601'N -59° 23.2602'W
Target- stratified sediment. Two attempts. First try recovered only 1 ft of sample from piston core, catcher failed. Second try recovered 2.1 m of sediment. Good trigger weight cores on both attempts.
Record- 237/0136 Water depth 1531 m

Core 55- 9 m 58° 17.8279'N -59° 27.7138' W
Target- thick mass transport deposit. Good recovery.
Record- 237/0201 Water depth 1433 m

Steamed to SOL 73 and deployed seismic gear. Tried the new Huntec console with success, except that we could not fire it from the MITS, but ran it autonomously.

Ran lines-

SOL 73	58° 19.9256'	-59° 19.324'
SOL 74	57° 41.7274'	-58° 36.9061'
SOL 75	57° 37.1317'	-58° 44.3803'
EOL 75	57° 28.5556'	-59° 30.3679'

Saturday, Aug 26, JD 238- Slope off northern Nain Bank

Recovered seismic gear at 0730. Steamed to core site 56.

Core 56- 12 m 57° 32.0528'N -59° 11.6216 'W
Target- stratigraphic section. Lost twc. Good recovery in piston core.
Record- 238/0905 Water depth 1026 m.

Core 57- 15 m 57° 35.0670’N -58° 55.4340’W
Target- stratigraphic section. Good recovery in piston core. Fine sandy layers, separation of beds.
Record- 238/0707 Water depth 1539 m

Core 58- 15 m 57° 40.5710’N-58° 38.7946’ W
Target- stratigraphic section. Good recovery in twc and piston core.
Record- 238/0505 Water depth 1999 m

Steamed to start of line 76. Deployed gear at 1630. Ran lines 76-78.

SOL 76	57° 42.126'	-58° 40.5585'
SOL 77	57° 24.6344'	-57° 34.4701'
SOL 78	57° 18.8684'	-56° 49.6341'
EOL 78	56° 58.2995'	-57° 00.9861'

Sunday, Aug 27, JD 239- Slope off Nain Bank

Recovered seismic gear at 0700. Used new Huntec console again with excellent results. Steamed to core site 59-

Core 59- 15 m 57° 05.7775'N -57° 08.6105 'W
Target- stratigraphic section, low ridge within canyon. Pengo winch acted up on way down. Would repeatedly stall while paying out wire in high gear. Engineering department had a look. Thought it might be a cooling problem. Manuals not on board for Pengo winch for changes that occurred during refit a few years ago. Continued down in low gear. Slowed operations considerably.
Record- 225/1908 Water depth 2422 m

Core 60- 15 m 57° 01.9736’N -57° 02.7460’W
Target- stratigraphic section next to canyon. Pengo winch could only operate in low gear. 50 minutes down, 50 minutes back up. Excellent recovery.
Record- 225/1810 Water depth 2284 m

Steamed to SOL 79 at 1615. Deployed seismic gear (Huntec DTS sparker-new console, and GI Guns). Survey lines-

SOL 79	57° 04.6234'	-56° 57.4549'
SOL 80	56° 18.8991'	-57° 48.6289'
EOL 80	55° 47.7456'	-56° 56.4667'

Monday, Aug 28, JD 240- Slope off Hopedale Trough

Recovered seismic gear at 0700. Began steam to the Gully to recover OBSs.

Tuesday, Aug 29, JD 241- On way to the Gully

Continue steaming to the Gully.

Wednesday, Aug 30, JD 242- On way to the Gully

Continue steam to the Gully, rough sea conditions.

Thursday, Aug 31, JD 243- The Gully

Arrive at OBS recovery site at 0600. Recover OBSs and begin steam to Halifax.

Friday, Sept 1, JD 244- BIO

Arrive at BIO at 0800. End of cruise.

3.0 Navigation

Paul Fraser

Autonomous, carrier phase GPS navigation was provided by a Thales Navigation ADU5 position and attitude determination system. The ADU5 uses four GPS antennas to measure position, velocity, and attitude. The position output from the ADU5 is the location of antenna one, which is the forward facing antenna in the current configuration on Hudson. The ADU5 provides a more accurate position and eliminates one of the problems which, was associated with the ship's MX-400 series GPS receivers. The MX-400 series receivers periodically output the same GPS position string continuously. This results in long periods (up to 5 minutes) without a GPS position update. This problem does not occur with the ADU5 system.

NMEA sentences from the ADU5 were combined with sentences from the ship's log, sounder, gyro, and the Trackpoint II USBL acoustic positioning system through a Baytech Multiplexer in the NAV centre. Data from the multiplexer was then forwarded to a Black Box line splitter for distribution throughout the ship at 9600 baud. A laptop running WinFltrNMA was used to distribute selected sentences throughout the ship at 4800 baud. In addition, the GP lab Regulus system rebroadcast all of the received NMEA sentences over the Ethernet network to the two GSCDIGS systems running in the GP lab.

Four Regulus systems were in use on the ship to view and log the scientific navigation. All systems were running the latest version of Regulus II (Build 28620). The systems were set up in the drawing office (5), the winch room (2), the forward lab (1), and the GP lab (3). A second monitor was attached to the GP lab Regulus system through a video splitter. This allowed for the concurrent display of the navigation data for the benefit of the Huntec operator. The winch room Regulus system was used as the primary data logger.

Prior to sailing, a problem was encountered with the Regulus systems that caused the software to crash whenever the user tried to rebroadcast navigation over the ship's Ethernet. The problem was caused by a bug in Regulus and was solved when ICAN sent the latest version to be installed. A problem that still exists with the latest version of Regulus is that it fails to recognize the standard output data string (Std EC w/pr format) from the Trackpoint II acoustic positioning system. Previous versions of Regulus were able to recognize the Trackpoint string and reformat it to a $POREB string for logging and display of the acoustic beacon position. This problem was brought to the attention of the technical support department at ICAN and they are currently working on a solution. As a workaround, Trackpoint data (Std EC w/pr format) was logged using Hyperterm running on a PC in the drawing office. Another problem with the Regulus software is with a feature which allows the user to enter a date and time to create a navigation marker based on a position from the Regulus voyage file. In some cases, a position is returned with a latitude value that is approximately half of the actual latitude value. The workaround is for the user to enter a time one second before or after the desired time until a position containing a valid latitude value is returned. There is also a problem that is caused by the automatic hardware recognition feature of the Windows XP operating system. This problem causes the system to view the navigation data input on the COM port as a serial mouse. The workaround is to reboot the PC with the navigation serial cable disconnected and then re-connect the navigation serial cable before starting the Regulus software.

Additional difficulties with cleaning and processing the navigation data were encountered due to differences between the ADU5 GPS system and the ship's MX400 series receivers. The ArcGIS command ReadEFile could not properly synchronize the times between the GPS and the ship's log, gyro, and sounder as the ADU5 does not have any latency in the GPS position as the MX400 series does. Also, the standard GSCA program ETOA would not work on the ADU5 data as the GPS position sentences ($GPGGA) are output at a rate greater than once per second. The workaround solution was to write a macro in VBA for ArcObjects to convert an E type file to a simple A type file at one second intervals using the $GPGLL string which is output at a rate of once per second. As a more permanent solution, the ReadEFile command will be updated to enable it to process navigation from the ADU5. The A type files could then be interpolated or decimated using the GSCA standard program INTA and were converted to shapefiles using the ArcGIS command AToShape. Cruise tracklines were also created using AToShape and an input .CSV file with line start and end times.

3.1 Trackpoint II

The Trackpoint II Ultra Short Base Line (USBL) acoustic positioning system was used throughout the cruise to provide positioning data for the GSCA deep ocean camera and for the Klein 3000 sidescan sonar. A Trackpoint transponder beacon was attached to the GSCA deep ocean camera for 5 camera stations on day 222. Beacon number 5 was used with an interrogate frequency of 17 kHz and a reply frequency of 27 kHz. The purpose was to test the logging procedures for the Trackpoint data because Regulus does not recognizing the Trackpoint data string. Another purpose was to evaluate the operation of the Trackpoint system itself as it has been known to be problematic. Overall, the system worked well and the data from the camera tests appeared to be less noisy than on some recent past cruises. Figure 3.1 shows a plot of the slant range, relative bearing, and depth from the Trackpoint beacon during the second camera station. As expected, the noise increases as the camera approaches the bottom and the chances for multi-path increase. It was also noted that the data gets very noisy when the ship is thrusting to hold station.

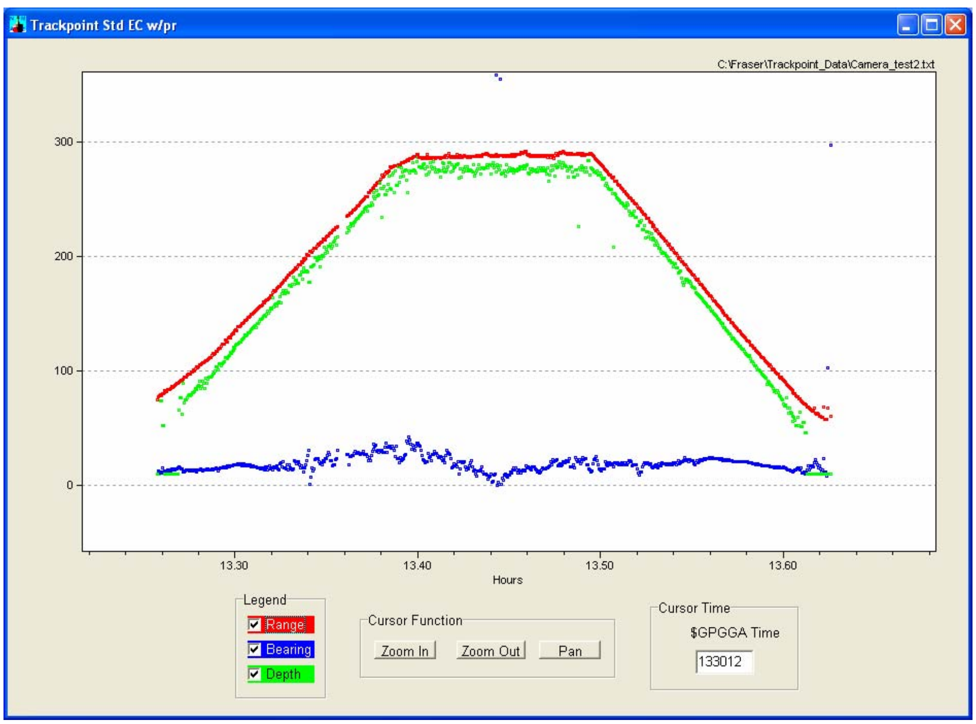


Figure 3.1 Plot showing the slant range (red), relative bearing (Blue), and depth (green) of the Trackpoint beacon during a camera station.

The Trackpoint system was also used to provide positioning data for the Klein 3000 sidescan. The Klein 3000 is equipped with a Trackpoint responder beacon that allows the Klein to electrically query the Trackpoint consol before sending an acoustic reply. This responder beacon was used on the sidescan for the survey on JD 222 without good results. The system was returning valid bearings but there was a range gate error that resulted in no valid positioning data being collected. It is suspected that the range gate error was caused by the Turn Around Time (TAT) not being properly set for the responder beacon. A number of different TAT values were tested but none improved the results. Because of this problem a Trackpoint transponder beacon (Beacon number 5) was used for positioning on the subsequent sidescan surveys.

4.0 Sampling Procedures

Kate Jarrett

4.1 Piston Coring

The piston coring system used was the AGC Long Corer (Figure 4.1) This device obtains a core sample with an ID of 99.2 mm and an OD of 106 mm. Barrel lengths are 10 ft (305cm) and the system is typically rigged to a maximum of 5 barrels. During this cruise the system was rigged with three, four and five barrels depending upon the seismic interpretation of the sediment. The core head is 3m long, 0.6m in diameter and weighs approximately 3000 lb (1350Kg). Each barrel has an ID of 4.25” (10.8cm), a 3/8” (9.5mm) wall thickness, and exterior couplings secured by set screws. The liner was a CAB plastic in 10 ft (305cm) lengths. A split piston with two O-rings and variable orifice size was used and a standard core catcher was used at all coring sites. The trip arm supported a 4.25” (10.8cm) diameter gravity corer with a single 7ft (2.14m) 10” barrel and 300 lb (135 kg) head. The corer used ¾” wire cable on the Pengo winch. The corer was operated using a handling system that includes a rotating core-head cradle, outboard support brackets, a monorail transport system, a lifting winch and a processing half-height sea going container. Each recovered core was broken down at the barrel joints and moved to a processing half-height container, where each 10ft (305cm) section of liner was extruded from the barrel and cut in half and labelled.

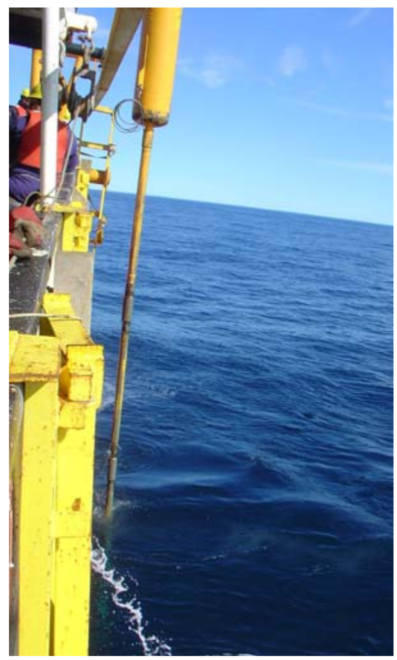


Figure 4.1 Recovering the Piston Corer.

Piston coring was successful at all attempted sites. We lost one Trigger Weight Corer and it was replaced with a single 5.5 ft (167cm) barrel and 300 lb (135 kg) head. Implosions in the liners created difficulty in extruding the liner from the barrels. All core damage and coring performance is summarized in Table 4.1. Problems with the pengo winch meant that it had to be operated in low gear for the last two core sites.

4.1.1 Onboard core processing and subsampling

A total of 273.72 m of sediment was obtained from 59 cores (31 Piston (PC) and 28 Trigger Weight (TWC). There was no sediment recovery for three TWC. All cores were processed according to standard GSC Atlantic core procedures (refer to GSC Open File #1044). All cores were identified alphabetically by section at the time of dismantling individual 10 ft core barrels from the bottom to the top, commencing with the bottom-most core barrel and proceeding to the uppermost barrel containing sediment. Each 10 ft length of liner was extruded from the barrel and cut in half, using a modified pipe cutter, in the half height container (Figure 4.2). The sediment in the liner was cut using a wire saw and the section ends were carefully capped to minimise disturbance to the sediment surface. The top end cap was labelled with the cruise number, station number, section label and top. The base of the core is designated with the letter A and the top of the base section is designated as B. The base section is AB. Each section was brought into the GP Lab and placed horizontally on the benches. Each core, starting with the base section AB, was processed using the following procedure. The core liner was labelled with an up arrow, cruise number, station number, section label and the top and base of the section were labelled with the appropriate letter. End caps were removed if the sediment was not too fluid, and the section length was recorded.

Figure 4. 2 Cutting a 10ft liner section in the half height container.

Undrained shear strength measurements and constant volume samples were taken at the top and base of each section where possible. 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 to prevent

The sealed core sections were stored upright in the refrigerated reefer container and maintained at 4°C. All core cutters and catchers were measured, labelled, placed in split liners, waxed and stored upright in buckets in the refrigerated container. All extruded core sections due to sediment expansion or core processing methods were likewise labeled and stored. All samples and subsamples were catalogued and their location information within the container was recorded in an excel spreadsheet.

All station location information, core section lengths, extruded pieces and cutter/catcher lengths, sediment description and core performance information have been documented on deck sheets and then input into the ED (Expedition) database. The ED database has been backed up and will be verified before downloading into the main ORACLE sample database.

4.1.2 Physical properties measurements

Undrained shear strength measurements and constant volume samples were taken at the ends of each section if the condition of the sediment allowed (Table 4.1). The constant volume sampler was inserted into the end of the section, the undrained shear strength measurement was taken and then the constant volume sampler was removed.

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 dial on the Torvane was zeroed, the fins on the vane was gently pushed into the sediment until they were completely inserted. The dial was rotated at a constant rate until the sediment failed (Figure 4.3).

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 4.3 Taking a Torvane measurement.

Figure 4.4 Inserting the constant volume sampler.

The L - Sensitive vane and the M – Regular vane were used for a total of 150 undrained shear strength measurements taken during the cruise.

Constant volume samples for bulk density and water content determinations were taken by inserting stainless steel samplers of a known volume. Prior to insertion, the sampler was lightly sprayed with Pam cooking oil and gently wiped with a small Kimwipe tissue. The bevelled edge of the sampler was placed on the flat sediment surface and the carefully inserted into the sediment at a constant rate using two flat headed spatulas (Figure 4.4). The sampler is inserted at a constant rate to minimize compression of the sediment within the sampler. 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 225 constant volume samples were taken during the cruise. The samples 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. All relevant information for the Torvane measurements and constant volumes was recorded on data sheets and input into excel spreadsheets and will be incorporated into the physical property database.

Table 4.1 Summary of 2006040 Physical Property sampling

Station Number	Sample Type	Number of constant volume samples	Number of Torvane Measurements
0001	TWC	-	-
0001	PC	8	6
0002	TWC	-	-
0002	PC	14	10
0003	TWC	-	-
0003	PC	10	2
0004	TWC	-	-
0004	PC	12	7
0005	TWC	2	2
0005	PC	10	7
0006	TWC	0	-
0006	PC	8	4
0036	TWC	-	-
0036	PC	8	7
0037	TWC	1	1
0037	PC	10	9
0038	TWC	3	1
0038	PC	8	5
0039	TWC	2	2
0039	PC	13	9
0040	TWC	0	-
0040	PC	10	8
0041	TWC	-	-
0041	PC	4	2
0042	TWC	-	-
0042	PC	-	-
0043	TWC	-	-
0043	PC	-	-
0044	TWC	-	-
0044	PC	4	3

0045	PC	10	5
0046	TWC	2	1
0046	PC	7	6
0047	TWC	2	2
0047	PC	7	4
0048	TWC	2	2
0048	PC	6	4
0049	TWC	-	-
0049	PC	-	-
0050	TWC	2	2
0050	PC	9	6
0051	TWC	-	-
0051	PC	3	3
0052	TWC	-	-
0052	PC	-	-
0053	TWC	-	-
0053	PC	-	-
0054	TWC	-	-
0054	PC	2	1
0055	TWC	1	1
0055	PC	3	3
0056	TWC	-	-
0056	PC	8	8
0057	TWC	-	-
0057	PC	9	4
0058	TWC	-	-
0058	PC	8	5
0059	TWC	-	-
0059	PC	6	5
0060	TWC	1	-
0060	PC	8	3

4.2 Grab Sampling

Fourteen grab samples were obtained using a medium- sized Van Veen grab sampler. This has an area of approximately 97cm^2 when the jaws are open. It was lowered over the starboard side from the oceanographic winch room (Figure 4.5). The sampler was

Figure 4.6 Van Veen on it's way down

Figure 4.5 Taking a surface subample

brought back on the deck in the winch room and a surface sample for grain size analysis was taken (Figure 4.6). The sampler was opened, photographed, described and an additional mixed grain size subsample was taken, and a bulk sample was bagged and labeled. A total of 24 grain size subsamples were taken from the fourteen grab samples. A summary of the grab sample location information and description, and the photographs of the samples are given in Appendix 2.

4.3 Underwater Photography

The camera system used was the GSC Atlantic Tritech Scorpio system. It consists of an aluminium frame, with a flash system, microcontroller and the Insite Tritech, Scorpio Digital Underwater camera (Nikon Coolpix 995) mounted in pressure cases. The system is rated to a maximum working depth of 2250 m and weighs 550 pounds. The camera is usually deployed form the oceanographic winch room but problems with the winch meant that it had to be deployed from the forward deck using the tugger winch Winch (Figure 4.7). The camera's flash photos are controlled by the microcontroller that senses bottom contact via a bottom contact switch and pinger arrangement. This novel configuration allows serial commands to be sent from the microcontroller to the Scorpio Digital Camera. The new system mimics the old Benthos Camera. Photo events were recorded on the Regulus computer each time the pinger recorded a bottom contact on the topside echo sounder. The camera generates an info.txt file that includes the day/time to the nearest minute and the associated camera settings for each photograph.

Figure 4.7 Camera back onboard

There were 14 successful and one unsuccessful camera deployments where the flash did not work because the battery was dead. A summary of the camera stations and underwater photographs are given in Appendix 2. All relevant photograph information has been input into a standardized excel spread sheet and will be verified and described prior to being input into the database.

5.0 Acoustic Systems

Ken Asprey, Dwight Reimer, Graham Standen and Fred Learning

During Hudson 2006-040 a suite of standard seismic surveying tools were used. Most days, surveying occurred during evening hours of 1600-0800. On a few occasions surveying continued over extended period of time up to 36 hours. The newly acquired Klein 3000 was used on Hudson for the first time this field season as well as the newly developed Huntec Digital System Console. Performance of this equipment will be discussed a little later.

The following seismic systems were used during this Cruise:

1. Single channel seismic system consisting of a pneumatic sound source and hydrophone streamer.
2. Huntec DTS (boomer in shallow water, sparker in deep)
3. Ore 3.5khz Hull mounted transducers
4. Raytheon 12khz ram mounted transducer.
5. Klein 3000 Digital Sidescan Sonar.

5.1 Single Channel Seismic System

5.1.1 Seismic Sources

During this study 3 seismic sources were used. In shallow areas over the “Banks” we normally fired a Haliburton 10 cu in sleeve gun. On one survey over Saglek Bank we used a Sercel Mini GI gun equipped with volume inserts in both the generator and injector chambers. This gun was only used during this one 36-hour period. During deeper water surveying two Sercel 210 GI guns were mounted together on a single beam. See Figure 5.1 for gun towing configuration.

These Primary Sources were towed from a cleat on the port side rail during. normal operations. Only during times when the sidescan was used the source was towed from the portside iron board to insure separation of the gear during turns. See Figure 5.2 for Hudson Quarter Deck configuration.

Two Price Diesel Air compressors supplied 1600psi of air. One compressor was mounted mid-ship on the flight deck (GSC-A Price model WII). The second was mounted on the starboard side of the flight deck (MUN Price A300). A 1250 litre fuel tank was mounted just forward of the GSC-A compressor. Fuel was supplied by the ships engine room staff. Both compressors were needed to fire the two 210 GI guns. Only one was used to fire the mini GI or sleeve gun. These compressors were monitored continuously by a watch keeper whenever they were in operation. See Figure 5.3 for Hudson Flight Deck configuration.

The sleeve gun was triggered by the MITS via an AGC Air Gun Control Box. The GI guns were triggered by the MITS using the LongShot Seismic Source Controller and the Four Shot Seismic Source Power Supply units.

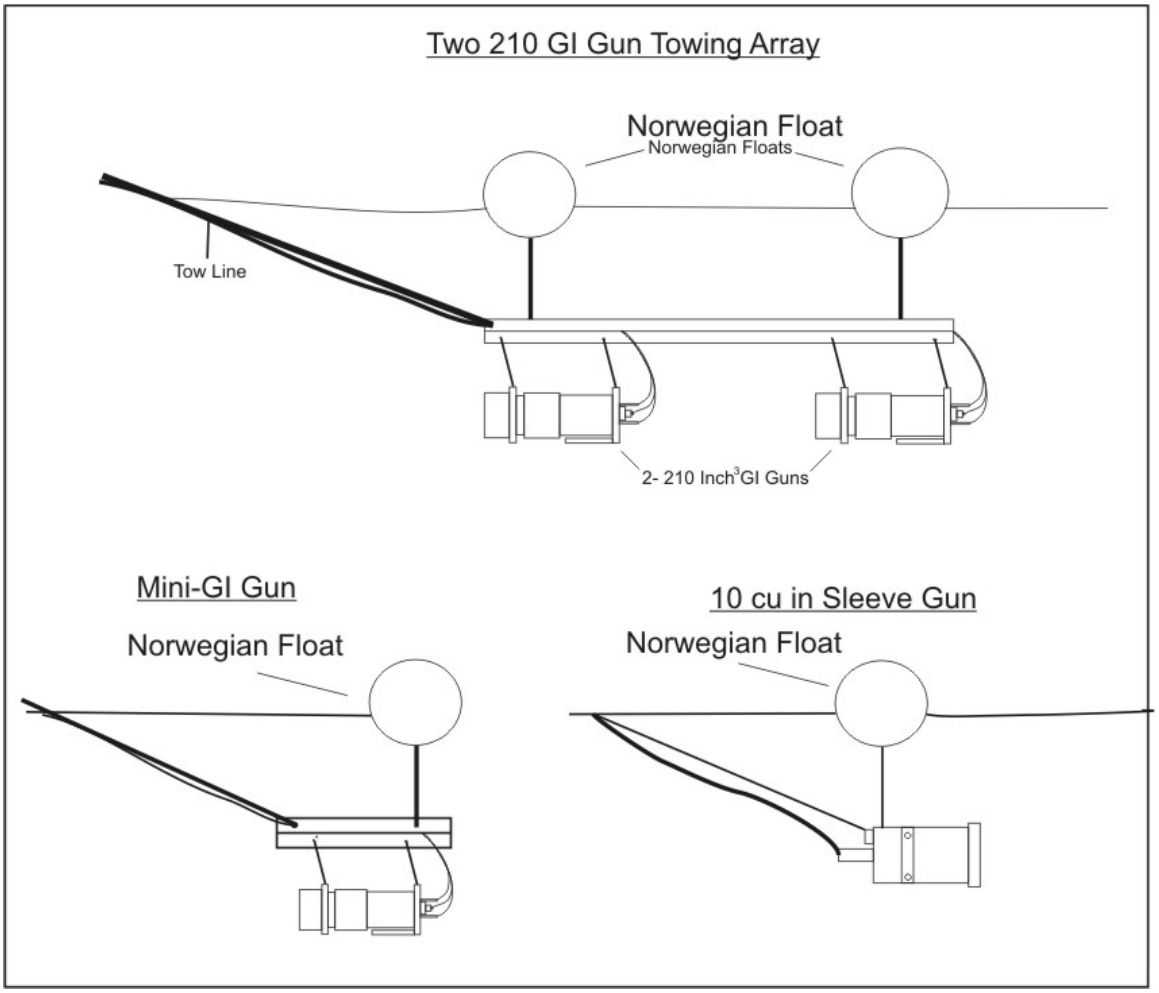


Figure 5.1 Towing configuration for seismic systems.

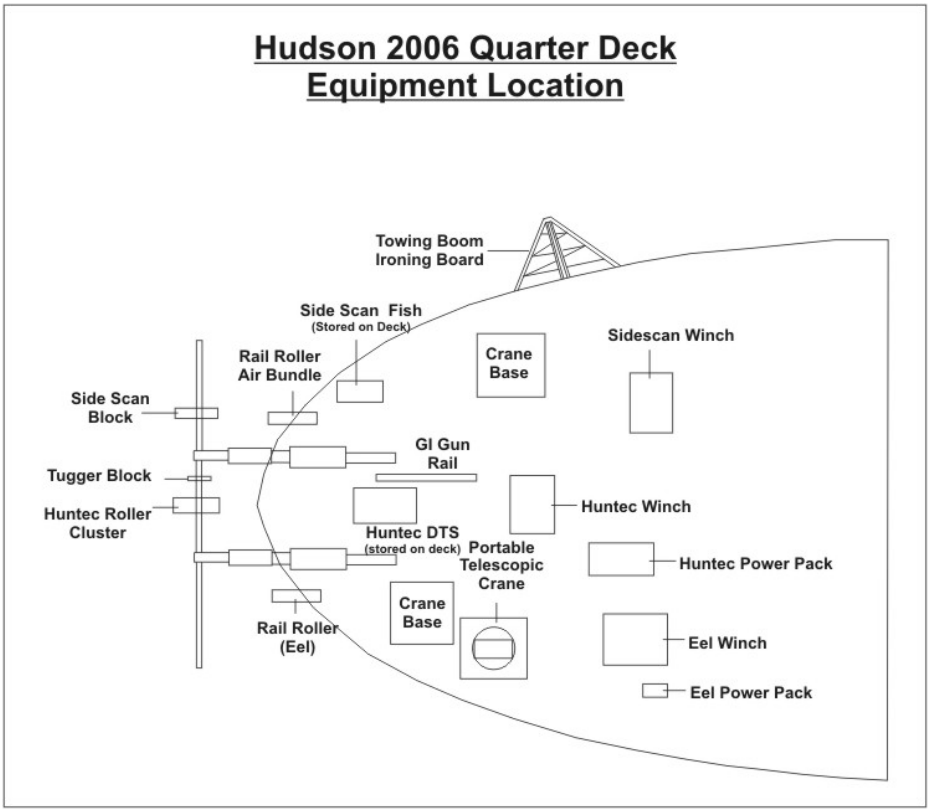


Figure 5.2 Quarter deck configuration.

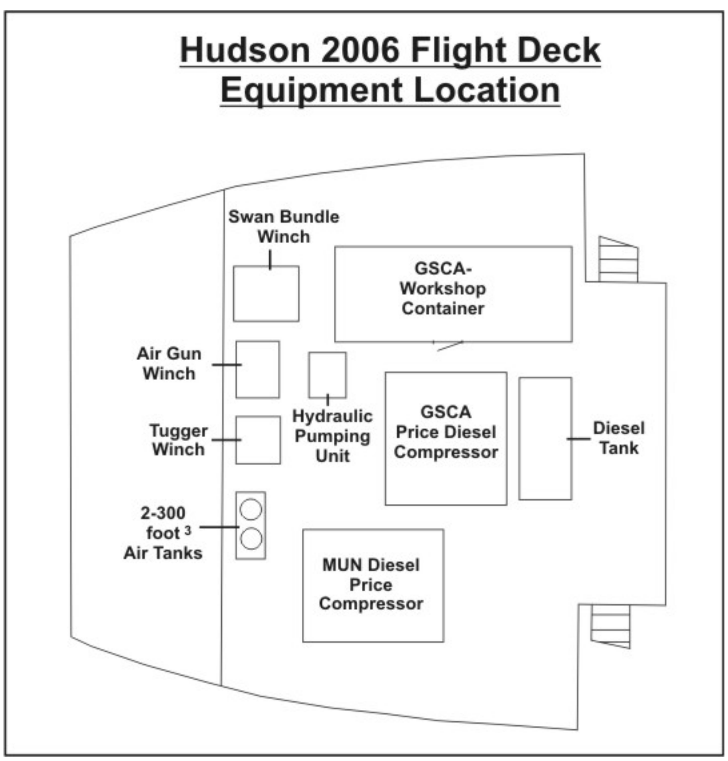


Figure 5.3 Flight deck configuration.

5.1.2 Hydrophone Streamer

The streamer was deployed from a winch on the starboard quarterdeck through a roller block on the starboard stern rail. The streamer was recently re-fitted by Swain Geophysical in Texas. During the refit the streamer was outfitted with two coils for operating two DigiBird streamer birds. Only the forward bird was used on this trip as we were missing connecting sleeves. The sleeves have now been manufactured at BIO and will be used in future programs. The Streamer has a 27ft dead section at the head and a 16ft dead section at the tail. The active section is approximately 150ft long containing 48 Teledyne B-1 acceleration canceling hydrophone cartridges. As in previous years the streamer was towed approximately 100 metres behind the ship. The average depth of the streamer was 3 metres. A cloth drogue was towed about 50ft behind the tail for stability. The streamer worked well with one DigiBird but at times the tow cable had to be let out or hauled in enough to allow the bird to operate in the programmed depth zone. The streamer has series of hydrophones connected to form a total of 6 groups. These 6 groups are summed together, amplified and then sent to the GSCDIGS for digitizing and storage. The signal is also sent to a Krohn-Hite filter and then to an EPC 9801 Thermal Recorder for a hardcopy.

Examination of the protective covering of the inactive part of the streamer cable showed several lateral cracks in the covering material. Rusty water oozed from the crack when flexing the cable at this point indicating that this was not recent but on going. These cracks do not appear to be from rough usage but rather from age or weather.

5.1.3 Data Acquisition, Display, Storage and Processing

Filters-	Krohn-Hite Model 3323 Filter		
	Settings-	High Pass 20db	80Hz
		Low Pass 0db	500Hz
	Applies filtered Acoustic signal to the EPC Model 9801 Thermal Hardcopy		
EPC-	Model 9801	Thermal Hardcopy	
	Settings	1 to 2 Second Sweep	
GSC Digs-	GDAIMS Ver 1.4 18		

*2 * 210 cu in GI Guns*
Sample rate set to 250uS
2-2.5 second window, number of samples ~8000-10000
In deep water delays were managed on the fly through software window and recorded in the segy header.
Data was written to the internal hard drive and backed up on DVD-R media.

Mini GI and 10 cu in Sleeve Gun
Sample rate set to 100uS
1 second window, number of samples ~10000
In deep water delays were managed on the fly through software window and recorded in the segy header. Data was written to the internal hard drive and backed up on DVD-R media.

5.2 Huntec Deep Towed System

(Also see GeoForce Consulting Client Report)

The AGC #3 DTS system was used on this mission. The maximum power output of this system is 1000 joules (60 mfd storage capacitance) with an ED10F/C Boomer and a multi tip sparker source. For this mission, the internal single element LC10 hydrophone was configured as Seismic #1. The externally towed Geoforce GF24/24P2i streamer hydrophone was connected as Seismic #2 (overall streamer length 24 feet, two inter-spliced channels with a combined fourteen foot active section, total of twenty-four AQ1 elements with an effective spacing of 12 inches).

The ED10 boomer source is depth compensated and outputs a highly repeatable broadband pulse, capable of resolving 10 centimetres. Peak output intensity is 118 db relative to 1 micro bar at 1 metre, with a pulse duration of 110 microseconds. The sparker source has twenty, #18 awg, solid core tips. Sparker peak amplitude and pulse width are depth dependant.

The deck equipment consists of a Haaglund 30000 Oceanographic winch, which includes a multi-way slip ring and a 900 metre, fourteen conductor, armoured tow cable. The winch is powered by a 440 VAC, 60 HP hydraulic pump unit. The tow cable is handled by a 36 inch diameter roller cluster rigged on the centre position of the aft A frame.

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

The new Geoforce /AGC developed Systems Console was used during the last three days of survey to evaluate. The unit worked very well and will be used during the remainder of the missions this year.

5.2.1 Graphic Display, Signal Processing and System Key

For surveys in deep water, only the external hydrophone data were displayed on a single EPC 9802 dual channel recorder (s/n184). Seismic #2 (external GF24/24P2i streamer) was band passed thru a Krohnhite 3700R filter with nominal settings of 900 to 4500 hertz. In shallow water, the two DTS seismic channels were displayed on a single EPC 9802 dual channel recorder (s/n184). Seismic #1 (internal LC10 hydrophone) was processed by the Systems Console's Adaptive Signal Processor (ASP) module then displayed on Channel A of the EPC recorder. Seismic #2 (external GF24/24P2i streamer) was band passed thru a Krohnhite 3700R filter with nominal settings of 900 to 4500 hertz. A TSS 312B graphic annotator provided time marks on the hard copy records. For the survey in deeper water on the last days of the mission, only the external GF24/24P2i streamer signal was displayed on channel A of the EPC recorder.

The PC based MITS system triggered the DTS and seismic systems. The MITS system allows several systems to be run using a common time base. The MITS masking feature significantly reduces acoustic interference by inhibiting the coincidental triggering of interfering system(s). Each source has two independent, adjustable delayed trigger outputs.

5.2.2 Data Recording

The two DTS signal channels were recorded on the PC based GSC DIG (# 9) digital four channel logger with hard drive storage and DVD disk writer. The data directory on the hard drive is C:/gscdigdata/campbell/day_xxx-xxx.

Huntec DTS
Sample rate set to 50uS
~0.5 second window, number of samples ~8000-10000
In deep water delays were managed on the fly through software window and recorded in the segy header.
Data was written to the internal hard drive and backed up on DVD-R media.

Table 5.1- Huntec DTS equipment parameters

Parameter	Setting
Fire rate	.5 second
PCU power setting	4 kv or 480 joules
ESU power setting	60 microfarad (1000 joules max.)
BMC (motion compensation)	Pressure Mode
Display Gain	Seismic #1- Fixed +20 Db. Seismic #2- Fixed +20 Db.
Filter Setting - Internal - External	Seismic #1 - 1000 - 5000 hertz Seismic #2 - 1000 - 4500 hertz
Processor Gain (System Console)	4 KV (both channels)
DTS source	See daily logs
GSC DIG trigger	master MITS trigger (Not used after Line # 76 for triggering Huntec)
GSC DIG sample rate	50 microsecond
GSC DIG samples per channel / range	8000-10000 /500 milliseconds
EPC 9802 sweep speed	(See daily logs for more info) 500 msec. channel A only 250 msec. channels A and B
EPC print polarity	Positive

5.3 Ore 3.5 kHz Sounder

The Ore 3.5kHz sounder was used as a tool for picking out core sites and as a survey instrument while the ship was transiting at speed without other gear in the water. It was not used while the Huntec DTS was used as it causes interference to the Huntec. The first time the 3.5 was to be used it was discovered that there were no interconnecting cables aboard. Richard Malin (Ship's Tech) managed to get it working by making up cables.

It was triggered and delayed using the MITS and recorded on an EPC 9800. Once up and running provided continuous sub-bottom profiling.

5.4 Raytheon 12 kHz Sounder

The 12 kHz ram mounted transducer, transceiver and recorder was used during much of the program. A few minor problems occurred related to the recorder and were promptly dealt with by the Ship's Tech. It should be noted that the paper situation has reached the critical stage again and if a source of paper cannot be found we will not have use of this sounder.

5.5 Sidescan Sonar

The Klein 3000 was used on the Hudson for the first time. It is a completely Digital system with no paper record. The fish was towed, rigged to a Neutrally Buoyancy Package. The system was used with 1500 metre cable on a newly acquired 25hp remotely controlled InterOcean winch. We were unable to use the Klein Internal Responder with the TrackPoint II system. A TrackPoint II Responder #5 was attached to the fish. It was set to 17KHz receive and 27KHz transmit.

It was usually operated on the 400 metre range. The system gave very high quality images and was easy to use. The Data was stored in .SDF and .XTF file format on the hard drive and backed up on DVD-R media.

The Klein 3000 sidescan system functioned well, with one exception, the re-furbished Interocean winch. The winch is too slow in both Pay out and Haul in positions. This created problems when operating in deep water with a rapidly changing bottom. As a result, the fish was operated at a much higher altitude off the bottom. The winch was also very erratic when Paying out slowly. This behavior made it difficult and at times unsafe during onboard recovery operations. The winch on occasion has spooled several metres at a time for no reason. This problem appears to be with the brake release or proportional valve control system. Another issue with the operation of the winch is the level wind system. It does not appear to have the correct gearing for that cable-drum combination. Attempts by the operator to keep the problems to a minimum were only possible over flat or low slope bottoms. The winch is required to work properly in order to be used safely.

Two things of note:

-The TOTCO cable counter variables were adjusted to reflect the true diameter and number of magnets, of the count wheel used.

-The Huntec Fish and the Sidescan Fish crossed over during Huntec deployment. This resulted in some 'Bird Caging' of the Sidescan cable at approximately the 250 metre mark.

Chesapeake processing software package was also aboard.

5.6 Timing of Seismic Systems

The lab triggers for the 3.5 KHz hull mounted profiler, the 12 kHz ram mounted transducer, the Huntec DTS, the seismic guns and the data recorders were handled by the GSCA-MITS Trigger unit. This kept the individual systems from interfering with each other and allowed delaying for depth to an accuracy of one millisecond. The Master timing for the 4 Channel TSS 312B Record Annotator originates from the Ships Clock system and gets its delay timing for the EPC recorders from the appropriate GSCA-MITS channel.

The GSCA-MITS supplied the timing for the Huntec EPC recorder (Chan 1B) through a TSS 312B Record Annotator channel, and the Air gun EPC (Chan 2A or Chan 3A) recorder through a TSS 312B Record Annotator channel. The GSCA-MITS (Chan 3A) also provides the trigger for the GSC Digs Data handling system.

The GSCA-MITS (Chan 1) timing for the Huntec DTS was supplied by the GSCA-MITS. To keep the Huntec from interfering with the Air Gun Data, the time interval and corresponding EPC delay (Chan 1B), was adjusted as needed. The GSCA-MITS (Chan 1A) also provides the trigger for the GSC Digs Data handling system.

The GSCA-MITS (Chan 2) supplied the timing for the AGC Air Gun Control box, which generates the Fire Pulse that is required by the Haliburton Sleeve gun and the GSC Digs Data handling system. The time interval set for the Sleeve Gun was 2 seconds.

The GSCA-MITS (Chan 3) supplied the timing for the LongShot Seismic Source Controller and the Four Shot Seismic Source Power Supply units, which generate the Generator and Injector Fire Pulses required to fire the Mini GI and GI Guns efficiently. The GSCA-MITS (Chan 3) also provides the trigger for the GSC Digs Data handling system. For the 210 GI Gun the time interval was 6 seconds. The air volume was set to 210 for each gun. The Injector timing for the forward gun was 55 ms with an 80 ms Bubble. The Injector timing for the after gun was 58 ms with a 60 ms Bubble. All settings were adjusted during the course of the survey but the best data quality came from these settings. The LongShot Seismic Source Controller and the Four Shot Seismic Source Power Supply units worked well during the survey period. For the Mini GI Gun the time interval was set to 4 seconds. The air volume was first set to 90 and later changed to 80. The Injector timing was set for 38.5 ms with a 60 ms Bubble. All settings were adjusted during the course of the survey but the best data quality came from these settings.

The newly developed Huntec System Console was tried on and used on the last two nights of the survey. The new unit was unable to operate on an external trigger. To continue with its use, the unit was used in an internal trigger mode. This allowed the Huntec data signal to drift through the Air gun seismic records. It was felt that the Huntec signal appeared to be better than with the old Huntec console and should be left as it was on those two evening seismic surveys. A fix, which will allow the unit to work in the external trigger mode has been determined and changes to the new system console will be done at BIO.

5.7 Mechanical Equipment

As mentioned previously under the section "Seismic Systems" two Price Diesel compressors were used. The GSC-A Price Gun Master WII compressor deliveries 185SCFM@2500rpm. It was installed at BIO prior to sailing and was used a couple of evenings on Hudson 2006-039. It has been kept in fine mechanical shape and ran perfectly during this mission.

The Memorial University of Newfoundland Price Compressor is a Gun Master A300 and delivers 300SCFM @2500rpm. It was loaded on the ship in St John's Newfoundland by Barnes Ship Yard. After a little plumbing of fuel, air and cooling lines it was ready to go. After close inspection several small problems were corrected during the first days of use. While in St John's we purchased two new batteries. Replaced all gages, cleaned out the heat exchangers and replaced Diesel coolant hoses. During two occasion's 2nd and 3rd stage valves were cleaned and resurface.

Once the scientific program was completed a complete service was performed on both compressors. (See details in Compressor Logs)

5.8 Performance

All systems worked well. The new Krohn-Hite Quad Bandpass filter was not used because of loose components heard and found inside the cabinet.

The Klein 3000 Sidescan System worked without any real issues. The software was easy to use and produced good records. The files were stored in .SDF and .XTF format on the internal hard drive and later stored on DVD-R media. The manual could be more informative. Initially, the Range was set to 150 meters on Hudson2006-39 but was the range was later set to 400 meter. On relatively flat bottom the fish was towed at 25 to 30 meters off bottom but on severe sloping bottoms, the fish was towed at 40 to 60 meters off bottom. This was necessary because of the speed limitations of the sidescan winch. An attempt to use the internal Responder with the Trackpoint II system was not satisfactory. A Trackpoint II #5 Responder was attached to the fish tow point to give layback and relative position to the ship data.

The Haliburton 10 cu in Sleeve gun was used in conjunction with the GSCA-MITS (Chan 2) and an AGC Air Gun Controller and worked well. The data was stored on the GSC Digs unit and a filtered signal was sent to an EPC 9801 Thermal Recorder.

The Sercel Mini GI gun, equipped with volume inserts in both the generator and injector chambers, was used during one 36-hour period and fired a total of 23,073 shots. LongShot Seismic Source Controller and the Four Shot Seismic Source Power Supply units were used to minimize the Bubble by controlling the timing of the generator and injector pulses. Despite the absence of a manual and an uncertainty of the volume reducer size, the Mini GI gun worked well, with a minimum of Bubble Errors. After the initial setup period, no other types of errors were generated. The data was stored on the GSC Digs unit and a filtered signal was sent to an EPC 9801 Thermal Recorder. A call was made to the manufacturer regarding the specifications of this particular model GI Gun, but little information was gained.

Two Sercel 210 GI guns were used on a single beam and fired a total of 129,601 shots each. The LongShot Seismic Source Controller and the Four Shot Seismic Source Power Supply units were used to minimize the Bubble by controlling the timing of the generator and injector pulses which resulted in less than 10 Bubble Errors a night. The data was stored on the GSC Digs unit and a filtered signal was sent to an EPC 9801 Thermal Recorder.

The new Huntec System Console was tried on and used on the last two nights of the survey. The new unit was unable to operate on an external trigger. A fix, which will allow the unit to work in the external trigger mode has been determined and changes to the new system console will be done at BIO. The unit will be tried at the next opportunity. The overall performance of the new console was favorable. The record on the EPC recorder was crisp and appeared to show more penetration into the bottom.

This phase experienced virtually no down time due to equipment failure. One night towing the two gun array an air line fitting broke. The gun was shut down and the survey continued the night with only one gun. Everything else worked well and with no incident. The MUN Compressor has had quite a bit of work to get it to peak working condition. This work was conducted during periods of coring during the day. One point, worthy of mentioning, is that at times we picked up seaweed in the heat exchangers. The heat exchangers were cleaned and flushed. The Senior Engineer William Sarty made a screen box, which was used to filter seawater for cooling water.

It was noted that the motor bearings of the Tugger Winch are very noisy. (GSC-A unit 26) These bearings will be changed during annual refit during the spring of 2007.

The last item that requires more thought is the sidescan winch. The winch was also very erratic when Paying out slowly. This behavior made it difficult and at times unsafe during onboard recovery operations. The winch on occasion has spooled several metres at a time for no reason. This problem appears to be with the brake release or proportional valve control system. Another issue with the operation of the winch is the level wind system. There is a problem with the level wind. The winch is slow to recover or raise the fish. The winch requires work to be safely used. There is a request for the winch to be serviced on the ships return to BIO on September 1, 2006. If the problem continues the sidescan should not be deployed as it is a safety issue,

5.9 Data Processing

The data acquired at sea were processed to transform the raw seismic lines into coherent seismic reflection profiles. The processing steps are described below and summarized in Figure 5.4. Gdmux, Vista 5.1 and Kindom suite 7.6 software were used. Teledyne streamer raw seismic lines were concatenated into line sections and delay changes were adjusted via GDMux. In Vista, lines were processed through a band-pass filter, the sea floor was picked and dejittered (heave corrected) by applying a static correction. Huntec interference was removed manually with surgical mute. Subsequently, each line was migrated and an exponential gain recovery from the seafloor was applied to enhance the deepest geological features. Noise above the sea floor was muted. Finally, data were exported into SMT Kingdom Suite where each line was displayed in its appropriate geographic location. The parameters for each processing step were:

Filter Step:
Input -> EditHed -> Ormsby Band Pass -> ResFFT -> ExpGain ->SegyOut -> Output

In EditHed, renumber the Shotpoint numbers and CMPs sequentially, starting with 1, Ormsby BandPass filter 35-65 and 500-600, ResFFT to 1 ms (this is to reduce file size for later FKMigration. ExpGain setting is 1

Dejitter step:
Pick the seafloor. Export first break pick (.fbp) file from Vista. Run file through dejitter.exe using 13 point smoothing (note, even number smoothing selection such as 12 or 10 point seems to give erroneous results). Import the difference between the original seafloor pick and the smoothed pick as a “total static” correction in Vista.

FK migration step:
Once the static correction is in the header, the next step is the FK-Migration flow.

Input -> StaticShft -> FKMig2D -> Output

Select Total Static radio button in the StaticShft command window. In FK migration, assign the 2006040.vel velocity file. It is a text file that defines the migration velocities as 1500 m/s and is the following format:

3-D: No
CDP: 1
0.00 1500
8000 1500
CDP: 20000

0.00 1500
8000 1500

In the other command parameters for FKMigration, W-Factor 1.5, Base Velocity 1500 Trace Distance (i.e. distance between shots, average based on survey speed and firing rate). A value of 13 was used for the deep water work. Check the box: Use Stolt Velocities.

Exponential Gain/Mute step:

The final flow applies the seafloor TVG (Seafloor_TVG.flw). First step is to repick the seafloor on the last output file (after dejitter and migration).

Input -> Flatten -> SphDiv -> Flatten -> Output -> SegyOut

Flatten 10 ms on DATA_FIRSTBREAK parameter. Spherical divergence correction: Within the command parameter window, added time velocity pairs, so the file looks like this

Time: 0.0 Vel: 1500.0
Time: 100.0 Vel: 1750.0
Time: 500 Vel: 2000.0

This is the assumed velocity structure beneath the seafloor. Other Parameters, Time Power 0.4, Velocity Power 2.

The output of this final step was then imported into Kingdom Suite v.7.6 for a quick visual inspection.

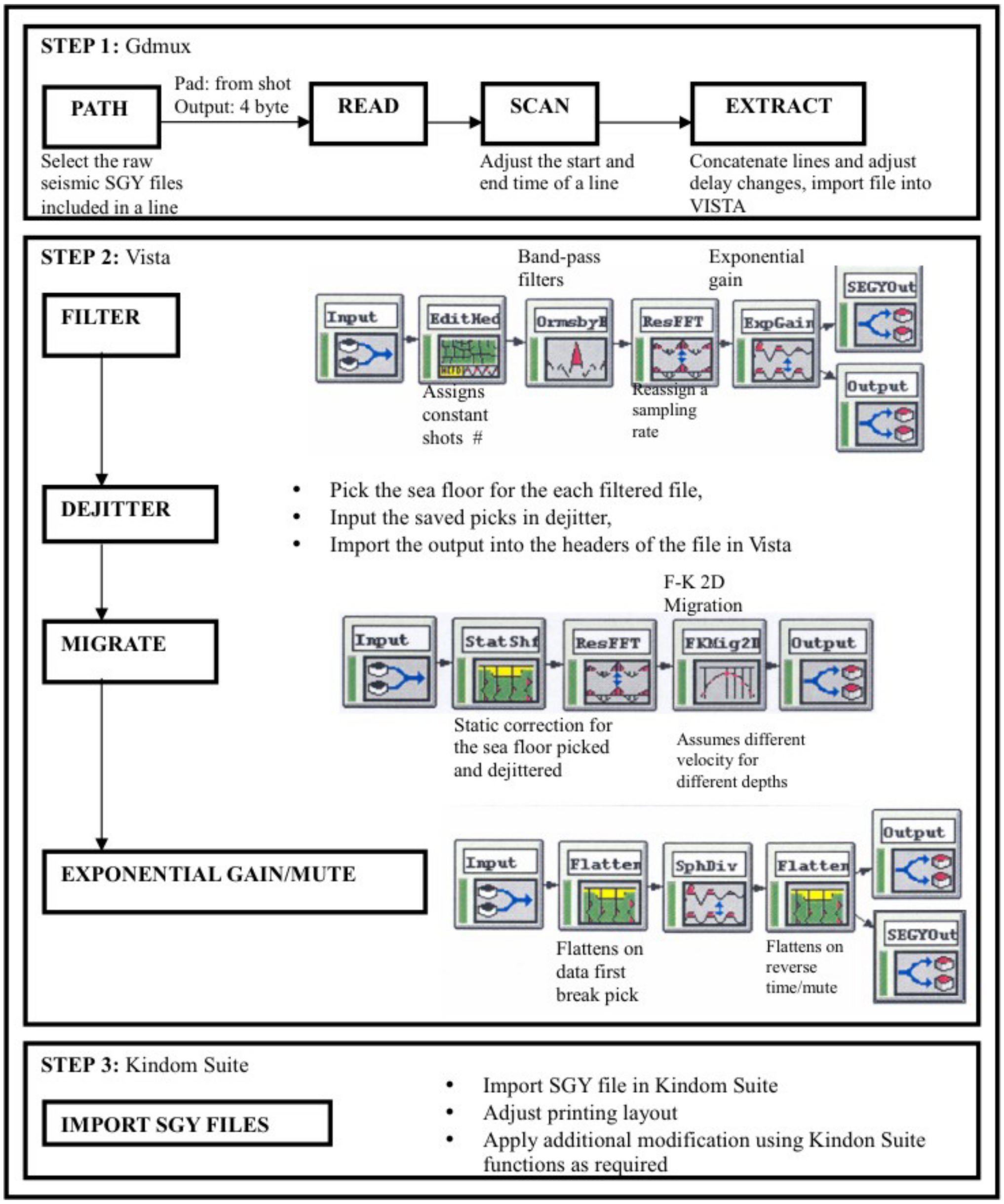


Figure 5.4 Summary of shipboard processing steps.

5.10 Acknowledgments

We would like to thank the Chief Engineer, Senior Engineer and 2nd engineer for supplying cooling water, a homemade seawater filter box and as a never ending supply of diesel fuel to the compressors. They also provided much in the way of technical support and advice for our many mechanical needs.

The Bosun and Deck Crew did a perfect job recovering and deploying gear on a quarterdeck. No cables, hoses or any equipment were damaged.

Finally we would like to extend a special thanks to Borden Chapman and Ryan Pike. They prepared and organized all the seismic equipment before the equipment was loaded. Their care and consideration took all the pressure and guess work out of mobilization of this equipment. Every single shackle, fitting or cable was ready to be loaded on the ship. With their support this trip would not have been successful.

Appendices

Appendix 1- Maps of data coverage

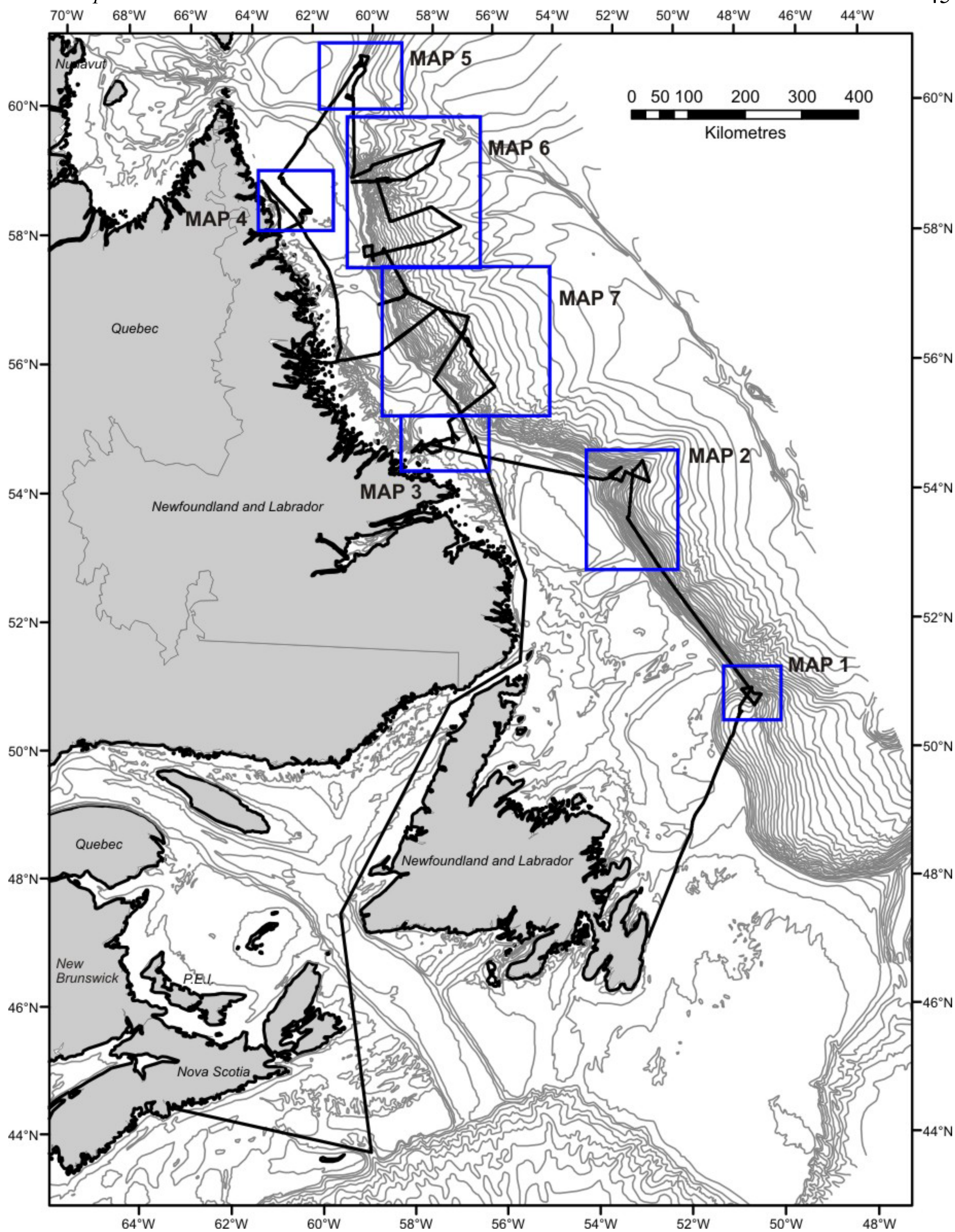
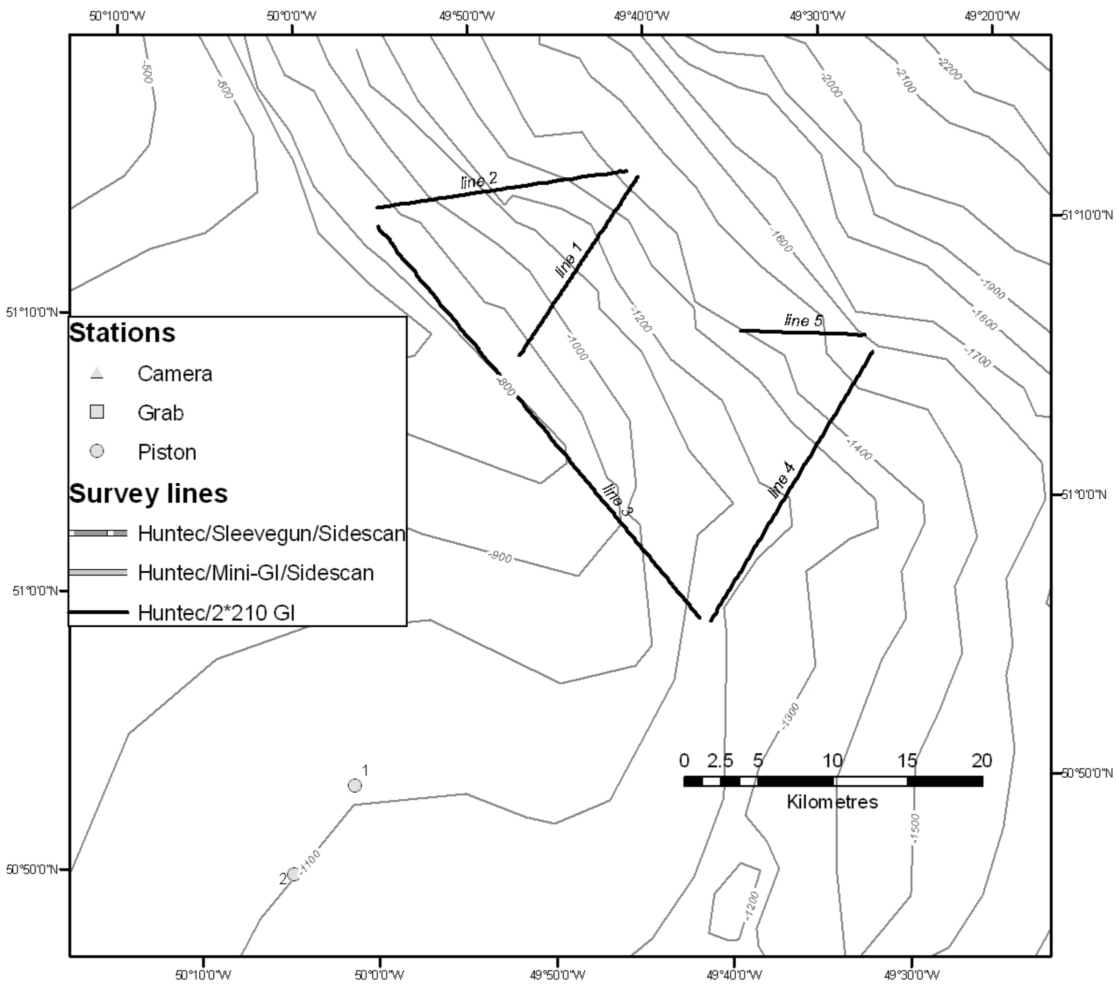
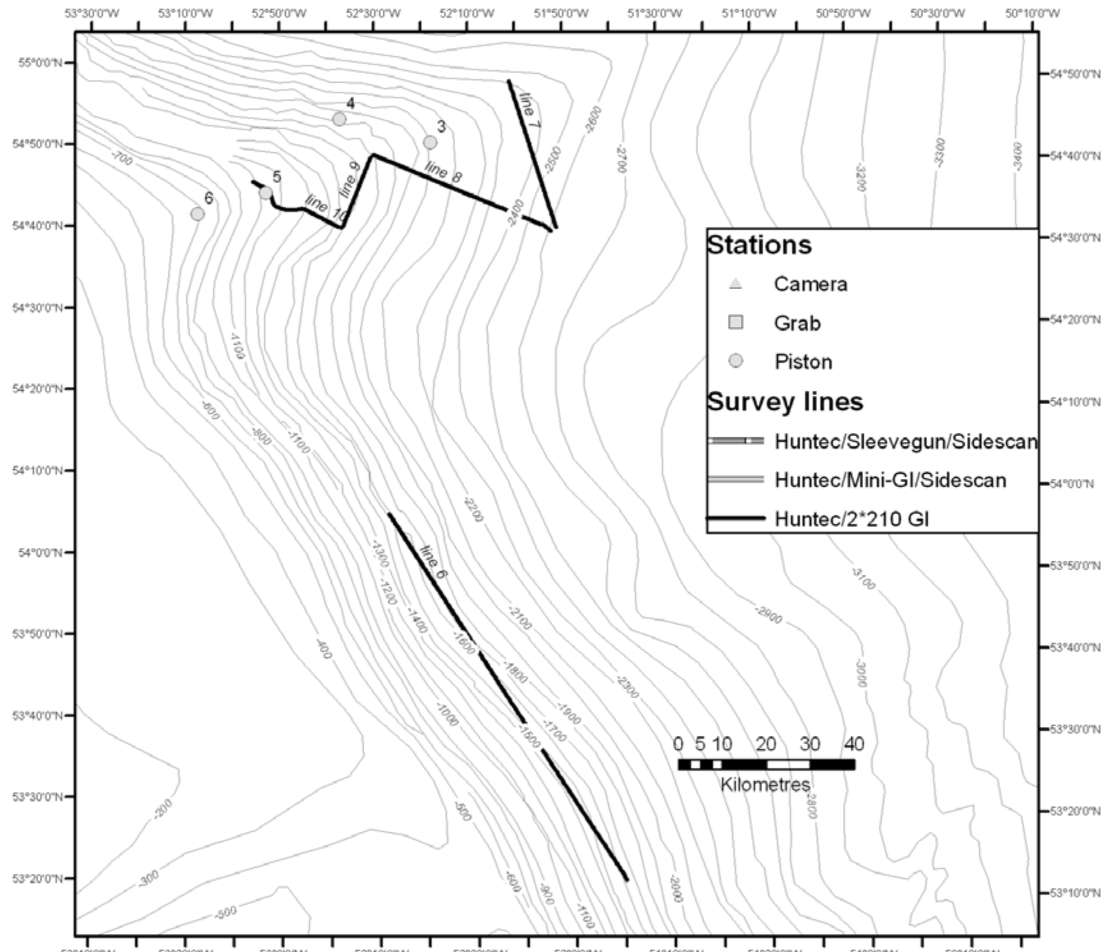


Figure A1.1 Index map of Appendix 1 map locations.

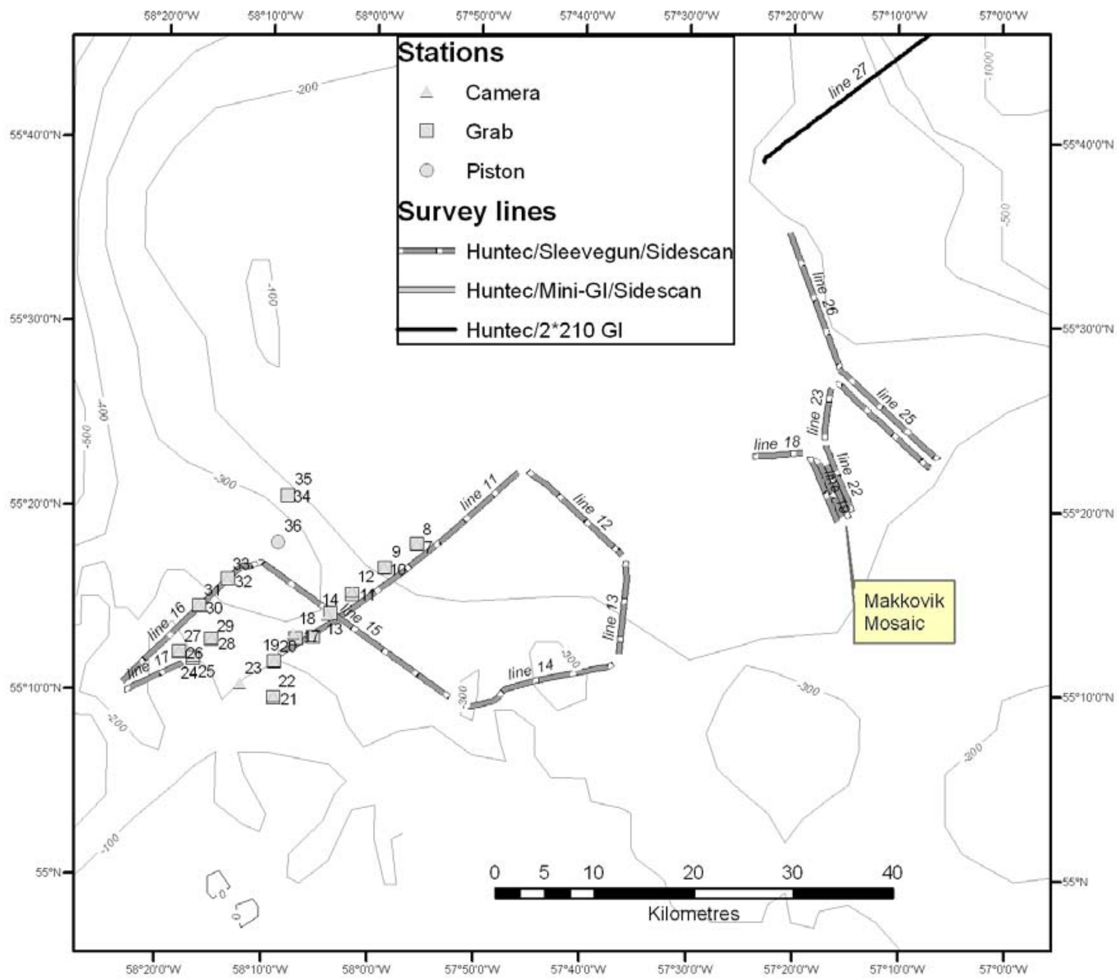
MAP 1- Orphan Spur



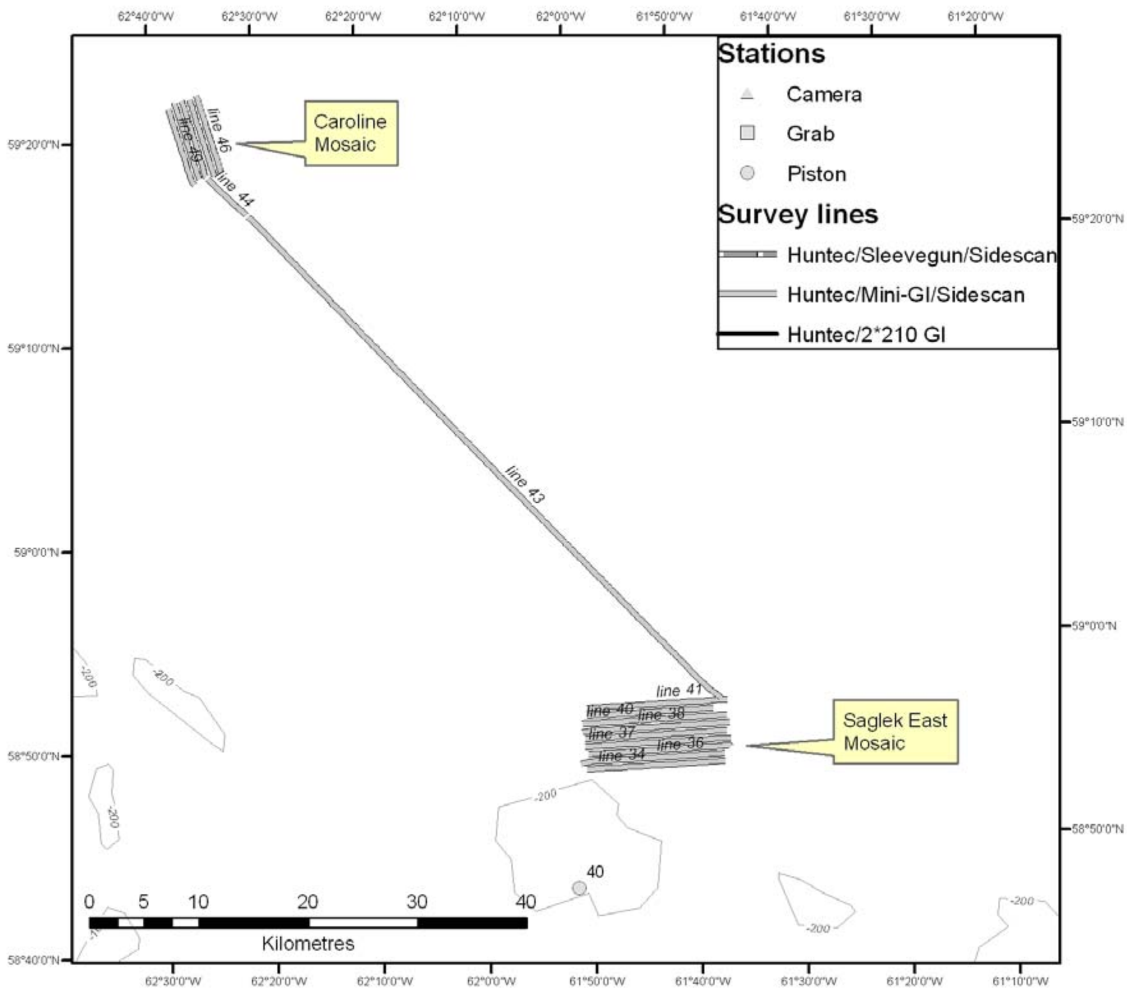
MAP 2- Hamilton Spur



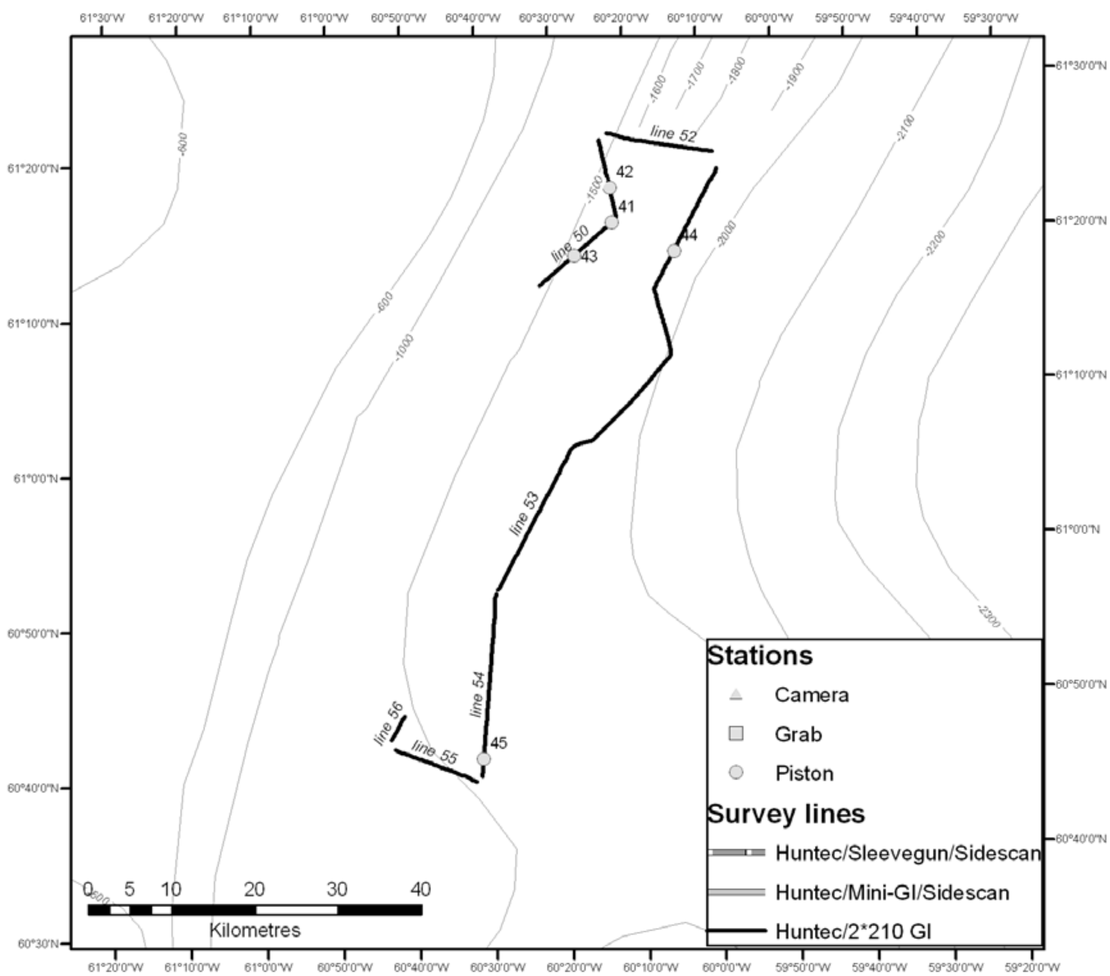
MAP 3- Makkovik Bank



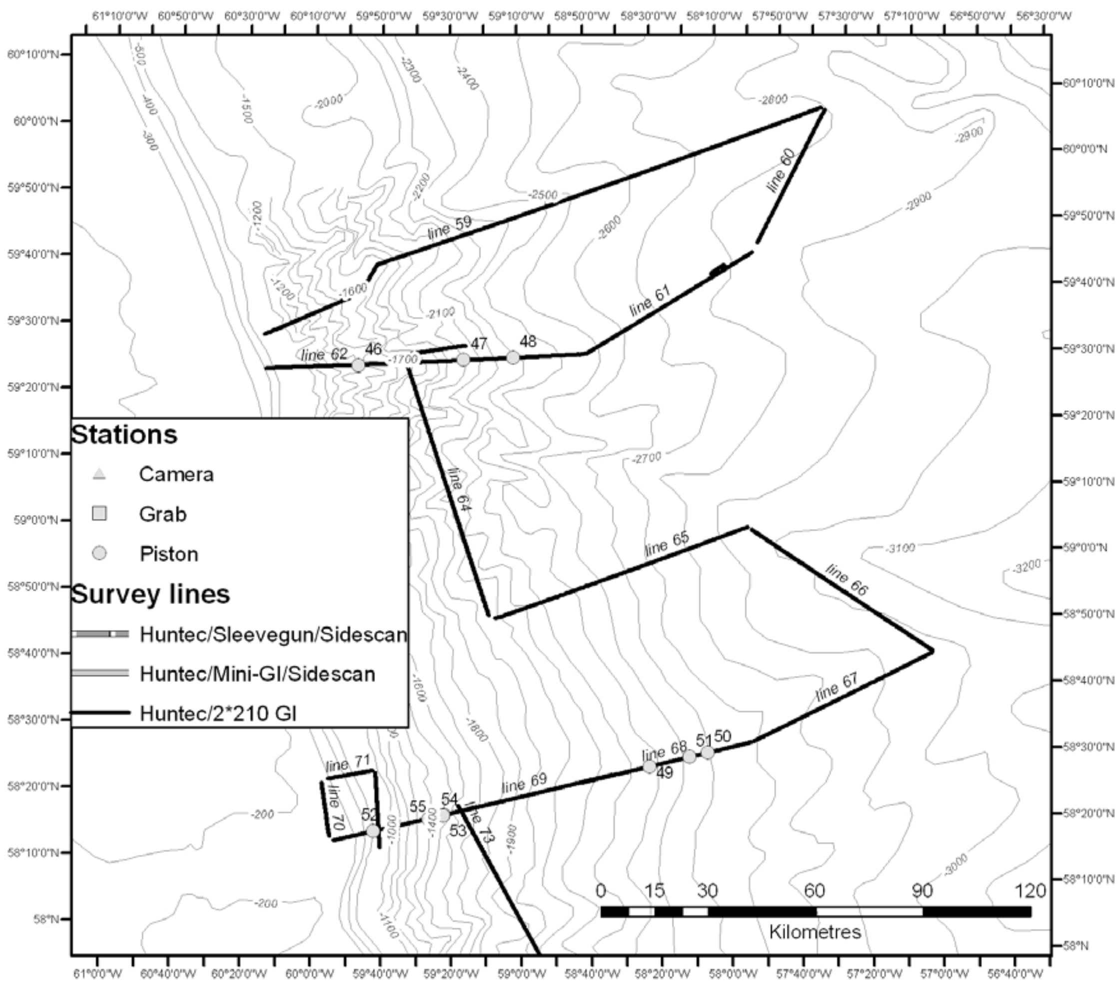
MAP 4- Saglek Bank



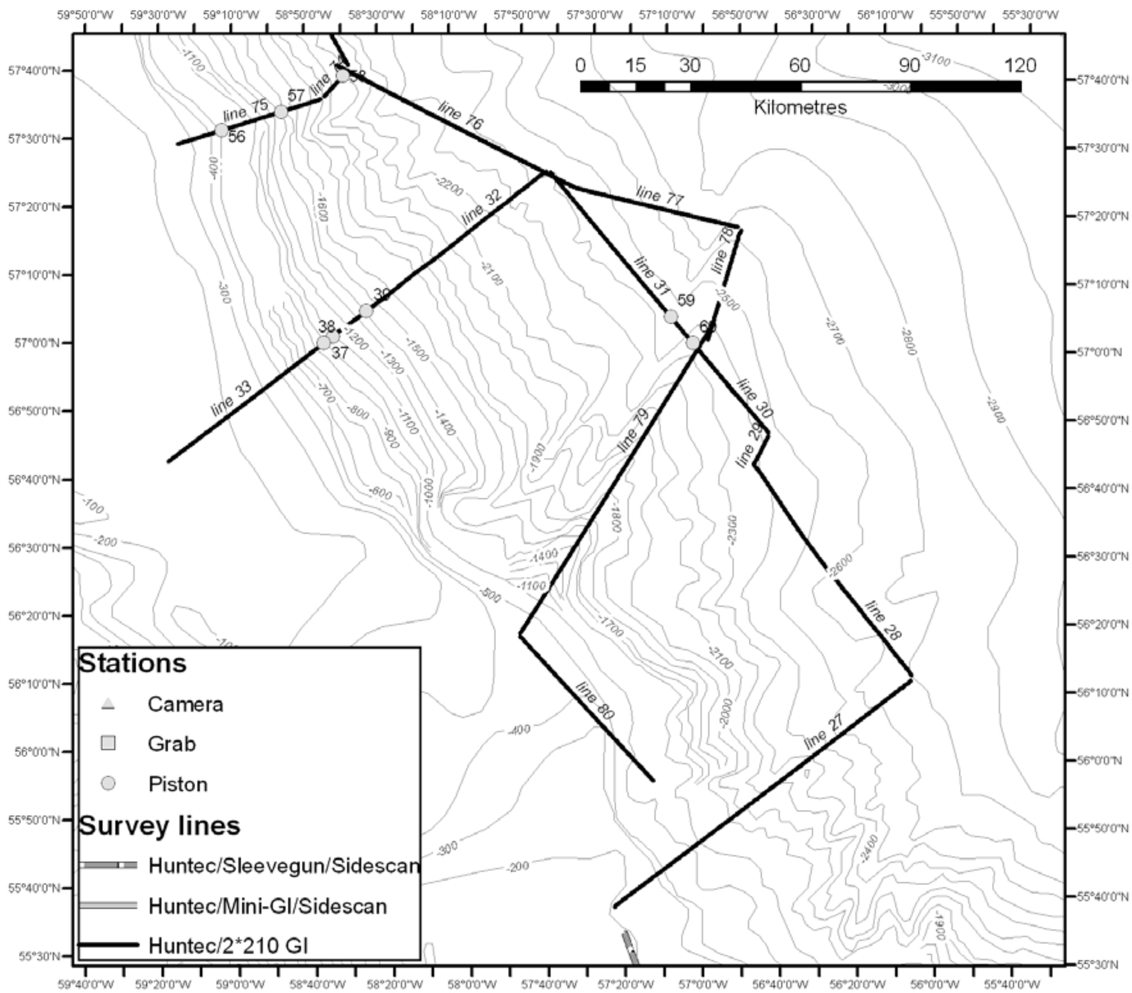
MAP 5- Slope off Hudson Strait



MAP 6- Slope off Saglek Bank



MAP 7- Slope off Hopedale Trough



Appendix 2- Station Summaries

Station Summary Table

2006040 Station Summary

Vessel: CCGS Hudson **Chief Scientist: Calvin Campbell** **Date: August 5th to September 1, 2006**

Sample loacation information							**Sesimic Record**			Cumulative sample	**Core**			**Camera**
Station No.	Sample Type	Day/Time (UTC)	Latitude	Longitude	Water Depth (m)	Location	Cruise	Day/Time (UTC)	Seismic Instr		Corer Length (cm)	TWC length (cm)	PC length (cm)	No of images
0001	Piston	218/1328	50.86729	-50.00815	1107	Orphan Spur	2005033B	212/1730	Huntec	1	1219	150	950	-
0002	Piston	218/1826	50.81739	-50.07327	1124	Orphan Spur	2005033B	212/1640	Huntec	2	1524	167	1173	-
0003	Piston	220/1751	54.79482	-52.32130	2002	Hamilton Spur	2005033B	225/2345	Huntec	3	1524	198.5	1240.5	-
0004	Piston	221/1237	54.85458	-52.63666	1770	Slope off Hamilton Bank	2005033B	225/2033	Huntec	4	1524	70.5	1245.5	-
0005	Piston	221/1628	54.71419	-52.91319	1148	Hamilton Spur	2005033B	228/0430	Huntec	5	1524	202.5	987.5	-
0006	Piston	221/1926	54.67770	-53.15729	736	Hamilton Spur	2005033B	228/0633	Huntec	6	1219	221	811.5	-
0007	VV Grab	222/1023	55.30211	-57.92821	99	Makkovik Bank	2006038	206/0045	3.5KHz	1	-	-	-	-
0008	Camera	222/1058	55.30114	-57.92840	99	Makkovik Bank	2006038	206/0045	3.5KHz	1	-	-	-	6
0009	VV Grab	222/1156	55.28022	-57.97870	147	Makkovik Bank	-	-	-	2	-	-	-	-
0010	Camera	222/1215	55.27941	-57.97977	139	Makkovik Bank	-	-	-	2	-	-	-	5
0011	VV Grab	222/1300	55.25592	-58.02930	282	Makkovik Bank	2006038	208/0802	3.5KHz	3	-	-	-	-
0012	Camera	222/1323	55.25772	-58.03028	284	Makkovik Bank	2006038	208/0802	3.5KHz	3	-	-	-	5
0013	VV Grab	222/1400	55.23840	-58.06346	261	Makkovik Bank	2006038	208/0131	3.5KHz	4	-	-	-	-
0014	Camera	222/1429	55.23647	-58.06739	259	Makkovik Bank	2006038	208/1314	3.5KHz	4	-	-	-	4
0015	VV Grab	222/1524	55.21689	-58.09074	249	Makkovik Bank	2006038	207/2134	3.5KHz	5	-	-	-	-

2006040 Station Summary Vessel: CCGS Hudson Chief Scientist: Calvin Campbell Date: August 5th to September 1, 2006														
Sample loacation information							Sesimic Record			Cumulative sample	Core			Camera
Station No.	Sample Type	Day/Time (UTC)	Latitude	Longitude	Water Depth (m)	Location	Cruise	Day/Time (UTC)	Seismic Instr		Corer Length (cm)	TWC length (cm)	PC length (cm)	No of images
0016	Camera	222/1553	55.21719	-58.09316	225	Makkovik Bank	2006038	207/2134	3.5KHz	5	-	-	-	6
0017	VV Grab	222/1630	55.21512	-58.11765	274	Makkovik Bank	2006038	207/1648	3.5KHz	6	-	-	-	-
0018	Camera	222/1701	55.21890	-58.12118	289	Makkovik Bank	2006038	207/1648	3.5KHz	6	-	-	-	6
0019	VV Grab	222/1749	55.19414	-58.15180	272	Makkovik Bank	2006038	206/1904	3.5KHz	7	-	-	-	-
0020	Camera	222/1816	55.19364	-58.15055	268	Makkovik Bank	2006038	206/1904	3.5KHz	7	-	-	-	6
0021	VV Grab	222/1858	55.16171	-58.15195	230	Makkovik Bank	2006038	205/1710	3.5KHz	8	-	-	-	-
0022	Camera	222/1924	55.16174	-58.15188	227	Makkovik Bank	2006038	205/1710	3.5KHz	8	-	-	-	6
0023	Camera	222/2009	55.17331	-58.20465	120	Makkovik Bank	2006038	205/1857	3.5KHz	9	-	-	-	0
0024	VV Grab	223/1105	55.19625	-58.27951	151	Makkovik Bank	2006038	206/1210	3.5KHz	9	-	-	-	-
0025	Camera	223/1130	55.19708	-58.27961	149	Makkovik Bank	2006038	206/1210	3.5KHz	10	-	-	-	6
0026	VV Grab	223/1200	55.20167	-58.30171	150	Makkovik Bank	2006038	206/1205	3.5KHz	10	-	-	-	-
0027	Camera	223/1222	55.20164	-58.30200	150	Makkovik Bank	2006038	206/1205	3.5KHz	11	-	-	-	9
0028	VV Grab	223/1307	55.21317	-58.25095	128	Makkovik Bank	2006038	206/1844	3.5KHz	11	-	-	-	-
0029	Camera	223/1327	55.21312	-58.25035	127	Makkovik Bank	2006038	206/1844	3.5KHz	12	-	-	-	9
0030	VV Grab	223/1411	55.24335	-58.27158	215	Makkovik Bank	2006038	207/1616	3.5KHz	12	-	-	-	-
0031	Camera	223/1434	55.24319	-58.27159	216	Makkovik Bank	2006038	207/1616	3.5KHz	13	-	-	-	9
0032	VV Grab	223/1545	55.26843	-58.22647	240	Makkovik Bank	2006038	207/2101	3.5KHz	13	-	-	-	-
0033	Camera	223/1612	55.26751	-58.22710	263	Makkovik Bank	2006038	207/2101	3.5KHz	14	-	-	-	7
0034	Camera	223/1726	55.34330	-58.13340	260	Makkovik Bank	-	-	-	15	-	-	-	7

2006040 Station Summary Vessel: CCGS Hudson Chief Scientist: Calvin Campbell Date: August 5th to September 1, 2006														
Sample loacation information							Sesimic Record			Cumulative sample	Core			Camera
Station No.	Sample Type	Day/Time (UTC)	Latitude	Longitude	Water Depth (m)	Location	Cruise	Day/Time (UTC)	Seismic Instr		Corer Length (cm)	TWC length (cm)	PC length (cm)	No of images
0035	VV Grab	223/1757	55.34466	-58.13330	248	Makkovik Bank	-	-	-	15	-	-	-	-
0036	Piston	223/1914	55.30175	-58.14845	270	Makkovik Bank	2005033B	217/0431	Huntec	7	1219	84	915.5	-
0037	Piston	226/1230	57.03754	-58.66287	1167	Slope off Nain Bank	2006040	226/0755	Huntec	8	1524	201	1245.5	-
0038	Piston	226/1608	57.02080	-58.70220	1104	Slope off Nain Bank	2006040	226/0817	Huntec	9	1524	222	1110.5	-
0039	Piston	226/1906	57.10130	-58.51418	1446	Slope off Nain Bank	2006040	226/0635	Huntec	10	1524	203	1187	-
0040	Piston	229/1814	58.75839	-61.86866	203	Karlsefni Trough	2006040	229/1711	3.5KHz	11	1219	58	1033	-
0041	Piston	231/1025	61.31022	-60.33117	1684	Slope off Hudson Strait	2006040	231/2310	Huntec	12	1524	76	529	-
0042	Piston	231/1318	61.34793	-60.34052	1720	Slope off Hudson Strait	2006040	231/2334	Huntec	13	914	44	182.5	-
0043	Piston	231/1631	61.27243	-60.41132	1725	Slope off Hudson Strait	2006040	231/2236	Huntec	14	914	11.5	295	-
0044	Piston	231/1859	61.28299	-60.18855	1862	Slope off Hudson Strait	2006040	232/0257	Huntec	15	914	12	389	-
0045	Piston	232/1239	60.72587	-60.55171	1589	Slope off Hudson Strait	2006040	232/0920	Huntec	16	1219	227	1008.5	-
0046	Piston	234/1214	59.42748	-59.88798	1214	Slope off Saglek Bank	2006040	234/0700	Huntec	17	1524	223	903	-
0047	Piston	234/1658	59.45061	-59.37049	2055	Slope off Saglek Bank	2006040	234/0410	Huntec	18	1524	199.5	913	-
0048	Piston	234/2005	59.46063	-59.12836	2275	Slope off Saglek Bank	2006040	234/0250	Huntec	19	1219	190.5	648	-
0049	Piston	236/ 1144	58.44383	-58.41133	2360	Slope off Okak Trough	2006040	236/0801	Huntec	20	1524	42	85	-
0050	Piston	236/1443	58.48119	-58.136	2544	Slope off Okak Trough	2006040	236/0621	Huntec	21	1219	209	969	-
0051	Piston	236/1759	58.46963	-58.22163	2493	Slope off Okak	2006040	236/0652	Huntec	22	1219	0	399	-

2006040 Station Summary

Vessel: CCGS Hudson **Chief Scientist: Calvin Campbell** **Date: August 5th to September 1, 2006**

Sample loacation information							**Sesimic Record**			Cumulative sample	**Core**			**Camera**
Station No.	Sample Type	Day/Time (UTC)	Latitude	Longitude	Water Depth (m)	Location	Cruise	Day/Time (UTC)	Seismic Instr		Corer Length (cm)	TWC length (cm)	PC length (cm)	No of images
						Trough								
0052	Piston	237/1156	58.26001	-59.72297	661	Slope off Okak Trough	2006040	237/0331	Huntec	23	914	0	178.5	-
0053	Piston	237/1431	58.30788	-59.38839	1531	Slope off Okak Trough	2006040	237/0136	Huntec	24	914	136.5	20	-
0054	Piston	237/1644	58.30666	-59.39080	1562	Slope off Okak Trough	2006040	237/0136	Huntec	25	914	66	211	-
0055	Piston	237/1851	58.29658	-59.46192	1443	Slope off Okak Trough	2006040	237/0201	Huntec	26	914	206.5	511	-
0056	Piston	238/1229	57.53408	-59.19344	1026	Slope off Nain Bank	2006040	238/0905	Huntec	27	1219	0	897	-
0057	Piston	238/1514	57.58436	-58.92383	1539	Slope off Nain Bank	2006040	238/0707	Huntec	28	1524	109.5	870.5	-
0058	Piston	238/1757	57.67613	-58.64638	1999	Slope off Nain Bank	2006040	238/0505	Huntec	29	1524	155	778	-
0059	Piston	239/1314	57.09620	-57.14353	2422	Slope off Hopedale Trough	2006040	225/1908	Huntec	30	1524	75	524	-
0060	Piston	239/1718	57.03283	-57.04581	2284	Slope off Hopedale Trough	2006040	225/1810	Huntec	31	1524	154	1119	-
								TOTALS				**3915**	**23330**	**91**

Piston Cores

2006040 Piston Core Summary											
Vessel: CCGS Hudson				Chief Scientist: Calvin Campbell				Date: August 5th to September 1, 2006			
Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Location	Target	Water Depth (m)	Corer Length (cm)	App. Penn. (cm)	Core Length (cm)	No. of Sections	Comments
0001	Piston	218/1328	50.8672 -50.00815	Orphan Spur	stratigraphic core into well stratified sediment	1107	1219	1219	950	6	overside 1254, on deck 1442. Problems with the winch. Tip of cutter 7cm, cutter 22cm, EE' 4cm. FG liner shattered.
0001	Trigger								170	2	
0002	Piston	218/1826	50.81738 -50.07327	Orphan Spur	mass transport deposit & overbank deposits from nearby channel.	1124	1524	1300	1173	8	overside 1803. PC cutter 17cm, firm grey silty clay with some fine to med sand and granules. Piston did not split. GH cracked and dimpled, FG dimpled.
0002	Trigger								167	2	
0003	Piston	220/1751	54.79481 -52.3213	Hamilton Spur	stratigraphic core on axis of Hamilton Spur	2002	1524	1371	1250	8	overside 1710, on deck 1840. PC catcher 3cm, cutter 16cm firm grey brown silty clay with clay balls and granules. GG' 1cm, II' 3cm I'I" 3cm. Piston did not split. Liner dimpled.
0003	Trigger								198.5	2	Grey silty clay with fine to med sand. BC liner dimpled, AB liner dimpled.
0004	Piston	221/1237	54.85457 -52.63666	Slope of Hamilton Bank	to date shallow debris flow, on high with well stratified sediment over thin mtd	1770	1524	1372	1246	8	overside 1208, on deck 1316. PC cutter 19cm, soft to firm dark grey silty clay. GG' 3cm, II' 4cm. Cutter folded over at base. HI cracked and dimpled.
0004	Trigger								70.5	1	Base soft light grey silty clay with minor sand becoming sandier up core.
0005	Piston	221/1628	54.71418 -52.91319	Hamilton Spur	stratigraphic core on axis of Hamilton Spur	1148	1524	1219	987.5	7	overside 1613, on deck 1655. PC cutter 21cm firm dark grey silty clay - clayey. E'E" 2cm, EE' 2cm. Piston did not split. EF liner imploded

Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Location	Target	Water Depth (m)	Corer Length (cm)	App. Penn. (cm)	Core Length (cm)	No. of Sections	Comments
2006040 Piston Core Summary											
Vessel: CCGS Hudson					**Chief Scientist: Calvin Campbell**				**Date: August 5th to September 1, 2006**		
											and shattered.
0005	Trigger								202.5	2	Soft grey silty clay.
0006	Piston	221/1926	54.67769 -53.15729	Hamilton Spur	stratigraphic core on axis of Hamilton Spur	736	1219	1067	811.5	6	overside 1916, on deck 1945. PC cutter 22cm firm dark grey clay with firmer clayballs and granules.
0006	Trigger								221	3	
0036	Piston	223/1914	55.30174 -58.14845	Makkovik Bank		270	1219	1150	915.5	6	overside 1903, on deck 1926. PC tip of cutter 4cm, cutter 16cm firm dark grey silty clay with granules. Rock jammed in the cutter above the tip of cutter.
0036	Trigger								84	1	0 to 40cm greenish grey silty clay with minor fine to medium sand, 40cm to base firm grey silty clay with small granules.
0037	Piston	226/1230	57.03754 -58.66287	Slope off Nain Bank	Upper core of composite stratigraphic section	1167	1524	1250	1246	9	overside 1201, on deck 1257. PC cutter 15cm soft grey silty clay with small stiff clay balls, base of AB is firm grey silty clay with small stiff clay balls. Sandy mud interval near the top. CC' 2cm. Minor damage to cutter - couple of dings. FG liner overridden at top by liner from above and cracked.
	Trigger								201	2	Base grey silty clay - very clayey.
0038	Piston	226/1608	57.02080 -58.70220	Slope off Nain Bank	Lower core of a composite stratigraphic section	1104	1524	1220	1111.	8	overside 1553, on deck 1631. PC cutter 10.5cm grey silty clay with fine gravel, catcher had coarse sand on outside, base of AB medium to coarse sand. EE' 6cm. GH dimpled top half and HI dimpled bottom half.

2006040 Piston Core Summary											
Vessel: CCGS Hudson				Chief Scientist: Calvin Campbell				Date: August 5th to September 1, 2006			
Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Location	Target	Water Depth (m)	Corer Length (cm)	App. Penn. (cm)	Core Length (cm)	No. of Sections	Comments
	Trigger								222	3	Base grey silty clay with clay granules up to 5mm.
0039	Piston	226/1906	57.10130 -58.51417	Slope off Nain Bank	Well stratified sediment over a shallow mass transport deposit	1446	1524	1371	1187	8	overside 1846, on deck 1932. PC tip of cutter 3.5cm, cutter 21cm firm grey clay, top of core greenish grey silty clay with fine to medium sand.
	Trigger								214	2	Base grey silty clay with minor fine sand, top is greenish grey silty clay with minor medium sand.
0040	Piston	229/1814	58.75838 -61.86866	Karlsefni Trough	Small basin in Karlsefni Trough to obtain good Holocene sample.	203	1219	1219	1033	7	overside 1810, on deck 1824. PC cutter 22cm soft to firm grey clay, base of AB firm grey clay. Intact brittle star on seabed surface. Piston did not split. CD liner imploded and shattered.
	Trigger								58	1	Olive green soft silty clay, preserved worm tubes on surface.
0041	Piston	231/1025	61.31022 -60.33117	Slope off Hudson Strait	Smooth ridge from multibeam data	1683	1524	750	529	4	Overside 1002, on deck 1105. Catcher soft grey clay, base of AB is firm grey clay, top of core grey silty clay with medium sand and sponge spicule mat. CC' 4cm and C'C" 4cm. Catcher fingers damaged and pulled away, probably lost sediment , no cutter sample. Section FG shattered but no sediment recovered in section.
	Trigger								76	1	Base soft to firm grey clay, top greenish grey silty clay with medium to coarse sand and fine gravel.
0042	Piston	231/1318	61.34792 -60.34052	Slope off Hudson Strait	Target was broad stripped-off area.	1720.20	914	287	182.5	2	Overside 1251, on deck 1354. PC cutter 20cm firm grey sandy silty clay with gravel, entire core is muddy sand with with a gravel bed at approx 60cm from

2006040 Piston Core Summary

Vessel: CCGS Hudson **Chief Scientist: Calvin Campbell** **Date: August 5th to September 1, 2006**

Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Location	Target	Water Depth (m)	Corer Length (cm)	App. Penn. (cm)	Core Length (cm)	No. of Sections	Comments
											top of core.
	Trigger								44	2	Base grey sandy sitly clay with gravel.
0043	Piston	231/1631	61.27243 -60.41132	Slope off Hudson Strait	"typical" canyon floor	1725	914	400	295	2	Overside 1606, on deck 1708. PC base grey silty clay with sand coarsening up core to medium to coarse sand and fine gravel. BB' 1cm and bagged.
	Trigger								11.5	1	TWC appears to have fallen over. Medium to coarse sand with gravel.
0044	Piston	231/1859	61.28298 -60.18854	Slope off Hudson Strait	smooth ridge on multibeam data	1862	914	550	389	3	Overside 1830, on deck 1935. PC cutter 20cm, firm grey clay, top of core tannish grey clay with fine gravel. CC' 2cm.
	Trigger								12	1	TWC fell over, brownish grey clay with sand on top.
0045	Piston	232/1239	60.72586 -60.55171	Slope off Hudson Strait	Core from smooth ridge based on Huntec and multibeam data	1589	1219	1040	1009.	7	Overside 1218, on deck 1312. PC tip of cutter 4cm, cutter 20cm, firm grey clay, top of core sandy silty clay. GG' 1cm, G'G" 4cm. GH dimpled and cracked.
	Trigger								227	3	Base dark grey silty clay, minor fine sand with silt granules.
0046	Piston	234/1214	59.42747 -59.88797	Slope off Hudson Strait	Stratigraphic core from smooth stratified area	1213	1524	1080	903	7	Overside 1153, on deck 1242. PC cutter 22cm, soft to firm grey silty clay with minor fine sand. EE' 8.5cm, E'E" 7cm. Subangular cobble 10 by 10cm jammed in liner jammed in section FG. Piston stuck in shattered liner in top barrel. EF imploded and shattered.
	Trigger								223	3	Top olive green sandy mud with pebbles.

2006040 Piston Core Summary

Vessel: CCGS Hudson **Chief Scientist: Calvin Campbell** **Date: August 5th to September 1, 2006**

Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Location	Target	Water Depth (m)	Corer Length (cm)	App. Penn. (cm)	Core Length (cm)	No. of Sections	Comments
0047	Piston	234/1658	59.45060 -59.37048	Slope off Saglek Bank	Stratigraphic core from smooth stratified area of seabed downslope from core 47	2055	1524	1219	913	6	Overside 1630, on deck 1740. PC cutter 25cm, firm grey clay, base of AB firm grey silty clay with small clay granules, top of AB soft grey sandy clay with fine gravel and stiff clay balls. EE' 2.5cm, E'E" 4cm. FG imploded and shattered.
	Trigger								199.5	2	Base dark grey silty clay with minor sand and clay granules, 17cm from base soft tan grey silty clay with fine sand, top of core tannish grey silty clay with medium to coarse sand and fine gravel.
0048	Piston	234/2005	59.46063 -59.12835	Slope off Saglek Bank	shallow mass transport deposit	2275	1219	914	648	5	Overside 1934, on deck 2052. PC cutter 14cm, firm grey clay, base of AB firm grey clay with clay balls. CC' 4cm. EF shattered above sediment surface, DE dimpled.
	Trigger								190.4	2	Base grey silty clay with sand, fine gravel and clay granules, colour change to dark grey silty clay with fine gravel approx 59cm from base, top of TWC greenish grey sandy silty clay with fine gravel.
0049	Piston	236/1144	58.44383 -58.41133	Slope off Okak Trough	Thin mass transport over stratified sediment	2360	1524	609	85	1	Overside 1109, on deck 1232. Top of core tannish grey silty clay with med to coarse sand and fine gravel, colour change to grey at 55cm from top. Cutter pulled back in 5 places.Liner shattered in top three barrels.
	Trigger								42	1	Top tannish grey soft silty clay with medium sand and gravel, base grey silty clay with sand and fine gravel.

2006040 Piston Core Summary											
Vessel: CCGS Hudson				**Chief Scientist: Calvin Campbell**				**Date: August 5th to September 1, 2006**			
Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Location	Target	Water Depth (m)	Corer Length (cm)	App. Penn. (cm)	Core Length (cm)	No. of Sections	Comments
0050	Piston	236/1443	58.48118 -58.13599	Slope off Okak Trough	Stratified sediment	2544	1219	1219	969	7	Overside 1407, on deck 1534. PC cutter 21cm, firm dark grey clay with some silt, base of AB firm dark grey clay with some silt, top of core tan grey silty clay with coarse sand and gravel. GH shattered.
	Trigger								209	3	Top tan silty clay with sand, AB base soft dark grey silty clay with fine sand and clay granules, base of BC soft grey silty clay with clay granules, top of BC tan silty clay with fine sand and gravel.
0051	Piston	236/1759	58.46963 -58.22162	Slope off Okak Trough	Eroded stratified sediment	2493	1219	500	399	3	Overside 1723, on deck 1851. PC cutter 24cm, soft grey sandy silty clay, PC base firm grey silty clay with clay granules, top of core tan grey silty clay with gravel with a colour change to grey at 44cm. Catcher fingers pulled away. CD cracked.
	Trigger								0	0	TWC fell over no recovery.
0052	Piston	237/1156	58.26001 -59.72297	Slope off Okak Trough	thin mass transport deposit over stratified sediment	661	914	609	178.5	2	Overside 1144, on deck 1216. Base sand and gravel, top of AB soft tan grey silty clay, top of core tan silty clay with sand and gravel. Sediment coming out of base when coming out of the water. BC shattered.
	Trigger								0	0	TWC fell over no recovery.
0053	Piston	237/1431	58.30787 -59.38839	Slope off Okak Trough	stratified sediment	1531	914	304	20	1	Overside 1408, on deck 1503. Tan grey medium to coarse sand and gravel. A couple of dings in the cutter. Catcher fingers inverted.
	Trigger								136.5	1	Top grey muddy medium to coarse sand with gravel, base grey silty clay with medium sand and gravel.

2006040 Piston Core Summary											
Vessel: CCGS Hudson				Chief Scientist: Calvin Campbell				Date: August 5th to September 1, 2006			
Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Location	Target	Water Depth (m)	Corer Length (cm)	App. Penn. (cm)	Core Length (cm)	No. of Sections	Comments
0054	Piston	237/1644	58.30665 -59.39080	Slope off Okak Trough	stratified sediment. Second attempt at site.	1562	914	304	211	2	Overside 1620, on deck 1716. PC cutter 13cm, very firm grey silty clay, catcher 5cm grey medium sand, base of AB grey medium sand, top of AB grey clay with fine sand, base BC grey clay with sandy silty partings, top BC greenish grey soupy silty clay with medium sand. Catcher fingers inverted.
	Trigger								66	1	Top stinky tan grey silty clay with fine to medium sand with gravel.
0055	Piston	237/1851	58.29658 -59.46192	Slope off Okak Trough	thick mass transport deposit	1443	914	609	511	4	Overside 1830, on deck 1922. PC cutter 24cm, firm dark grey clayey silt with fine granules, PC base firm dark grey clayey silt grading to grey silty clay with fine granules. Transition to tannish grey silty clay in BC and top of core tannish grey silty clay with medium to coarse sand. Cutter hit a rock and folded back in a couple of places.
	Trigger								206.5	2	Base soft grey silty clay with fine to medium sand with granules and pebbles, top greenish grey silty clay with medium to coarse sand.
0056	Piston	238/1229	57.53408 -59.19344	Slope off Nain Bank	stratified sediment	1026	1219	914	897	6	Overside 1214, on deck 1251. PC tip of cutter 6cm, cutter 23cm, very firm dark grey silty clay, base AB firm dark grey silty clay to grey silty clay with fine to medium sand and fine granules 44cm from the base, top of core greenish grey silty clay with minor fine sand.
	Trigger								0	0	Lost the TWC.

2006040 Piston Core Summary											
Vessel: CCGS Hudson				Chief Scientist: Calvin Campbell				Date: August 5th to September 1, 2006			
Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Location	Target	Water Depth (m)	Corer Length (cm)	App. Penn. (cm)	Core Length (cm)	No. of Sections	Comments
0057	Piston	238/1514	57.58435 -58.92382	Slope off Nain Bank	stratified sediment	1539	1524	1219	870.5	6	Overside 1453, on deck 1547. PC cutter 19cm, firm grey clayey silt with clay balls, AB base firm grey silty clay with minor sand, granules and one large pebble 5cm, top AB grey silty clay with fine to medium sand and granules, top of core soft olive green silty clay with medium sand and small pebbles.
	Trigger								109.5	1	TWC top greenish grey soft soupy silty clay with med to coarse sand and pebbles, base grey silty clay with med sand, granules and pebbles up to 7cm.
0058	Piston	238/1757	57.67613 -58.64638	Slope off Nain Bank	stratified sediment	1999	1524	1339	778	5	Overside 1726, on deck 1840. Cutter 21.5cm, soft grey silty clay with fine granules, AB base dark grey silty clay with fine to medium sand and granules, top AB firm grey clayey silt, top of core greenish grey silty clay with fine to medium sand. Rock 13 x 7cm jammed in base of cutter, cutter pulled back in two places.
	Trigger								155	1	Top soft greenish grey silty clay with minor fine sand, base firm grey very silty clay.
0059	Piston	239/1314	57.09620 -57.14353	Slope off Hopedale Trough	stratified ridge within a canyon	2422	1524	304	524	4	Overside 1126, on deck 1423. Cutter 7cm, soft very disturbed grey clayey silt with a hole in the centre, base AB dark grey fine to medium sand, top AB soft dark grey silty clay, top of core tannish greenish grey silty clay with medium to coarse sand, granules and small to medium pebbles. Problems with the winch had to run it in low gear.

2006040 Piston Core Summary											
Vessel: CCGS Hudson				Chief Scientist: Calvin Campbell				Date: August 5th to September 1, 2006			
Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Location	Target	Water Depth (m)	Corer Length (cm)	App. Penn. (cm)	Core Length (cm)	No. of Sections	Comments
	Trigger								75	1	TWC may have taken a double sample, top soft to firm grey silty clay, base soft to firm greenish grey slightly silty clay.
0060	Piston	239/1718	57.03283 -57.04581	Slope off Hopedale Trough	smooth stratified	2284	1524	1433	1119	8	Overside 1628, on deck 1819. PC cutter 21cm, firm dark grey silty clay, base firm dark grey silty clay with sand lenses with clay balls at the top of AB, top of core tannish grey silty clay with fine to medium sand. Problems with the winch had to run it in low gear.
	Trigger								154	1	Base soft grey silty clay grading to tannish grey silty clay with fine to medium sand at 50cm from top of core.

Grab samples

2006040 Grab Station Summary							
Vessel: CCGS Hudson			Chief Scientist: Calvin Campbell			Date: August 5th to September 1, 2006	
Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Water Depth (mtrs)	Location	No of subsamples	Comments
0007	Van Veen Grab	222/1023	55.30210 -57.92821	99	Labrador Shelf - Makkovik Bank	2	Greenish brown poorly sorted med to coarse sand with sub rounded to sub angular pebbles up to 4cm in length. One brittle star and amphapod. One bag of bulk sample taken in addition to the subsamples.
0009	Van Veen Grab	222/1156	55.28022 -57.97870	147	Labrador Shelf - Makkovik Bank	1	1st attempt grab tripped but only 1 sub angular granitic cobble 10cm and one subangular limestone 5cm long. 2nd attempt very poorly sorted greenish brown fine sand to granules. Mixed lithologies of angular to sub rounded pebbles and cobbles.

2006040 Grab Station Summary

Vessel: CCGS Hudson **Chief Scientist: Calvin Campbell** **Date: August 5th to September 1, 2006**

Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Water Depth (mtrs)	Location	No of subsamples	Comments
0011	Van Veen Grab	222/1300	55.25592 -58.02930	282	Labrador Shelf - Makkovik Bank	1	1st attempt little recovery, a few assorted subrounded pebbles up to 5cm long, 1 small sea urchin, 1 small star fish, 1 piece of reddish pink coral 4cm. Sample placed in one vial.
0013	Van Veen Grab	222/1400	55.23840 -58.06345	261	Labrador Shelf - Makkovik Bank	2	Greenish grey silty clay with fine sand with a veneer of sub angular to sub rounded pebbles and cobbles. One brittle star and one sea urchin. One bag of bulk sample taken in addition to the subsamples.
0015	Van Veen Grab	222/1524	55.21689 -58.09073	249	Labrador Shelf - Makkovik Bank	2	greenish brown slightly silty clay, numerous drop stones (angular cobbles and pebbles), subsurface mottled with black patches (slight odour - reduced). Pebbles are sub angular, mostly granite with some organic growth (bryozoan) on surface.
0017	Van Veen Grab	222/1630	55.21511 -58.11764	274	Labrador Shelf - Makkovik Bank	2	Greenish brown soupy silty clay at surface a few cm thick. Below surface is blackish green cohesive silty clay. A few angular drop stones on the surface, largest being 6cm in length. One bag of bulk sample taken in addition to the subsamples.
0019	Van Veen Grab	222/1749	55.19414 -58.15179	272	Labrador Shelf - Makkovik Bank	2	surface greenish brown soupy layer approx 3cm on top, silty clay with fine sand. Numerous drop stones. Sub surface blackish grey reduced sticky silty clay. Pebbles and cobbles are sub rounded to sub angular, largest approx 10cm and they have a surface growth on one side only. One bag of bulk sample taken in addition to the subsamples.
0021	Van Veen Grab	222/1858	55.16171 -58.15194	230	Labrador Shelf - Makkovik Bank	2	Greenish brown poorly sorted sandy silty mud with fine sand. Numerous angular to sub rounded pebbles and cobbles of mixed lithologies. One tunicate attached to a cobble. One bag of bulk sample taken in addition to the subsamples.
0024	Van Veen Grab	223/1105	55.19624 -58.27950	151	Labrador Shelf - Makkovik Bank	2	Jaws not fully closed. Top surface minor worm tubes, greenish brown soft sandy silt with granules over blackish green poorly sorted sandy clay. Three sub rounded drop stones up to max 6cm. On bag of bulk sample taken in addition to the subsamples.

2006040 Grab Station Summary							
Vessel: CCGS Hudson			**Chief Scientist: Calvin Campbell**			**Date: August 5th to September 1, 2006**	
Station No.	Sample Type	Day / Time (UTC)	Latitude Longitude	Water Depth (mtrs)	Location	No of subsamples	Comments
0026	Van Veen Grab	223/1200	55.20166 -58.3017	150	Labrador Shelf - Makkovik Bank	1	Green brown silty clay with medium to coarse sand. No surface visible. Many sub rounded pebbles and cobbles up to a maximum of 15cm, a few tubes on the surface of pebbles.Mixed lithologies. One bag of bulk sample including pebbles and cobbles taken in addition to the subsamples.
0028	Van Veen Grab	223/1307	55.21316 -58.25094	128	Labrador Shelf - Makkovik Bank	2	Surface veneer greenish brown fine sand, numerous pebbles on surface, worm tubes, bivalve and brittle stars. One bag of bulk sample taken in addition to the subsamples.
0030	Van Veen Grab	223/1411	55.24335 -58.27157	215	Labrador Shelf - Makkovik Bank	2	Greenish brown sandy silt, small sub rounded to sub angular pebbles of mixed lithologies, one large cobble (15cm) granitic, encrusted growth on one side and black on the other. Below surface is blackish green sticky and stiffer. One bag of bulk sample taken in addition to the subsamples.
0032	Van Veen Grab	223/1545	55.26843 -58.22646	240	Labrador Shelf - Makkovik Bank	2	1st attempt Van Veen did not close. 2nd attempt jaws still open on rocks. Mostly sub rounded pebbles and angular cobbles on the surface, greenish brown silty clay with fine sand. Brittle stars and sea urchins. One bag of bulk sample taken in addition to the subsamples.
0035	Van Veen Grab	223/1757	55.34466 -58.13329	248	Labrador Shelf - Makkovik Bank	3	Greenish brown muddy sand on top, blackish green clay with silt layer in subsurface. Numerous dropstones on the surface. One bag of bulk sample taken in addition to the subsamples.

Camera Stations

Station No.	Camera Type	Film Type	Orientation	Day (UTC)	Time (UTC)	Latitude	Longitude	Water Depth (m)	Image Name	Image Quality
2006040 Camera Station Summary										
Vessel: CCGS Hudson				**Chief Scientist: Calvin Campbell**				**Date: August 5th to September 1, 2006**		
0008	Tritech Scorpio	Digital	Vertical	222	10:58:00	55.30114	-57.92840	99	DSCN1502.JPG	Good
				222	10:59:16	55.30123	-57.92854	99	DSCN1503.JPG	Good
				222	11:01:37	55.30152	-57.92850	99	DSCN1504.JPG	Dark
				222	11:02:33	55.30167	-57.92858	99	DSCN1505.JPG	Good
				222	11:03:40	55.30180	-57.92873	99	DSCN1506.JPG	Good
				222	11:04:41	55.30200	-57.92883	99	DSCN1507.JPG	Good
0010	Tritech Scorpio	Digital	Vertical	222	12:15:47	55.27941	-57.97977	139	DSCN1513.JPG	Good
				222	12:17:00	55.27951	-57.98014	139	DSCN1514.JPG	Good
				222	12:19:07	55.27977	-57.98052	139	DSCN1515.JPG	Good
				222	12:20:08	55.27988	-57.98076	139	DSCN1516.JPG	Dark
				222	12:21:20	55.28006	-57.98081	139	DSCN1517.JPG	Dark
0012	Tritech Scorpio	Digital	Vertical	222	13:23:59	55.25772	-58.03028	284	DSCN1525.JPG	Good
				222	13:25:02	55.25763	-58.03071	284	DSCN1526.JPG	Good
				222	13:27:34	55.25740	-58.03173	284	DSCN1527.JPG	Good
				222	13:28:46	55.25729	-58.03227	284	DSCN1528.JPG	Good
				222	13:29:42	55.25720	-58.03264	284	DSCN1529.JPG	Good
0014	Tritech Scorpio	Digital	Vertical	222	14:29:19	55.23647	-58.06739	259	DSCN1535.JPG	Good
				222	14:30:27	55.23641	-58.06789	259	DSCN1536.JPG	Good
				222	14:31:31	55.23638	-58.06847	259	DSCN1537.JPG	Good

2006040 Camera Station Summary

Vessel: CCGS Hudson **Chief Scientist: Calvin Campbell** **Date: August 5th to September 1, 2006**

Station No.	Camera Type	Film Type	Orientation	Day (UTC)	Time (UTC)	Latitude	Longitude	Water Depth (m)	Image Name	Image Quality
				222	14:32:41	55.23648	-58.06912	259	DSCN1538.JPG	Good
0016	Tritech Scorpio	Digital	Vertical	222	15:53:46	55.21719	-58.09316	225	DSCN1545.JPG	Good
				222	15:54:41	55.21721	-58.09364	225	DSCN1546.JPG	Good
				222	15:55:11	55.21721	-58.09390	225	DSCN1547.JPG	Good
				222	15:55:40	55.21722	-58.09415	225	DSCN1548.JPG	Out of focus
				222	15:56:38	55.21725	-58.09465	225	DSCN1549.JPG	Good
				222	15:59:13	55.21732	-58.09590	225	DSCN1550.JPG	Good
0018	Tritech Scorpio	Digital	Vertical	222	17:01:41	55.21890	-58.12118	287.9	DSCN1556.JPG	Good
				222	17:04:25	55.21923	-58.12167	289.8	DSCN1557.JPG	cloudy
				222	17:06:12	55.21967	-58.12201	291.9	DSCN1558.JPG	Good
				222	17:08:37	55.21998	-58.12316	294	DSCN1559.JPG	Good
				222	17:10:22	55.22032	-58.12345	295	DSCN1560.JPG	Good
				222	17:11:45	55.22056	-58.12346	295.5	DSCN1561.JPG	Good
0020	Tritech Scorpio	Digital	Vertical	222	18:16:08	55.19364	-58.15055	266.8	DSCN1566.JPG	Good
				222	18:17:17	55.19376	-58.15072	267.8	DSCN1567.JPG	Good
				222	18:18:26	55.19381	-58.15067	267.8	DSCN1568.JPG	Good
				222	18:19:37	55.19386	-58.15045	267.8	DSCN1569.JPG	Good
				222	18:20:44	55.19394	-58.15035	266.9	DSCN1570.JPG	Good
				222	18:21:53	55.19390	-58.15041	267.8	DSCN1571.JPG	Good
0022	Tritech Scorpio	Digital	Vertical	222	19:24:41	55.16174	-58.15188	225.8	DSCN1576.JPG	Good
				222	19:25:59	55.16169	-58.15192	225.8	DSCN1577.JPG	Good
				222	19:27:38	55.16163	-58.15194	225.8	DSCN1578.JPG	Little dark
				222	19:29:23	55.16151	-58.15190	225.8	DSCN1579.JPG	Good

2006040 Camera Station Summary

Vessel: CCGS Hudson **Chief Scientist: Calvin Campbell** **Date: August 5th to September 1, 2006**

Station No.	Camera Type	Film Type	Orientation	Day (UTC)	Time (UTC)	Latitude	Longitude	Water Depth (m)	Image Name	Image Quality
				222	19:30:58	55.16144	-58.15192	227	DSCN1580.JPG	Good
				222	19:32:35	55.16149	-58.15184	227	DSCN1581.JPG	Good
0023	Tritech Scorpio	Digital	Vertical	222	20:09:01	55.17331	-58.20465	120	DSCN1589.JPG	underexposed
				222	20:10:23	55.17340	-58.20466	120	DSCN1590.JPG	underexposed
				222	20:11:50	55.17344	-58.20460	120	DSCN1591.JPG	underexposed
				222	20:13:22	55.17346	-58.20457	120	DSCN1592.JPG	underexposed
				222	20:14:56	55.17348	-58.20462	120	DSCN1593.JPG	underexposed
0025	Tritech Scorpio	Digital	Vertical	223	11:30:22	55.19708	-58.27961	149.9	DSCN1603.JPG	Good
				223	11:31:14	55.19713	-58.27991	149.9	DSCN1604.JPG	Little dark
				223	11:34:35	55.19682	-58.28110	149	DSCN1605.JPG	Good
				223	11:35:47	55.19671	-58.28106	149	DSCN1606.JPG	Good
				223	11:37:00	55.19668	-58.28113	149	DSCN1607.JPG	Good
				223	11:38:15	55.19670	-58.28134	149	DSCN1608.JPG	Dark
0027	Tritech Scorpio	Digital	Vertical	223	12:22:00	55.20164	-58.30200	149	DSCN1615.JPG	Good
				223	12:23:16	55.20163	-58.30199	149.9	DSCN1616.JPG	Good
				223	12:24:30	55.20158	-58.30192	149.9	DSCN1617.JPG	Good
				223	12:25:50	55.20153	-58.30196	149.9	DSCN1618.JPG	Good
				223	12:27:02	55.20148	-58.30202	149.9	DSCN1619.JPG	Good
				223	12:28:11	55.20139	-58.30190	149.9	DSCN1620.JPG	Good
				223	12:30:40	55.20132	-58.30162	150.8	DSCN1621.JPG	Good
				223	12:31:49	55.20138	-58.30167	150.8	DSCN1622.JPG	Good
				223	12:33:17	55.20148	-58.30186	149.9	DSCN1623.JPG	Good

Station No.	Camera Type	Film Type	Orientation	Day (UTC)	Time (UTC)	Latitude	Longitude	Water Depth (m)	Image Name	Image Quality
2006040 Camera Station Summary										
Vessel: CCGS Hudson			**Chief Scientist: Calvin Campbell**				**Date: August 5th to September 1, 2006**			
0029	Tritech Scorpio	Digital	Vertical	223	13:27:01	55.21312	-58.25035	125.8	DSCN1629.JPG	Good
				223	13:27:51	55.21316	-58.25035	125.8	DSCN1630.JPG	Good
				223	13:29:04	55.21332	-58.25029	127	DSCN1631.JPG	Good
				223	13:30:24	55.21343	-58.25015	125.8	DSCN1632.JPG	Good
				223	13:31:43	55.21351	-58.24997	124.8	DSCN1633.JPG	Good
				223	13:33:09	55.21337	-58.24980	125.8	DSCN1634.JPG	Good
				223	13:34:06	55.21321	-58.24974	125.8	DSCN1635.JPG	Good
				223	13:35:24	55.21298	-58.24987	125.8	DSCN1636.JPG	Good
				223	13:37:49	55.21295	-58.25028	127	DSCN1637.JPG	Good
0031	Tritech Scorpio	Digital	Vertical	223	14:34:18	55.24319	-58.27159	216	DSCN1644.JPG	Good
				223	14:35:20	55.24320	-58.27169	216	DSCN1645.JPG	Good
				223	14:36:38	55.24322	-58.27174	216	DSCN1646.JPG	Good
				223	14:37:51	55.24320	-58.27173	216	DSCN1647.JPG	Good
				223	14:39:03	55.24319	-58.27159	216	DSCN1648.JPG	Good
				223	14:40:18	55.24320	-58.27142	216	DSCN1649.JPG	Good
				223	14:41:28	55.24321	-58.27123	216	DSCN1650.JPG	Good
				223	14:42:49	55.24326	-58.27119	216	DSCN1651.JPG	Good
				223	14:44:15	55.24332	-58.27133	216	DSCN1652.JPG	Good
0033	Tritech Scorpio	Digital	Vertical	223	16:11:09	55.26754	-58.22695	264.8	DSCN1659.JPG	Good
				223	16:12:20	55.26751	-58.22710	264.8	DSCN1660.JPG	Good
				223	16:15:25	55.26717	-58.22753	264.8	DSCN1661.JPG	Good
				223	16:16:45	55.26696	-58.22765	264.8	DSCN1662.JPG	Good
				223	16:18:06	55.26685	-58.22755	263.9	DSCN1663.JPG	Good
				223	16:19:24	55.26675	-58.22752	263.9	DSCN1664.JPG	Good

2006040 Camera Station Summary										
Vessel: CCGS Hudson			**Chief Scientist: Calvin Campbell**				**Date: August 5th to September 1, 2006**			
Station No.	Camera Type	Film Type	Orientation	Day (UTC)	Time (UTC)	Latitude	Longitude	Water Depth (m)	Image Name	Image Quality
				223	16:20:54	55.26662	-58.22750	263.9	DSCN1665.JPG	Good
0034	Tritech Scorpio	Digital	Vertical	223	17:26:28	55.34330	-58.13340	255	DSCN1674.JPG	Good
				223	17:27:37	55.34317	-58.13320	255	DSCN1675.JPG	Good
				223	17:28:56	55.34298	-58.13306	256.9	DSCN1676.JPG	Good
				223	17:30:24	55.34271	-58.13308	257.8	DSCN1677.JPG	Good
				223	17:31:38	55.34258	-58.13313	257.8	DSCN1678.JPG	Good
				223	17:32:47	55.34246	-58.13327	259	DSCN1679.JPG	Good
				223	17:34:06	55.34235	-58.13362	259	DSCN1680.JPG	Good

Appendix 3- Geophysical Records

Hard copy records

Seismic Teledyne 2K Records

Record #	Start Time	End Time	Line #	Notes	Record #	Start Time	End Time	Line #	Notes
1	218/2110	219/0935	1, 2, 3, 4, 5	GI Airgun	2	219/2335	220/1210	6	GI Airgun
3	220/2100	221/1000	7, 8, 9, 10	GI Airgun	4	222/2215	223/1015	11, 12, 13, 14, 15, 16, 17	Sleeve Gun
5	223/2320 224/0425	224/0345 224/1000	18, 19, 20, 21, 22, 23, 24, 25, 26	Sleeve Gun	6	224/1120	225/1000	27, 28, 29, 30	GI Airgun
					7	225/1640	226/1000	31, 32	GI Airgun
8	226/2155	227/0300	33	Sleeve Gun	9	229/2006	230/0830	34, 35, 36, 37, 38, 39, 40, 41	Mini GI Airgun
10	230/1700	230/2150	42, 43, 44, 45, 46, 47, 48, 49	Mini GI Airgun	11	231/2205	232/1105	50, 51, 52, 53, 54, 55, 56	GI Airgun
12	232/2110 233/1920	233/1855 234/0930	57, 58, 59, 60, 61, 62	GI Airgun	13	235/0126	235/1731	63, 64, 65	GI Airgun
14	235/1736	236/0931	66, 67, 68	GI Airgun	15	236/2021	237/1000	69, 60, 71, 72	GI Airgun
16	237/2116	238/1029	73, 74, 75	GI Airgun	17	238/1954	239/1000	76, 77, 78	GI Airgun
18	239/1945	240/1035	79, 80	GI Airgun					

Huntec Records

Record #	Start Time	End Time	Line #	Notes	Record #	Start Time	End Time	Line #	Notes
1	218/2119	219/0940	1, 2, 3, 4, 5		2	219/2345	220/1205	6	
3	220/2050	221/1000	7, 8, 9, 10		4	222/2105	223/1010	11, 12, 13, 14, 15, 16, 17	
5	223/2310	224/1000	18, 19, 20, 21, 22, 23, 24, 25, 26		6	224/1115	225/1000	27, 28, 29, 30	
7	225/1535	226/1000	31, 32		8	226/2150	227/0300	33	

Huntec Records

Record #	Start Time	End Time	Line #	Notes	Record #	Start Time	End Time	Line #	Notes
9	229/2000	229/2250	34, 35		10	229/2255	230/0835	35, 36, 37, 38, 39, 40, 41	
11	230/0835	230/1655	42, 43, 44		12	230/1700	230/2150	45, 46, 47, 48, 49	
13	231/2200	232/1105	50, 51, 52, 53, 54, 55, 56		14	232/2105	233/0225	57, 58, 59	
15	233/0235	233/1900	59, 60, 61		16	233/1920	234/0930	61, 62	
17	235/0116	235/1731	63, 64, 65		18	235/1736	236/0931	66, 67, 68	
19	236/2016	237/1000	69, 70, 71, 72		20	237/2100	238/1029	73, 74, 75	
21	238/1944	239/0954	76, 77, 78		22	239/1950	240/0955	79, 80	

3.5 KHZ

Record #	Start Time	End Time	Line #	Notes	Record #	Start Time	End Time	Line #	Notes
1	221/1050	222/2105			2	223/1820	223/1955		
3	223/2000	223/2245			4	225/1050 226/1105	225/1545 226/2125		
5	229/1455	229/1915			6	230/2235	231/1920		
7	232/1330	232/1950			8	234/1010	234/2025		
9	236/1126 237/1026	236/1931 237/1131			10	237/1136	237/1851		
11	238/1109	238/1919			12	239/1034	239/1825		

12 KHZ

Record #	Start Time	End Time	Line #	Notes	Record #	Start Time	End Time	Line #	Notes
1	218/2120	221/2130			2	222/2140	225/1829		
3	225/1900 229/1525	227/0300 231/1415			4	231/1420	235/2225		
5	235/2345	240/1020							

Digital data records

Sidescan DVD's				
DVD #	Start Time	End Time	Line #	Notes
1	222/2109	223/2359	11, 12, 13, 14, 15, 16, 18	
2	224/0005	224/1015	19, 20, 21, 22, 23, 24, 25, 26	
3	226/2304	227/0306	33	
4	229/1958	230/0603	34, 35, 36, 37, 38, 39, 40	
5	230/0603	230/1424	40, 41, 42, 43	
6	230/1424	230/2150	43, 44, 45, 46, 47, 48	
7				Sonar Wiz Mosaics (all)

Huntec DVD's			
DVD #	Start Time	End Time	Line #
1	218/2116	219/0945	1, 2, 3, 4, 5
2	220/0002	220/1205	6
3	220/2103	222/2359	7, 8, 9, 10, 11
4	223/0000	223/0959	11, 12, 13, 14, 15, 16, 17
5	223/1000	224/0627	17, 18, 19, 20, 21, 22, 23, 24, 25
6	224/0627	224/2359	25, 26, 27, 28
7	225/0000	225/2359	28, 29, 30, 31
8	226/0000	227/0304	31, 32, 33
9	229/2002	230/0601	34, 35, 36, 37, 38, 39, 40
10	230/0601	230/1501	40, 41, 42, 43
11	230/1501	232/1105	43 - 56
12	232/2113	233/1540	57, 58, 59, 60
13	233/1540	234/0021	60, 61
14	234/0021	234/0930	61, 62
15	235/0118	235/2218	63, 64, 65, 66
16	235/2219	236/0931	66, 67, 68
17	236/2017	237/1006	69, 70, 71, 72
18	237/2058	238/1030	73, 74, 75
19	238/1947	239/1001	76, 77, 78
20	239/1932	240/1008	79, 80

Seismic Teledyne DVD's			
DVD #	Start Time	End Time	Line #
1	218/2123	226/1001	1 - 32
2	226/2159	234/0933	33 - 62
3	235/0120	240/1000	63 - 80

Line record summaries

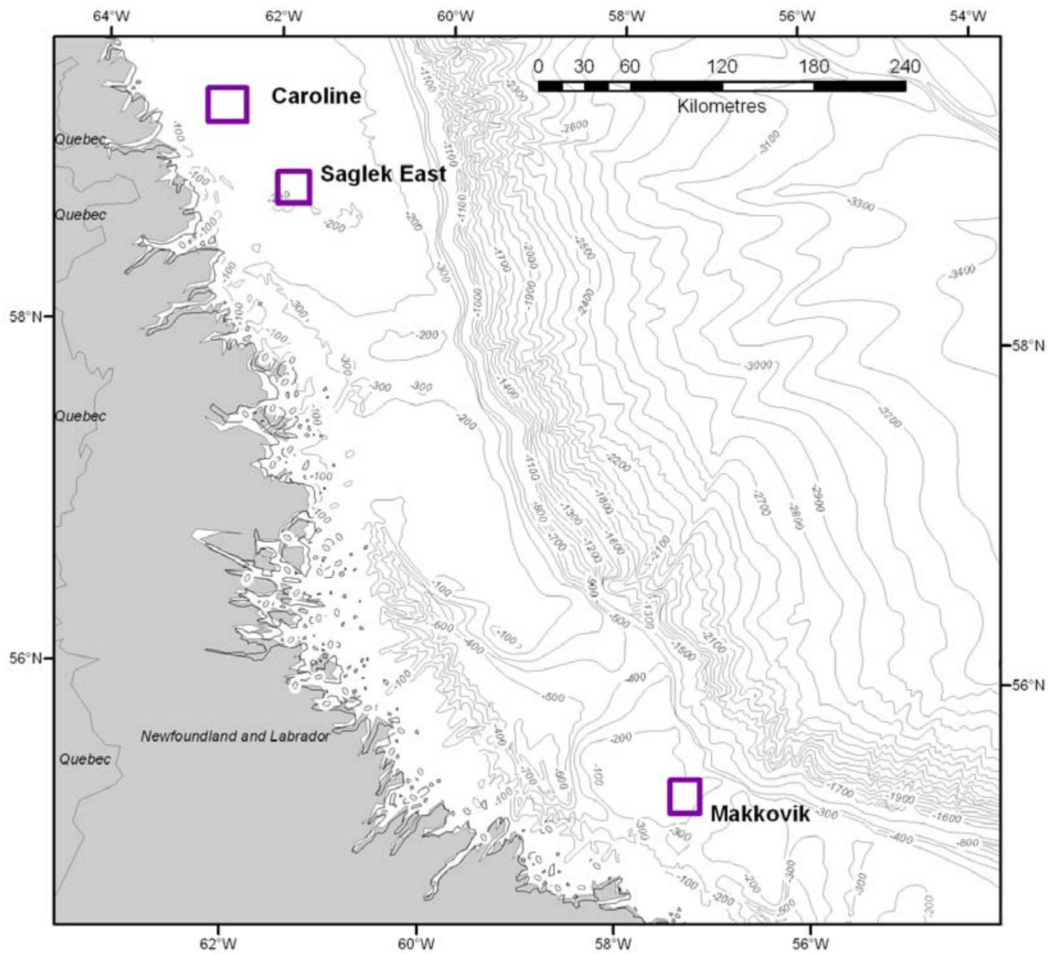
Line	Start	End	Seismics TELEDYNE Rec. #	Seismics TELEDYNE DVD #	Gun Vol.		Huntec Rec. #	Huntec DVD #	Sidescan DVD #	12 KHz Rec. #
1	218/2119	219/0037	1	1	2*210	GI Airgun	1	1		1
2	219/0047	219/0248	1	1	2*210	GI Airgun	1	1		1
3	219/0258	219/0608	1	1	2*210	GI Airgun	1	1		1
4	219/0610	219/0838	1	1	2*210	GI Airgun	1	1		1
5	219/0848	219/0940	1	1	2*210	GI Airgun	1	1		1
6	219/2337	220/1300	2	1	2*210	GI Airgun	2	2		1
7	220/2035	221/0025	3	1	2*210	GI Airgun	3	3		1
8	221/0036	221/0500	3	1	2*210	GI Airgun	3	3		1
9	221/0506	221/0700	3	1	2*210	GI Airgun	3	3		1
10	221/0703	221/1002	3	1	2*210	GI Airgun	3	3		1
11	222/2108	223/0041	4	1	10"	Sleeve Gun	4	3	1	2
12	223/0047	223/0207	4	1	10"	Sleeve Gun	4	4	1	2
13	223/0211	223/0310	4	1	10"	Sleeve Gun	4	4	1	2
14	223/0317	223/0452	4	1	10"	Sleeve Gun	4	4	1	2
15	223/0500	223/0726	4	1	10"	Sleeve Gun	4	4	1	2
16	223/0726	223/0924	4	1	10"	Sleeve Gun	4	4	1	2
17	223/0930	223/1011	4	1	10"	Sleeve Gun	4	5	1	2
18	223/2305	223/2351	5	1	10"	Sleeve Gun	5	5	1	2
19	223/2357	224/0044	5	1	10"	Sleeve Gun	5	5	2	2
20	224/0056	224/0132	5	1	10"	Sleeve Gun	5	5	2	2
21	224/0141	224/0223	5	1	10"	Sleeve Gun	5	5	2	2
22	224/0232	224/0316	5	1	10"	Sleeve Gun	5	5	2	2
23	224/0320	224/0354	5	1	10"	Sleeve Gun	5	5	2	2
24	224/0358	224/0512	5	1	10"	Sleeve Gun	5	5	2	2
25	224/0520	224/0727	5	1	10"	Sleeve Gun	5	5, 6	2	2
26	224/0727	224/1000	5	1	10"	Sleeve Gun	5	6	2	2
27	224/1131	224/2305	6	1	2*210	GI Airgun	6	6		2
28	224/2315	225/0654	6	1	1*210	GI Airgun	6	6, 7		2
29	225/0658	225/0758	6	1	1*210	GI Airgun	6	7		2
30	225/0802	225/1000	6	1	1*210	GI Airgun	6	7		2
31	225/1610	226/0023	7	1	2*210	GI Airgun	7	7, 8		2, 3
32	226/0030	226/1000	7	1	2*210	GI Airgun	7	8		3
33	226/2200	227/0300	8	2	10"	Sleeve Gun	8	8	3	3
34	229/2006	229/2140	9	2		Mini GI Airgun	9	9	4	3
35	229/2151	229/2316	9	2		Mini GI	9,	9	4	3

Line	Start	End	Seismics TELEDYNE Rec. #	Seismics TELEDYNE DVD #	Seismics Gun Vol.		Huntec Rec. #	Huntec DVD #	Sidescan DVD #	12 KHz Rec. #
						Airgun	10			
36	229/2335	230/0054	9	2		Mini GI Airgun	10	9	4	3
37	230/0103	230/0226	9	2		Mini GI Airgun	10	9	4	3
38	230/0237	230/0401	9	2		Mini GI Airgun	10	9	4	3
39	230/0415	230/0526	9	2		Mini GI Airgun	10	9	4	3
40	230/0546	230/0710	9	2		Mini GI Airgun	10	9, 10	4, 5	3
41	230/0725	230/0834	9	2		Mini GI Airgun	10	10	5	3
42	230/0858	230/1011	10	2		Mini GI Airgun	11	10	5	3
43	230/1018	230/1625	10	2		Mini GI Airgun	11	10, 11	5, 6	3
44	230/1625	230/1653	10	2		Mini GI Airgun	11	11	6	3
45	230/1653	230/1736	10	2		Mini GI Airgun	12	11	6	3
46	230/1750	230/1839	10	2		Mini GI Airgun	12	11	6	3
47	230/1900	230/1944	10	2		Mini GI Airgun	12	11	6	3
48	230/2000	230/2045	10	2		Mini GI Airgun	12	11	6	3
49	230/2101	230/2149	10	2		Mini GI Airgun	12	11		3
50	231/2204	231/2314	11	2	2*210	GI Airgun	13	11		4
51	231/2314	232/0005	11	2	2*210	GI Airgun	13	11		4
52	232/0012	232/0130	11	2	2*210	GI Airgun	13	11		4
53	232/0143	232/0727	11	2	2*210	GI Airgun	13	11		4
54	232/0730	232/0932	11	2	2*210	GI Airgun	13	11		4
55	232/0938	232/1036	11	2	2*210	GI Airgun	13	11		4
56	232/1044	232/1103	11	2	2*210	GI Airgun	13	11		4
57	232/2105	232/2356	12	2	2*210	GI Airgun	14	12		4
58	232/2358	233/0057	12	2	2*210	GI Airgun	14	12		4
59	233/0057	233/1306	12	2	2*210	GI Airgun	14, 15	12		4
60	233/1315	233/1734	12	2	2*210	GI Airgun	15	12, 13		4
61	233/1756	234/0053	12	2	2*210	GI Airgun	15, 16	13, 14		4
62	234/0053	234/0930	12	2	2*210	GI Airgun	16	14		4
63	235/0120	235/0304	13	3	2*210	GI Airgun	17	15		4

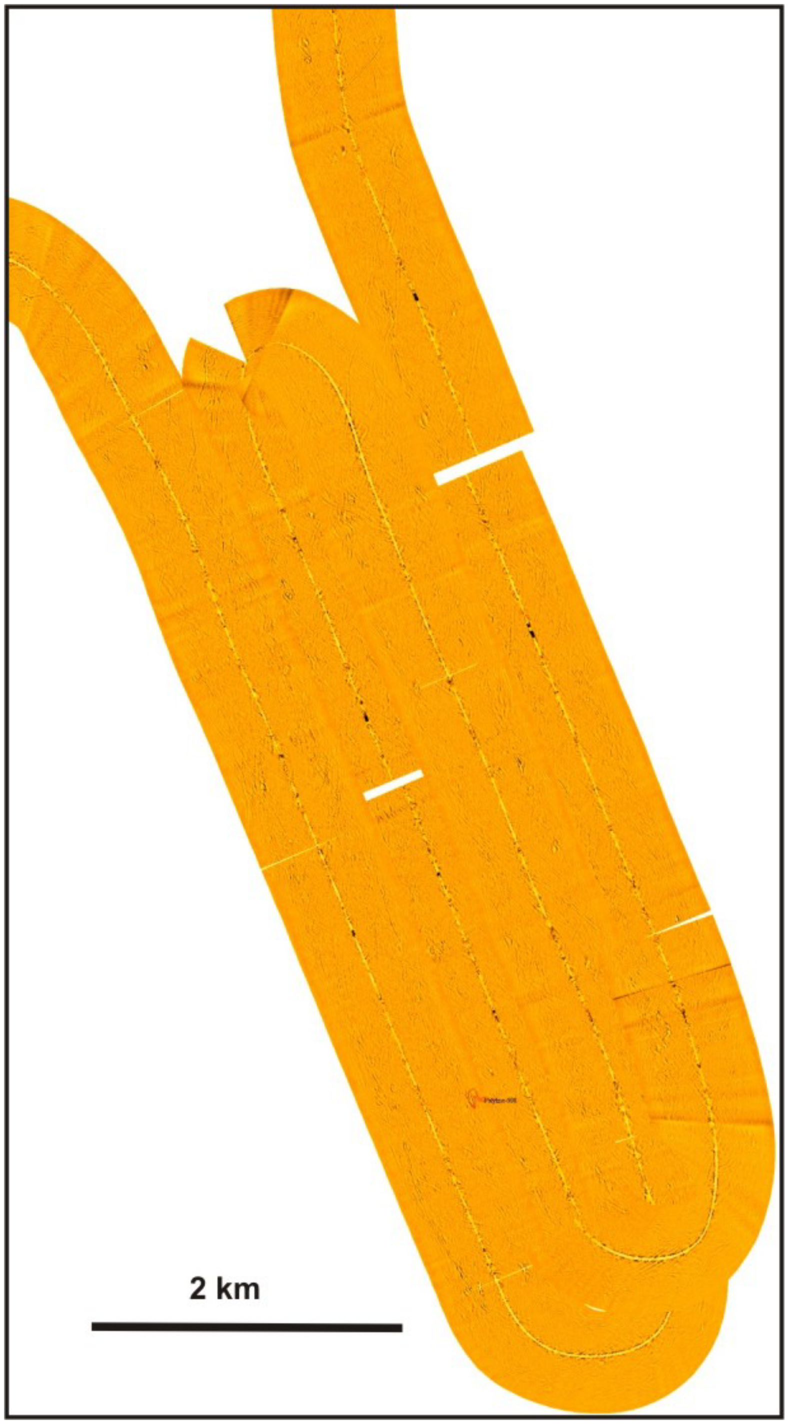
Line	Start	End	Seismics				Huntec		Sidescan	12 KHz
			TELEDYNE		Gun					
			Rec. #	DVD #	Vol.		Rec. #	DVD #	DVD #	Rec. #
64	235/0309	235/1000	13	3	2*210	GI Airgun	17	15		4
65	235/1010	235/1733	13	3	2*210	GI Airgun	17	15		4
66	235/1741	235/2341	14	3	2*210	GI Airgun	18	15, 16		4
67	235/2341	236/0459	14	3	2*210	GI Airgun	18	16		5
68	236/0503	236/1000	14	3	2*210	GI Airgun	18	16		5
69	236/2103	237/0442	15	3	2*210	GI Airgun	19	17		5
70	237/0457	237/0638	15	3	2*210	GI Airgun	19	17		5
71	237/0651	237/0807	15	3	2*210	GI Airgun	19	17		5
72	237/0813	237/1000	15	3	2*210	GI Airgun	19	17		5
73	237/2110	238/0445	16	3	2*210	GI Airgun	20	18		5
74	238/0453	238/0548	16	3	2*210	GI Airgun	20	18		5
75	238/0556	238/1030	16	3	2*210	GI Airgun	20	18		5
76	238/1957	239/0253	17	3	2*210	GI Airgun	21	19		5
77	239/0257	239/0703	17	3	2*210	GI Airgun	21	19		5
78	239/0710	239/1000	17	3	2*210	GI Airgun	21	19		5
79	239/1947	240/0524	18	3	2*210	GI Airgun	22	20		5
80	240/0530	240/1000	18	3	2*210	GI Airgun	22	20		5

Appendix 4- Sidescan Sonar Mosaics

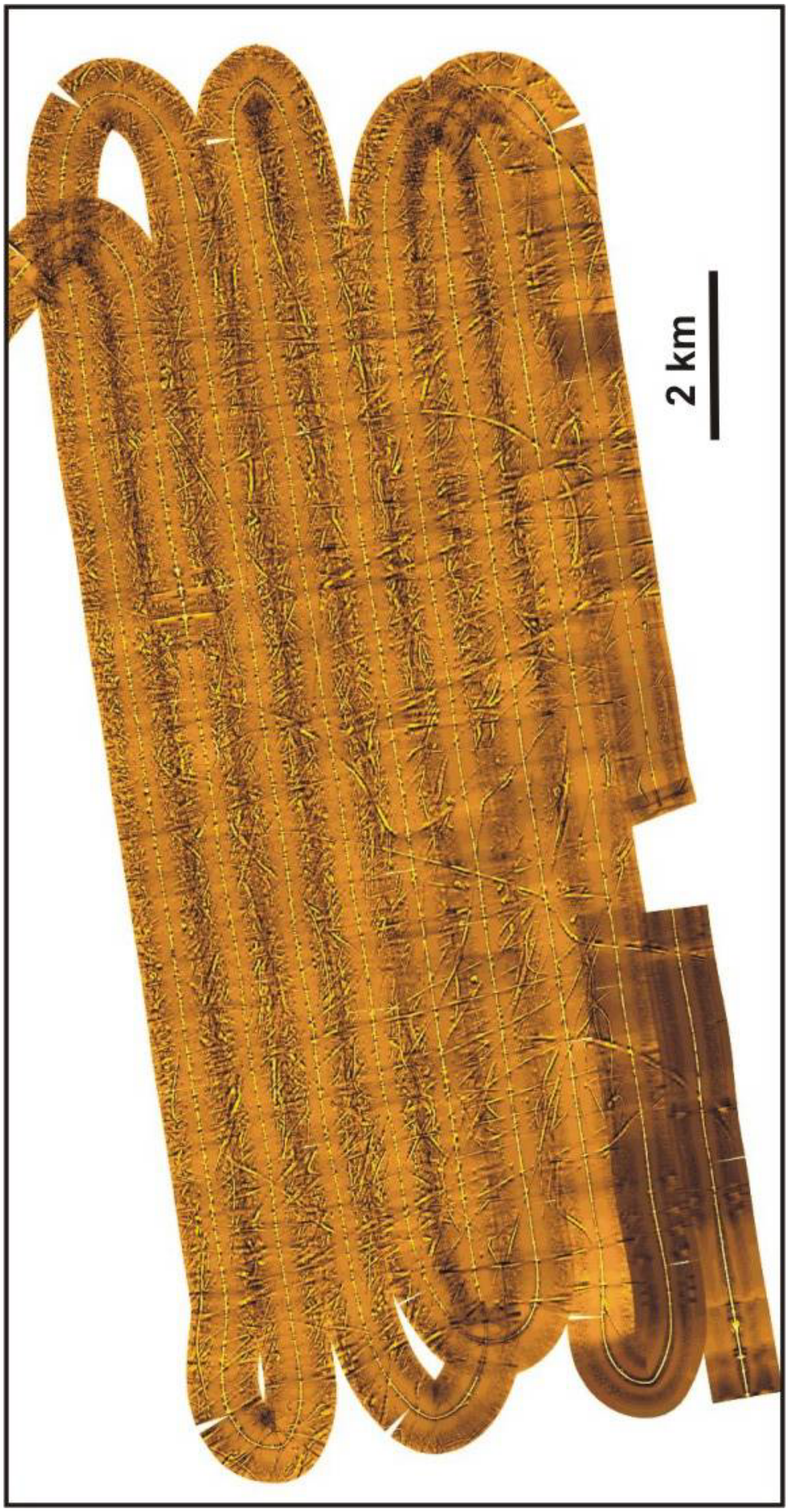
Overview of mosaic locations



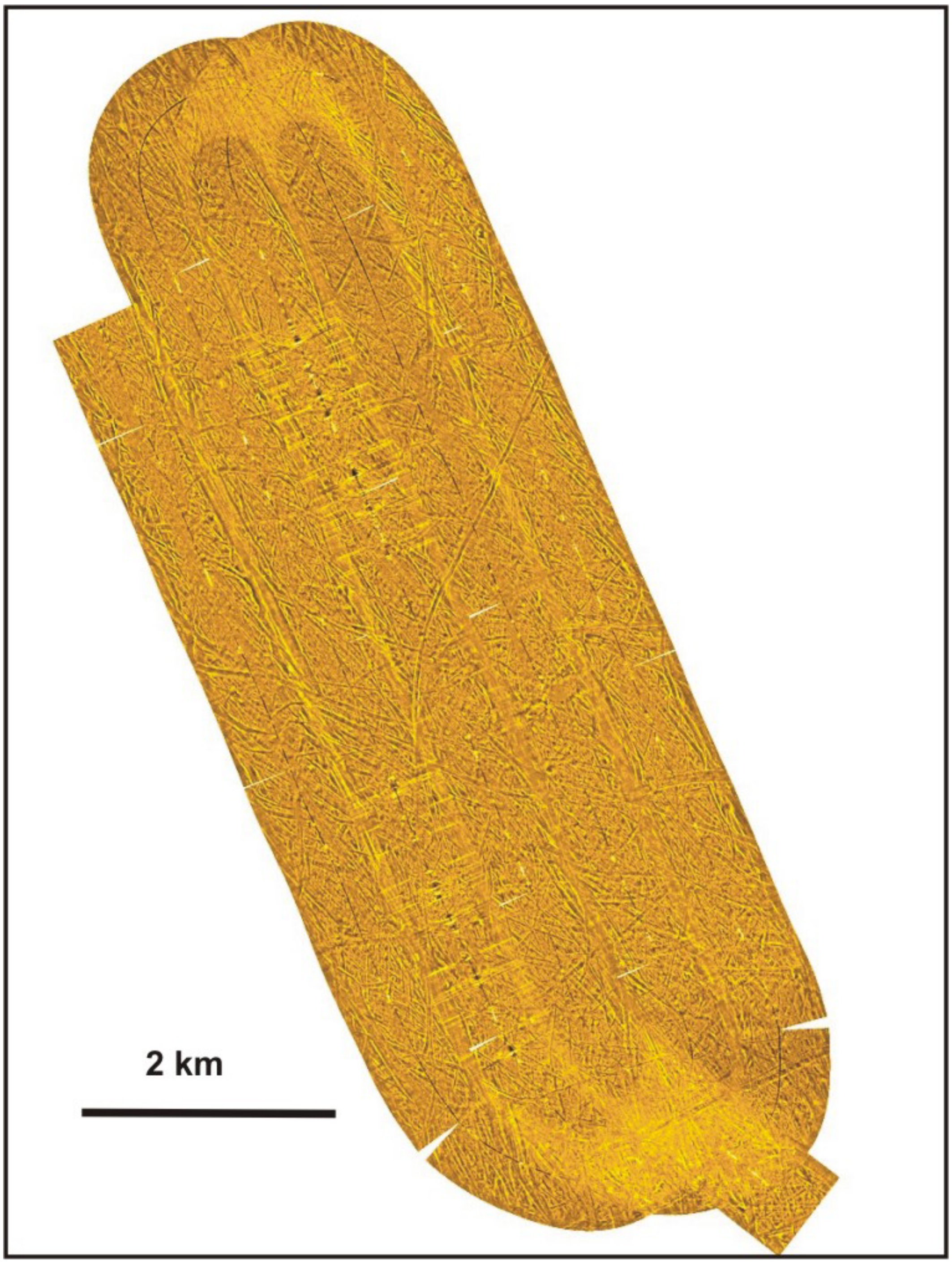
Makkovik Mosaic



Saglek East Mosaic

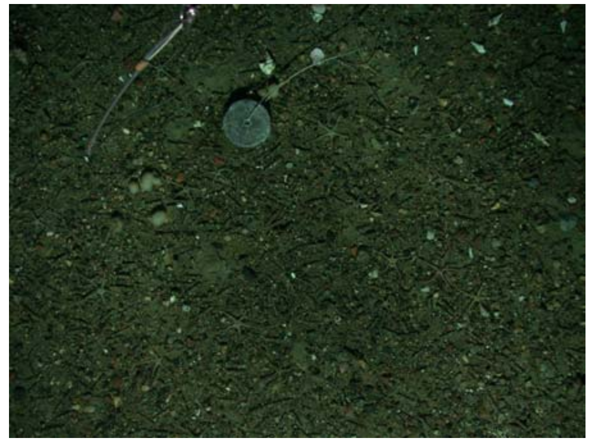


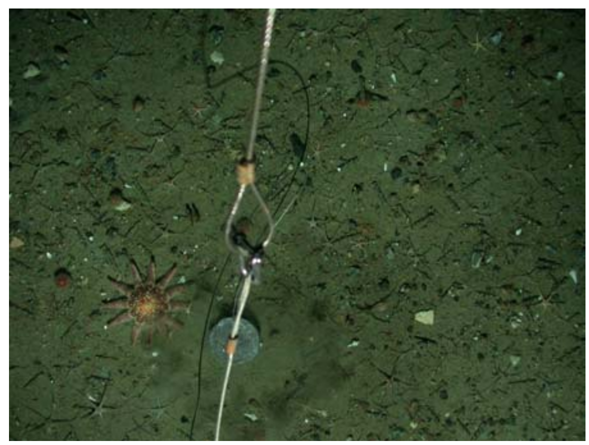
Caroline Mosaic



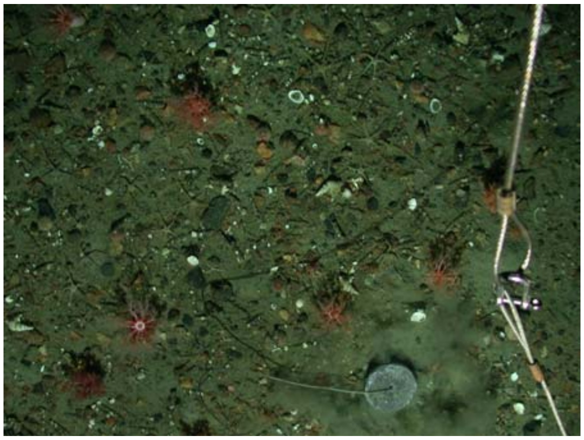
Appendix 5- Seafloor Photographs

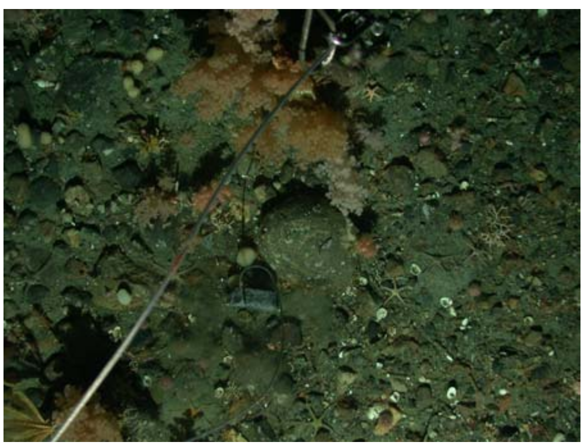
2006040 Camera Station 0008

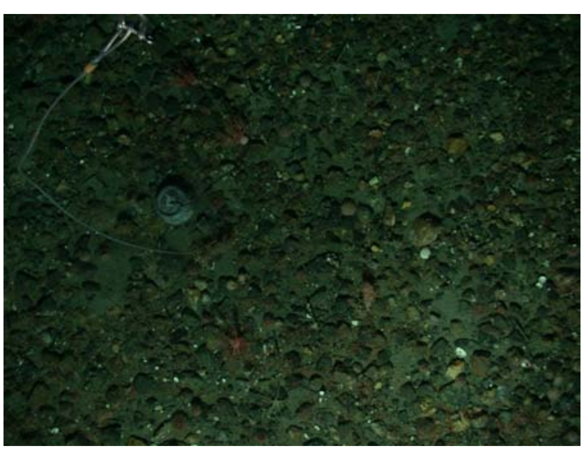




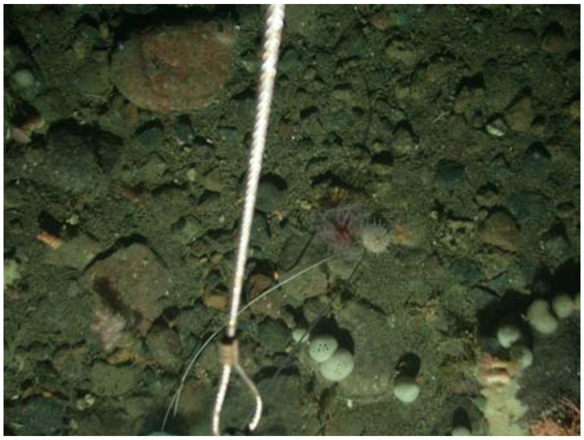
2006040 Camera Station 0010

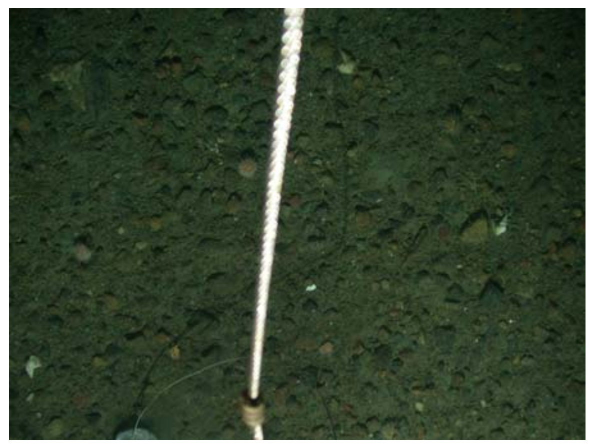


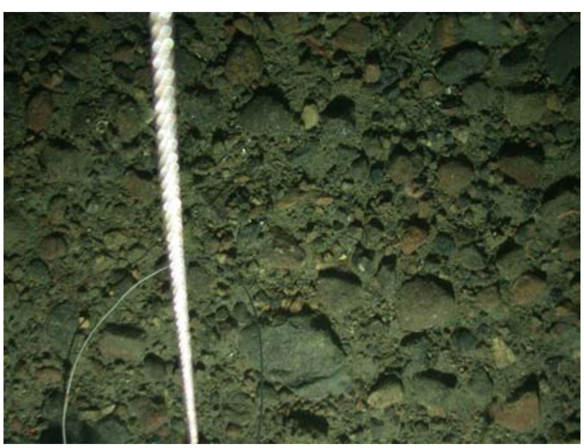




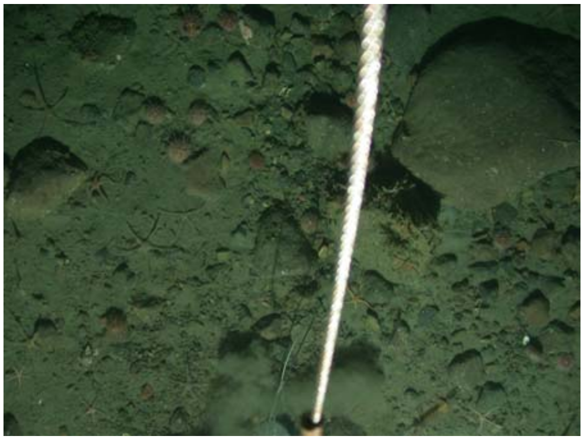
2006040 Camera Station 0012

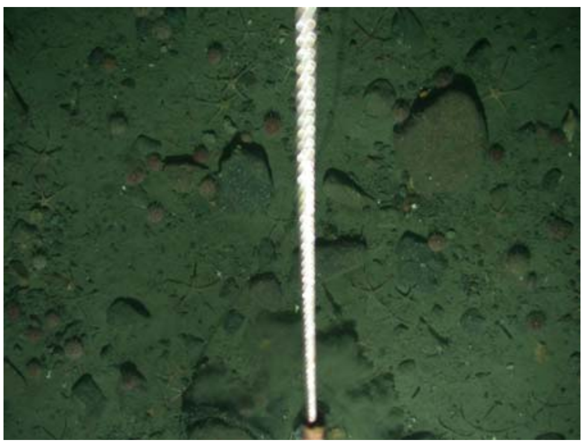


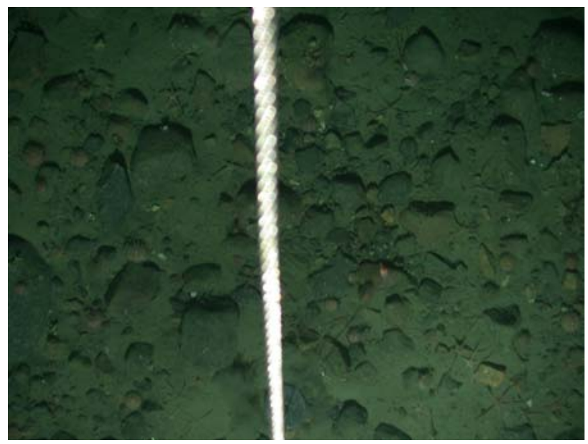




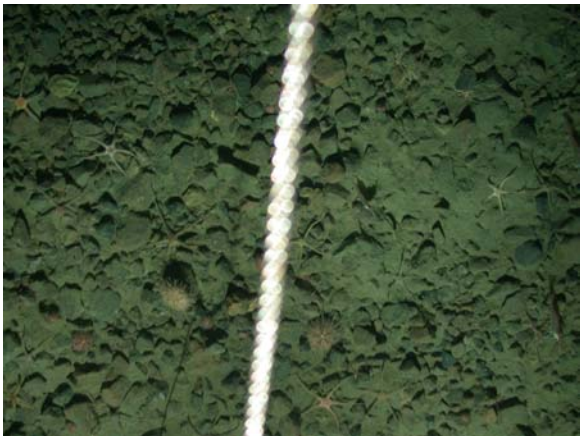
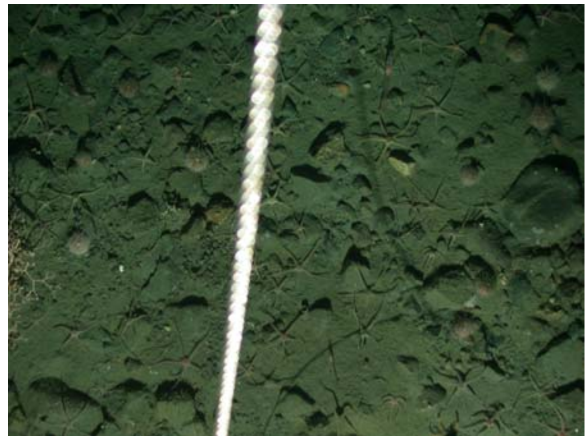
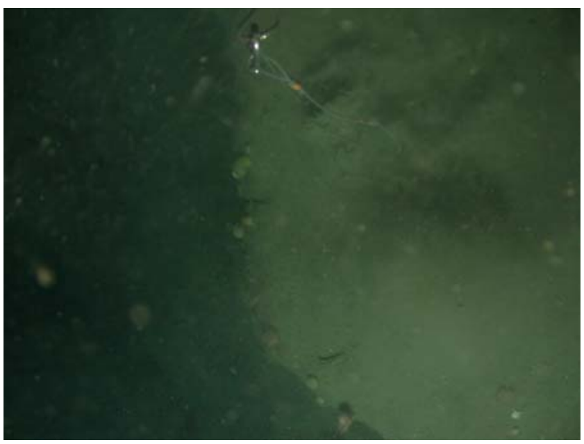
2006040 Camera Station 0014

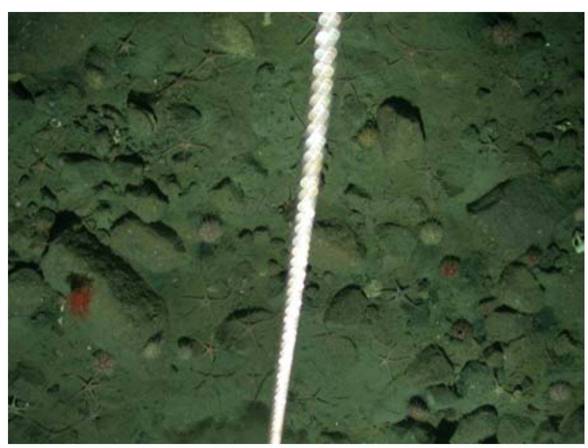




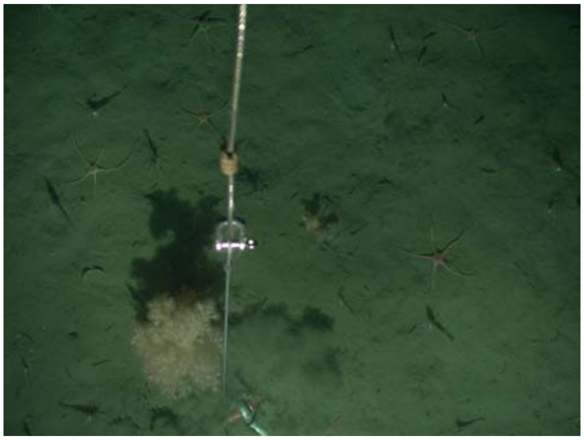


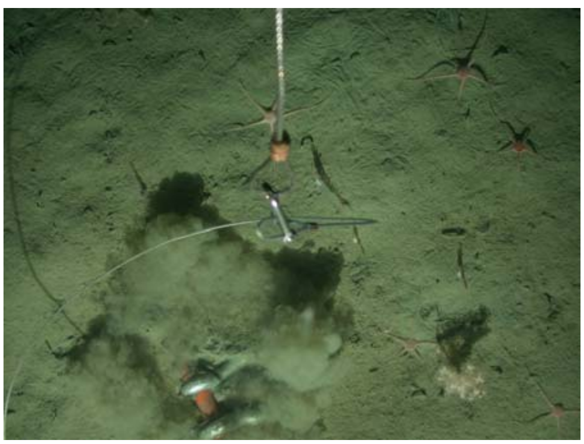
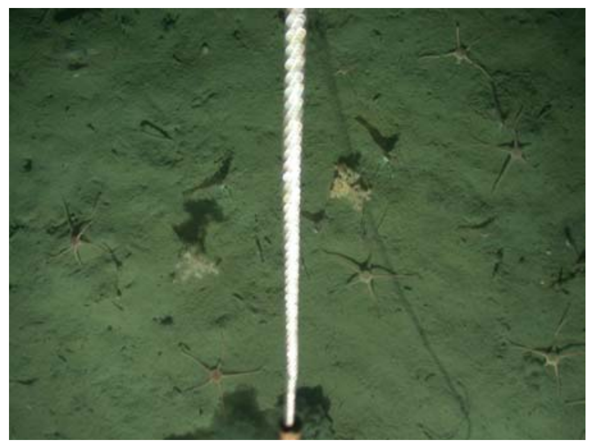
2006040 Camera Station 0016

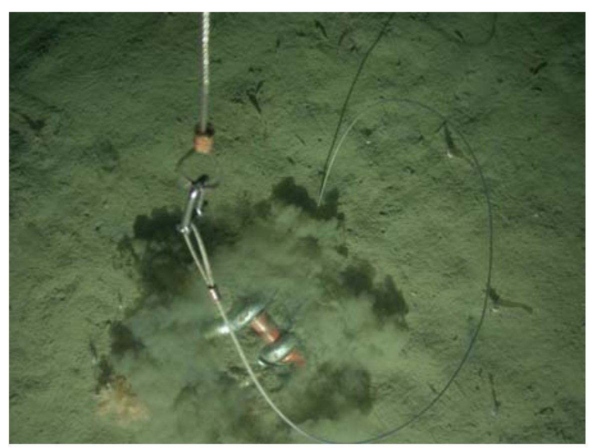




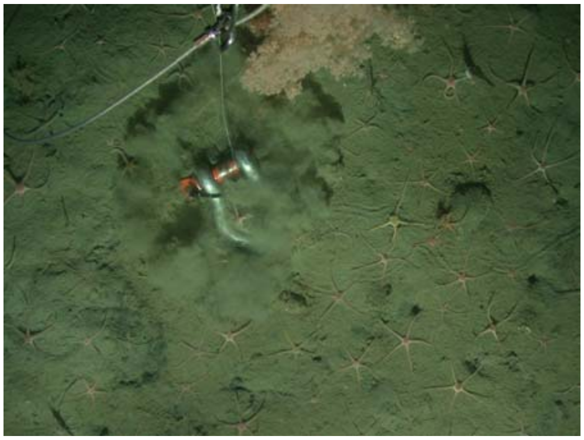
2006040 Camera Station 0018

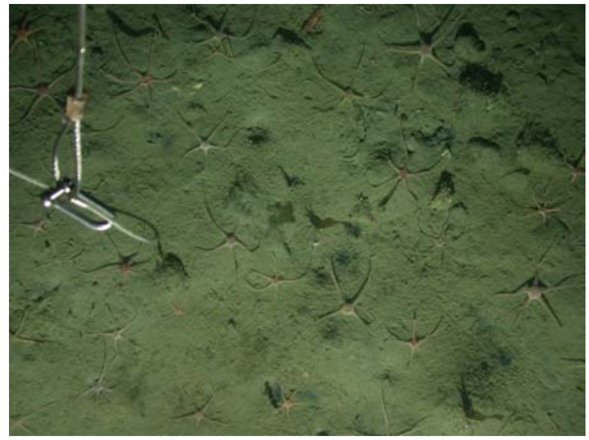


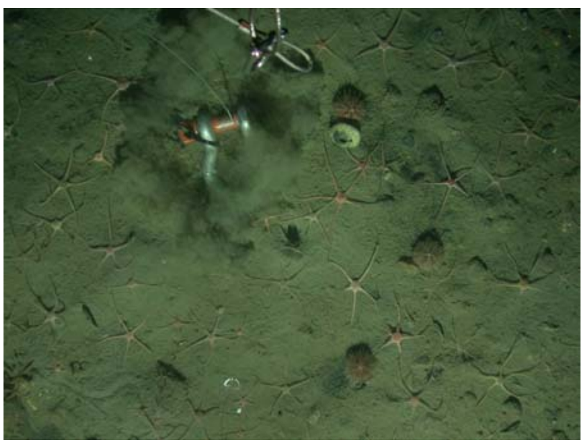



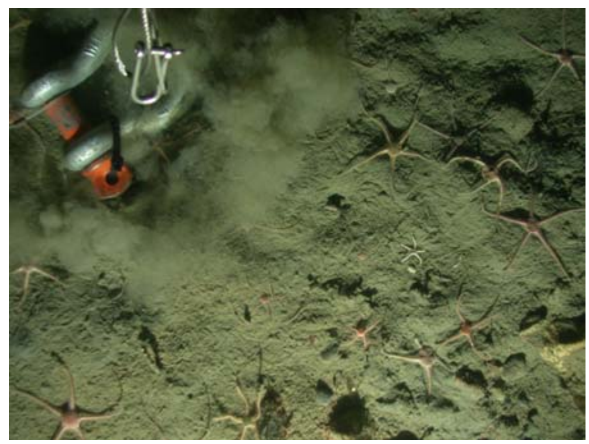


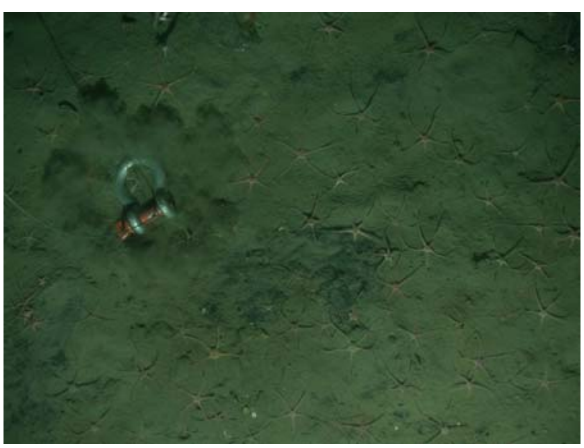
2006040 Camera Station 0020

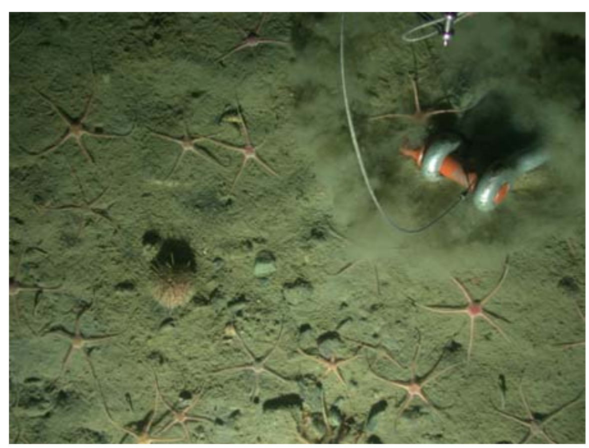






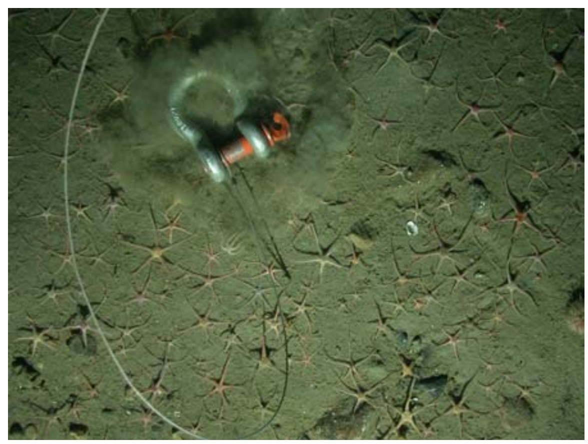
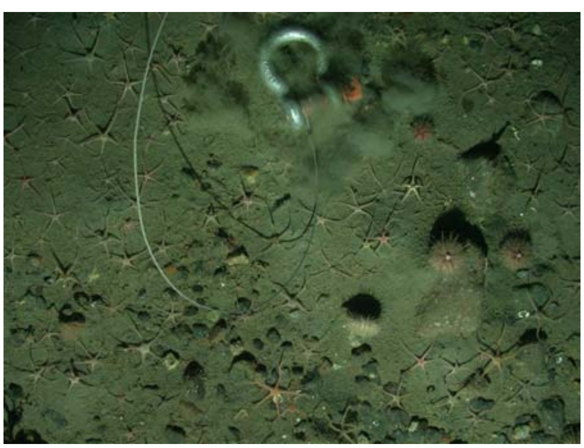
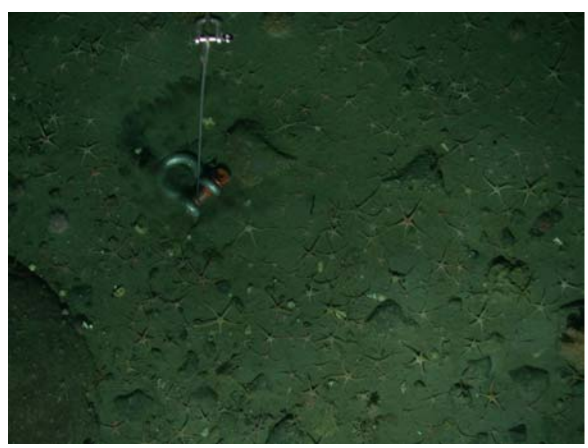




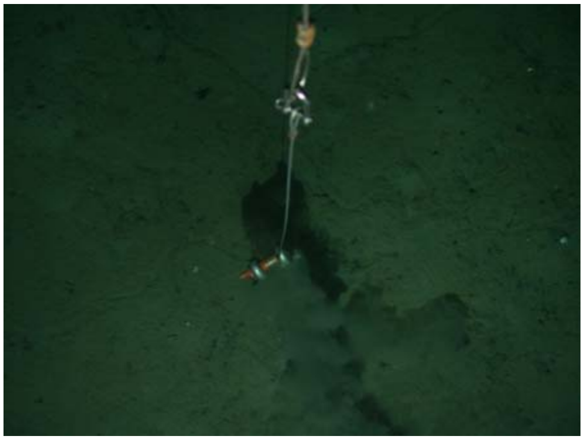


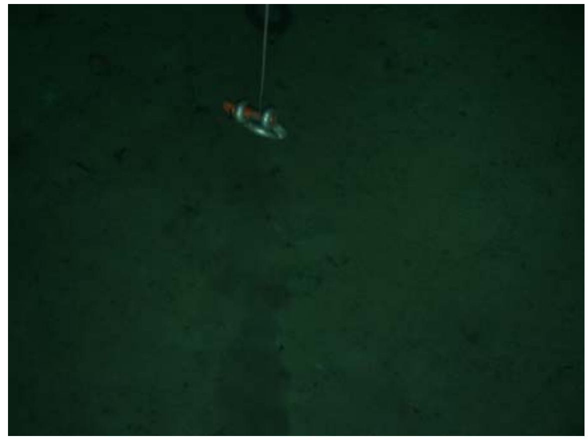
2006040 Camera Station 0022

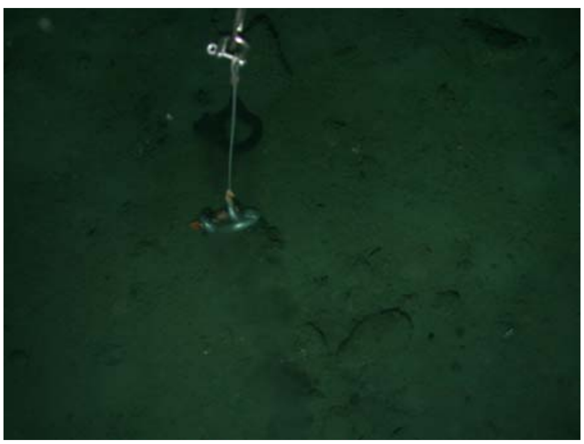


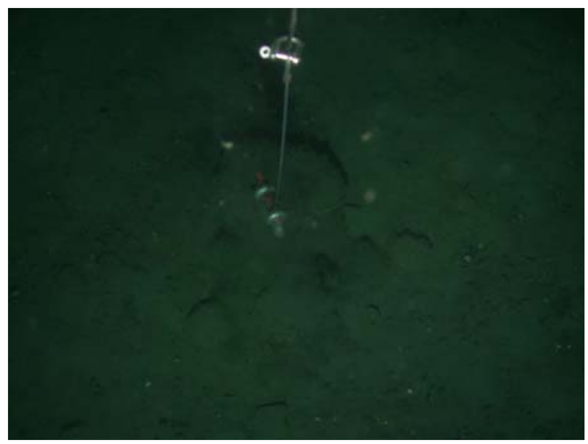





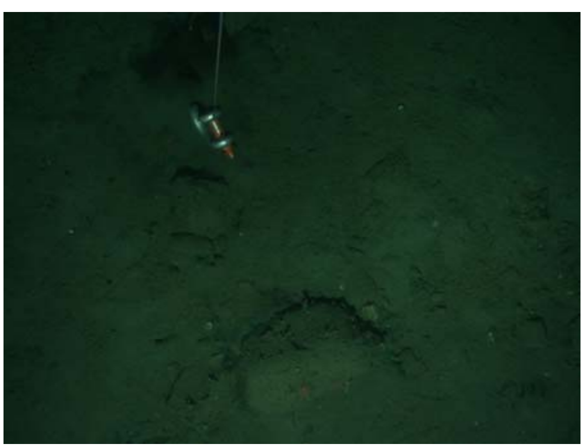
2006040 Camera Station 0025



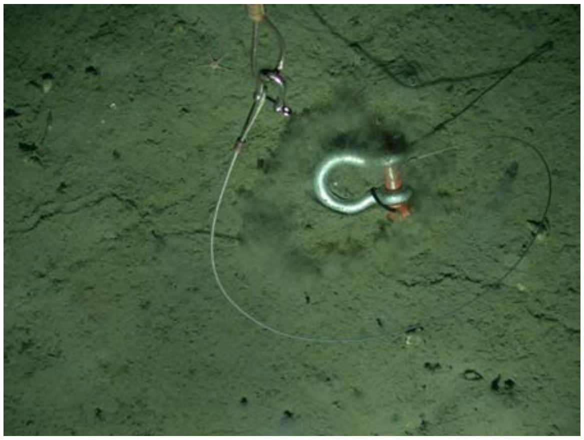
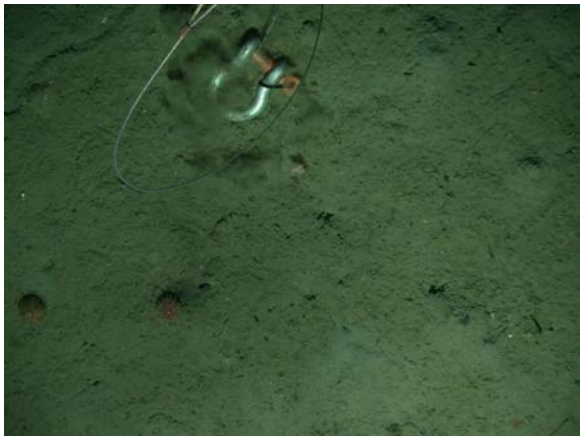
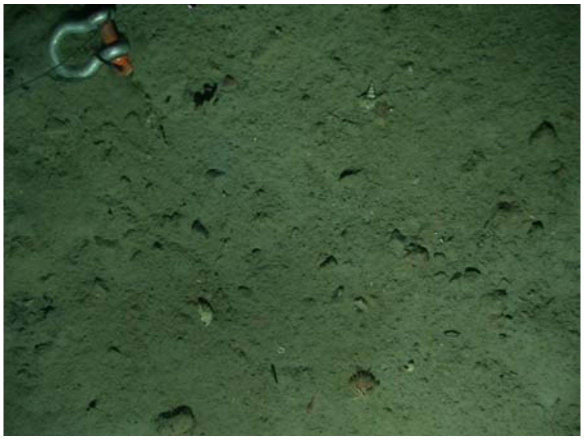


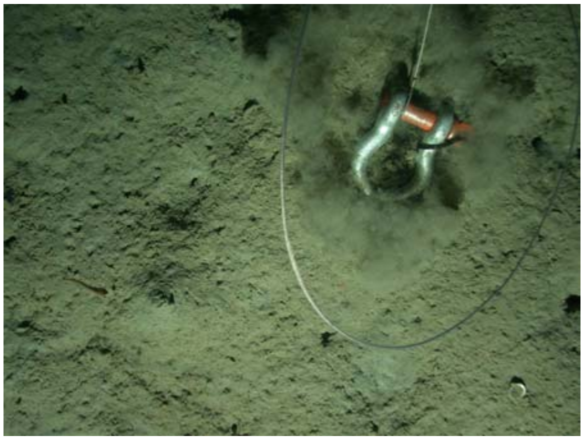
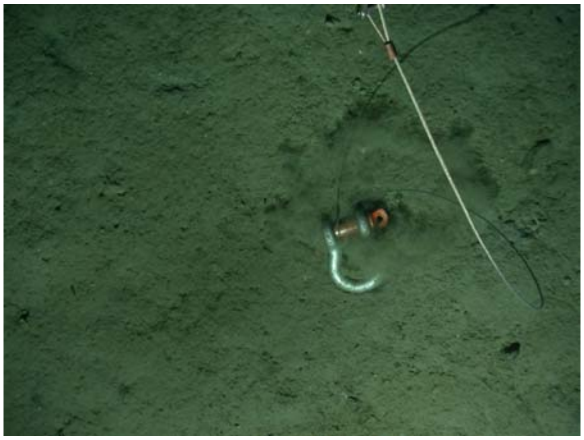




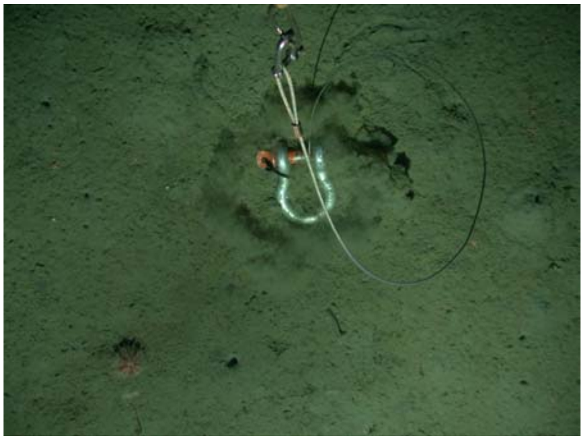


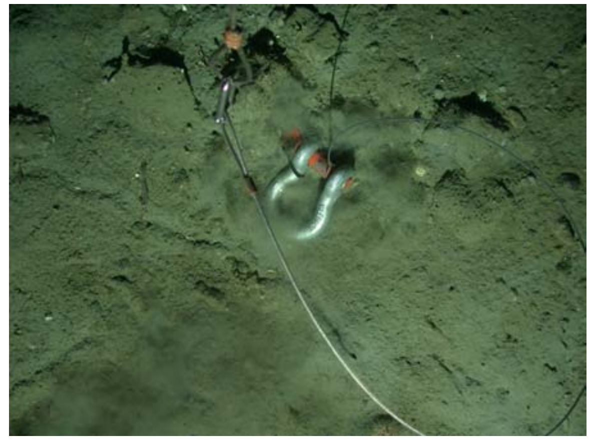
2006040 Camera Station 0027

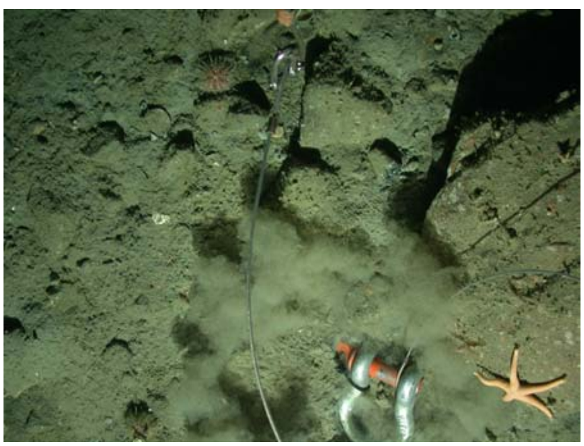




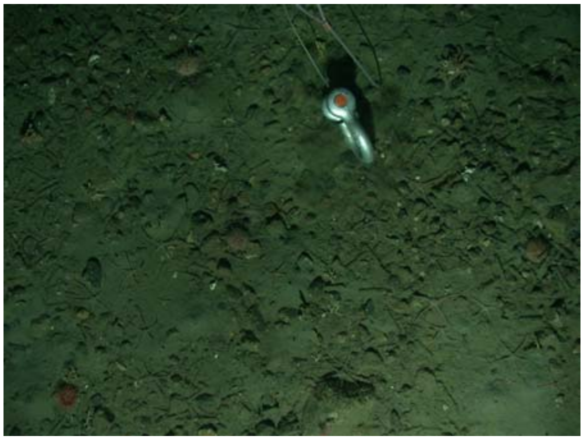
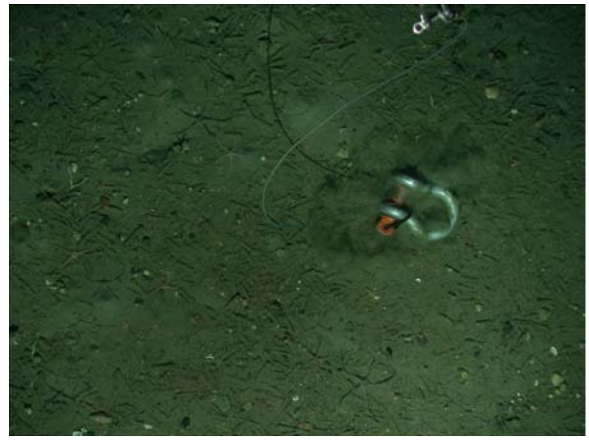
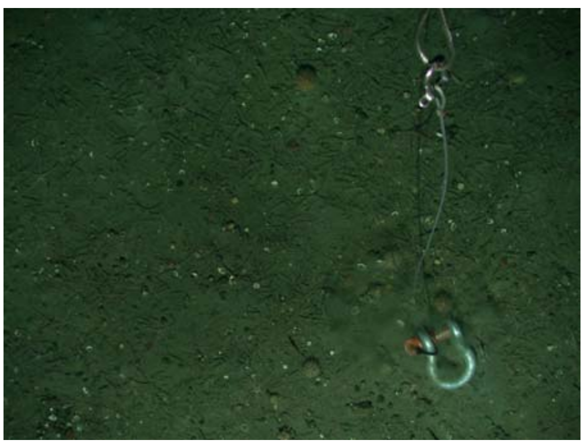
2006040 Camera Station 0027







2006040 Camera Station 0029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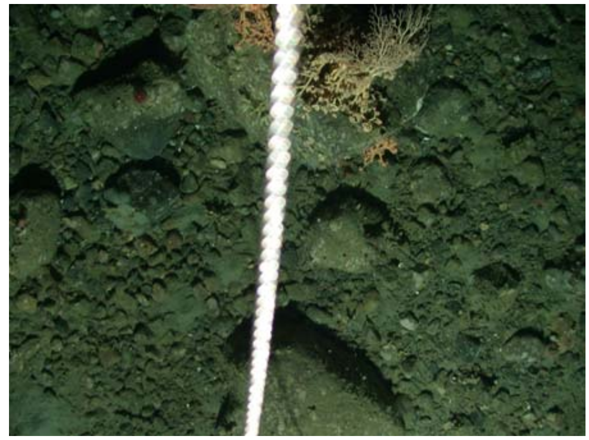
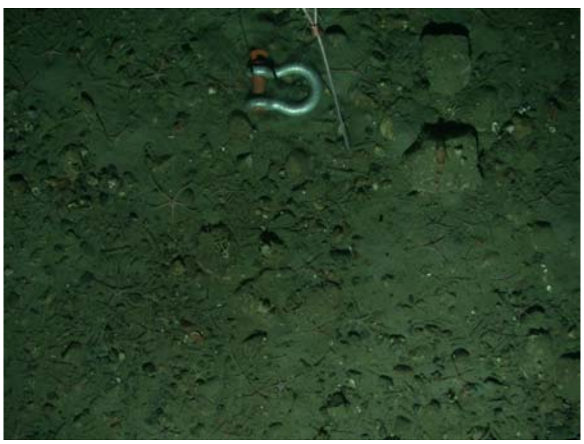
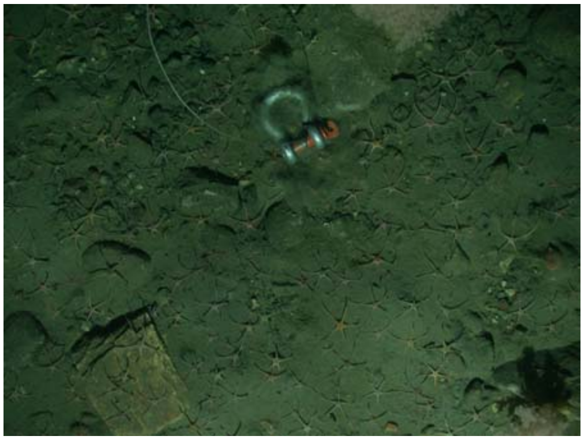
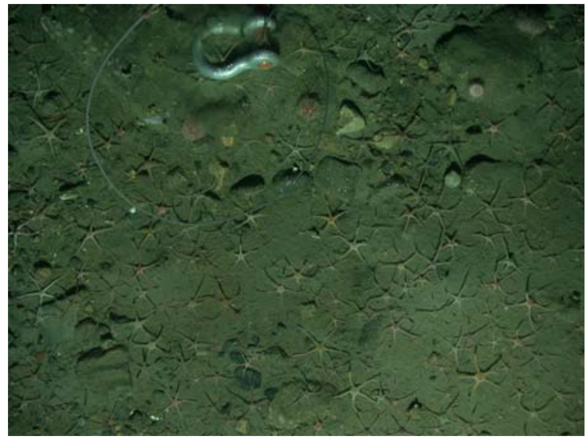
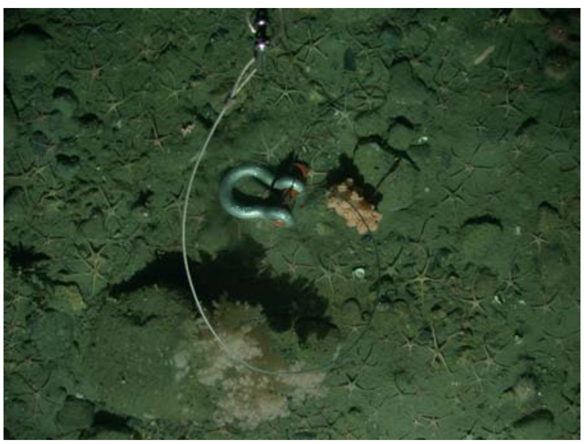
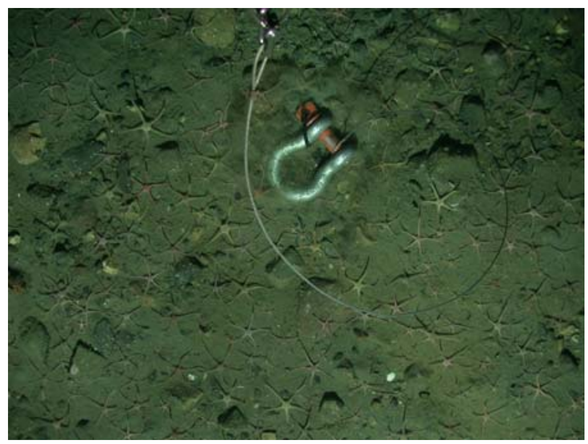
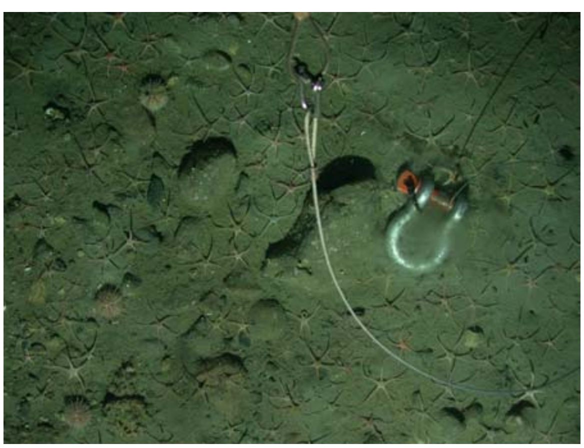
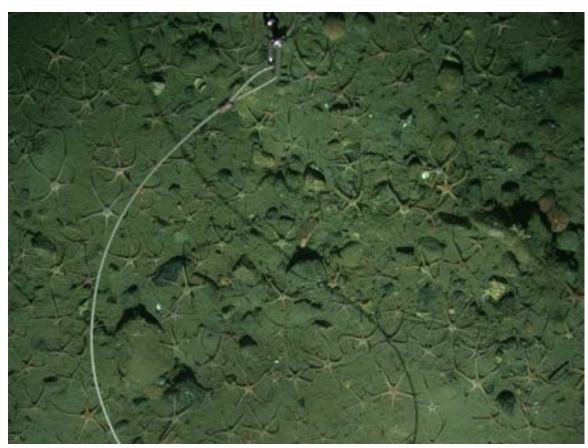
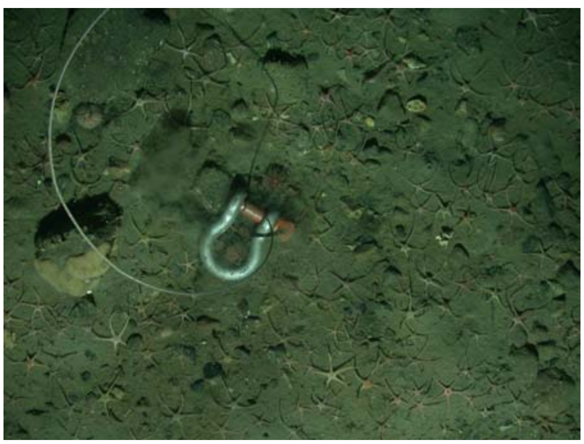




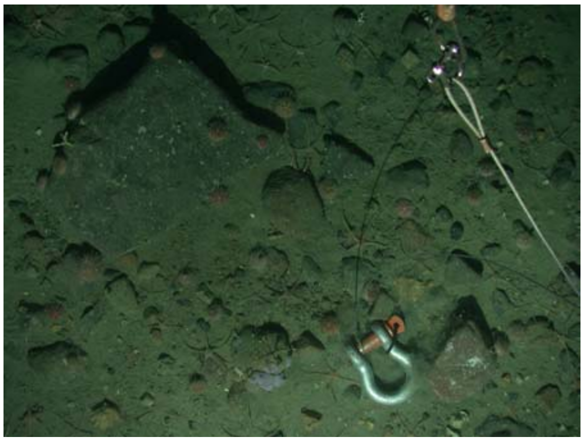
2006040 Camera Station 0031

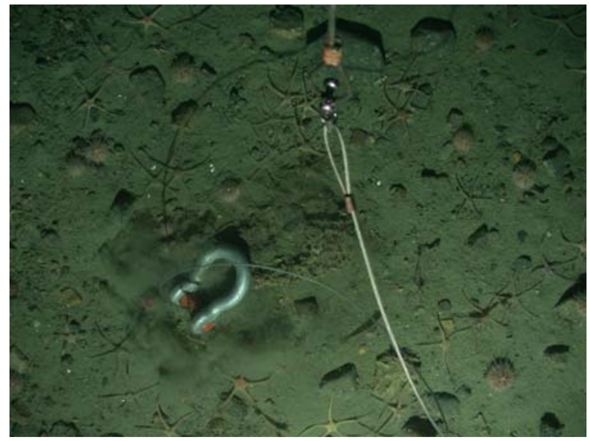







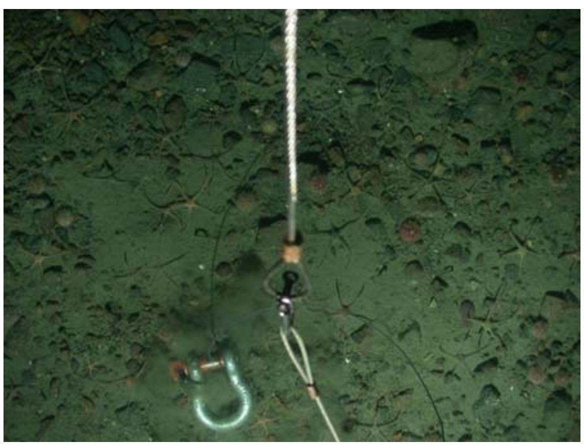
2006040 Camera Station 0031



2006040 Camera Station 0033



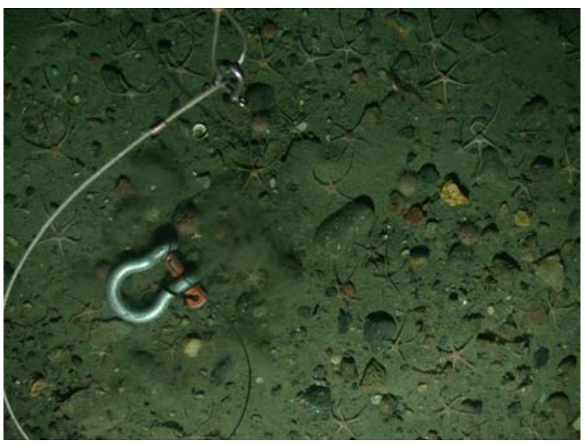




2006040 Camera Station 0033

2006040 Camera Station 0034

2006040 Camera Station 0034



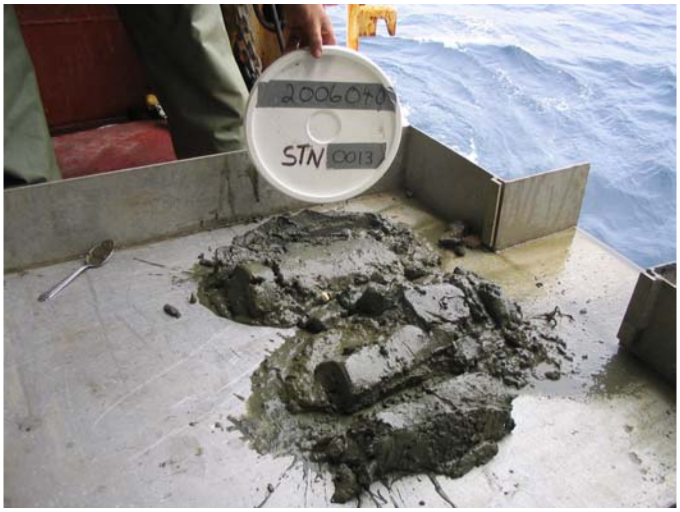
Appendix 6- VanVeen grab sample photographs

2006040 Van Veen Grab Station 0007

2006040 Van Veen Grab Station 0009

2006040 Van Veen Grab Station 0011

2006040 Van Veen Grab Station 0013



2006040 Van Veen Grab Station 0015

2006040 Van Veen Grab Station 0017

2006040 Van Veen Grab Station 0019

2006040 Van Veen Grab Station 0021

2006040 Van Veen Grab Station 0024

2006040 Van Veen Grab Station 0026

2006040 Van Veen Grab Station 0028

2006040 Van Veen Grab Station 0030

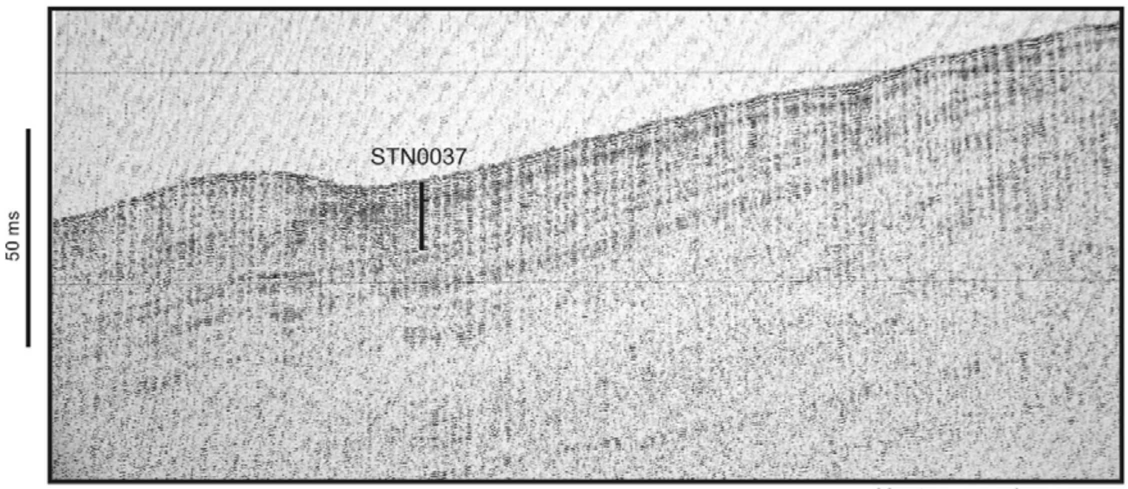
2006040 Van Veen Grab Station 0032

2006040 Van Veen Grab Station 0035

Appendix 7- Core site seismic reflection data

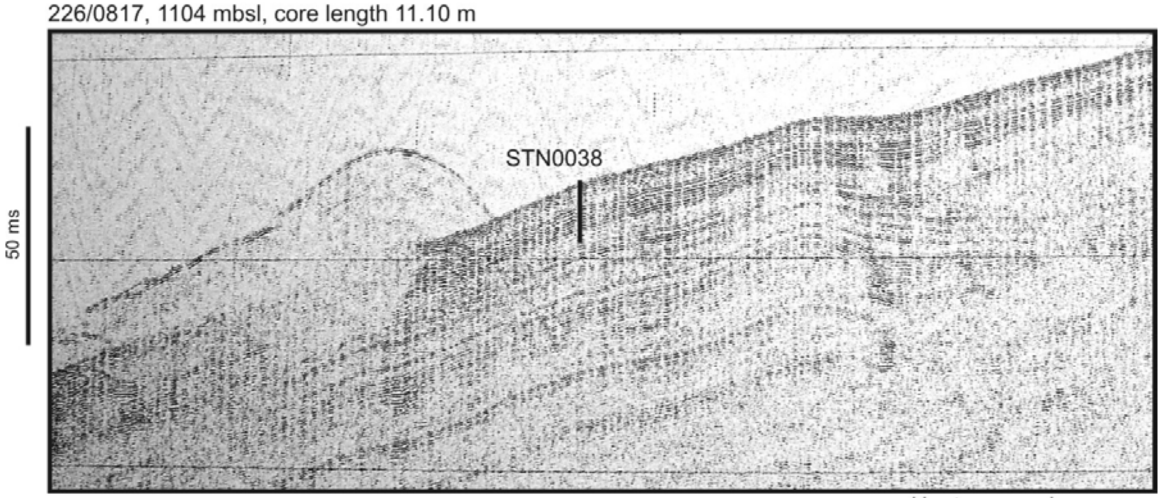
(collected during 2006-040)

226/00755, 1167 mbsl, core length 12.45 m



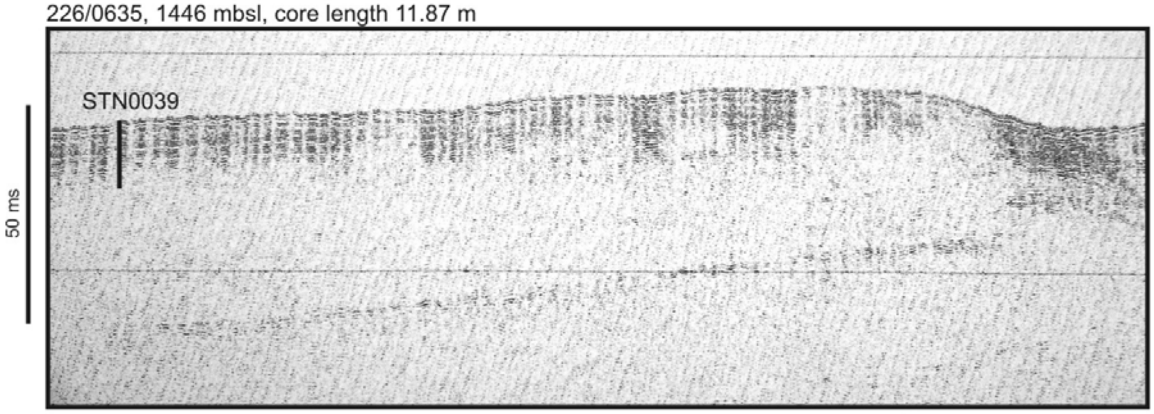
Huntec - sparker source

226/0817, 1104 mbsl, core length 11.10 m



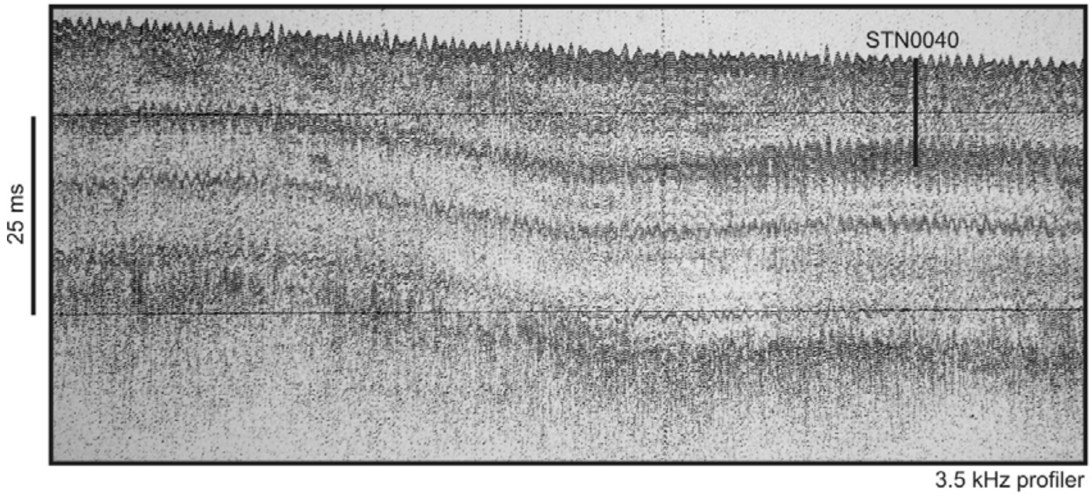
Huntec - sparker source

226/0635, 1446 mbsl, core length 11.87 m

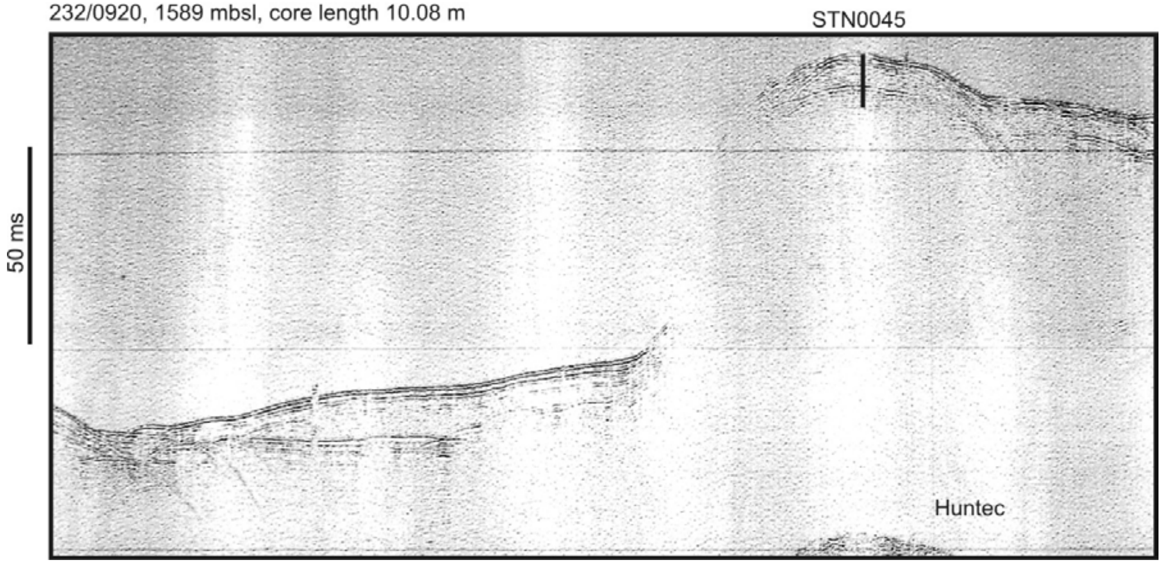


Huntec - sparker source

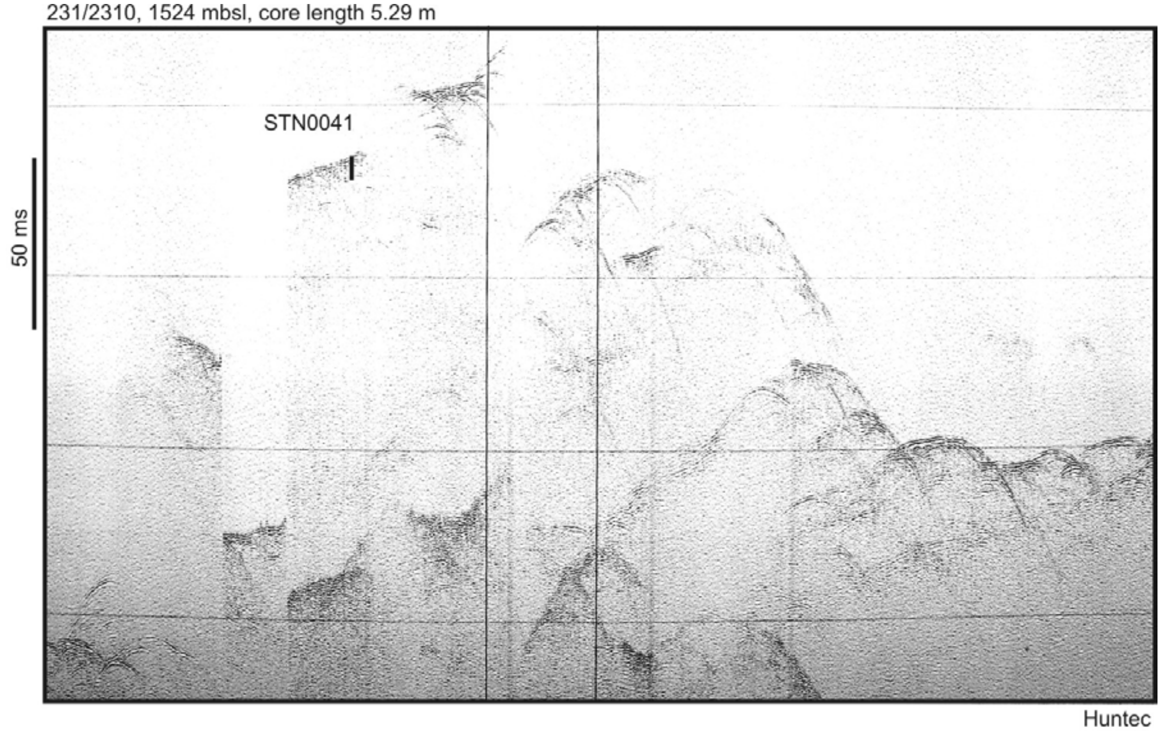
229/1711, 203 mbsl, core length 10.33 m



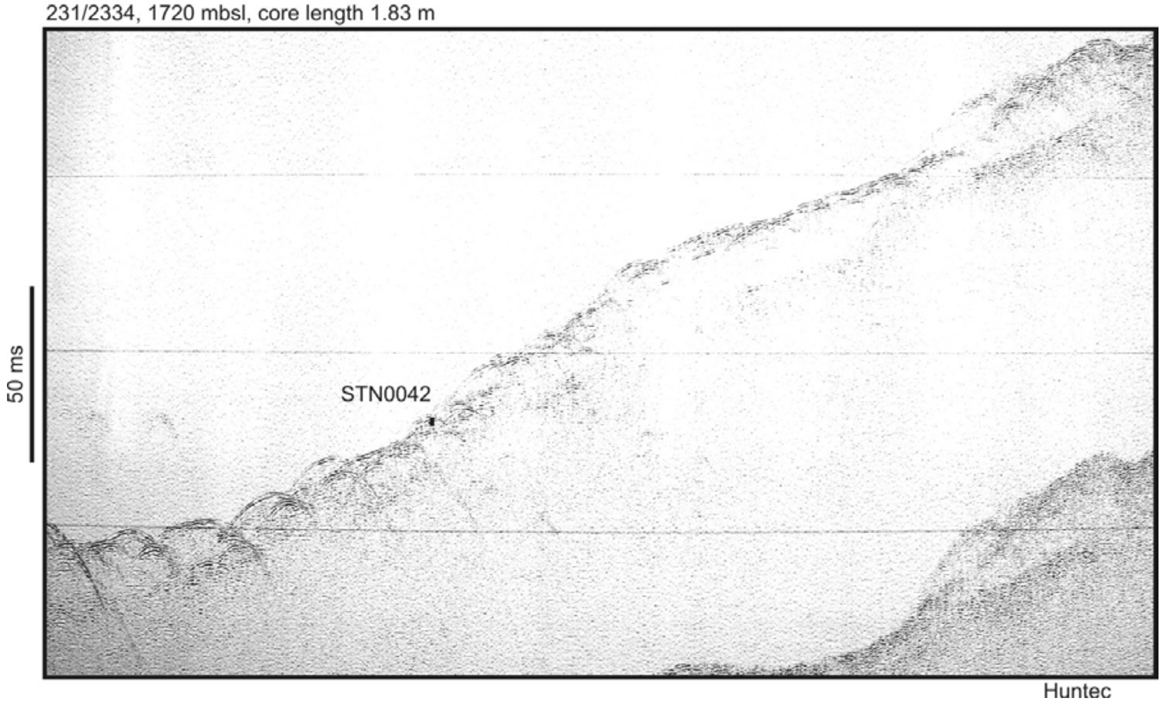
232/0920, 1589 mbsl, core length 10.08 m



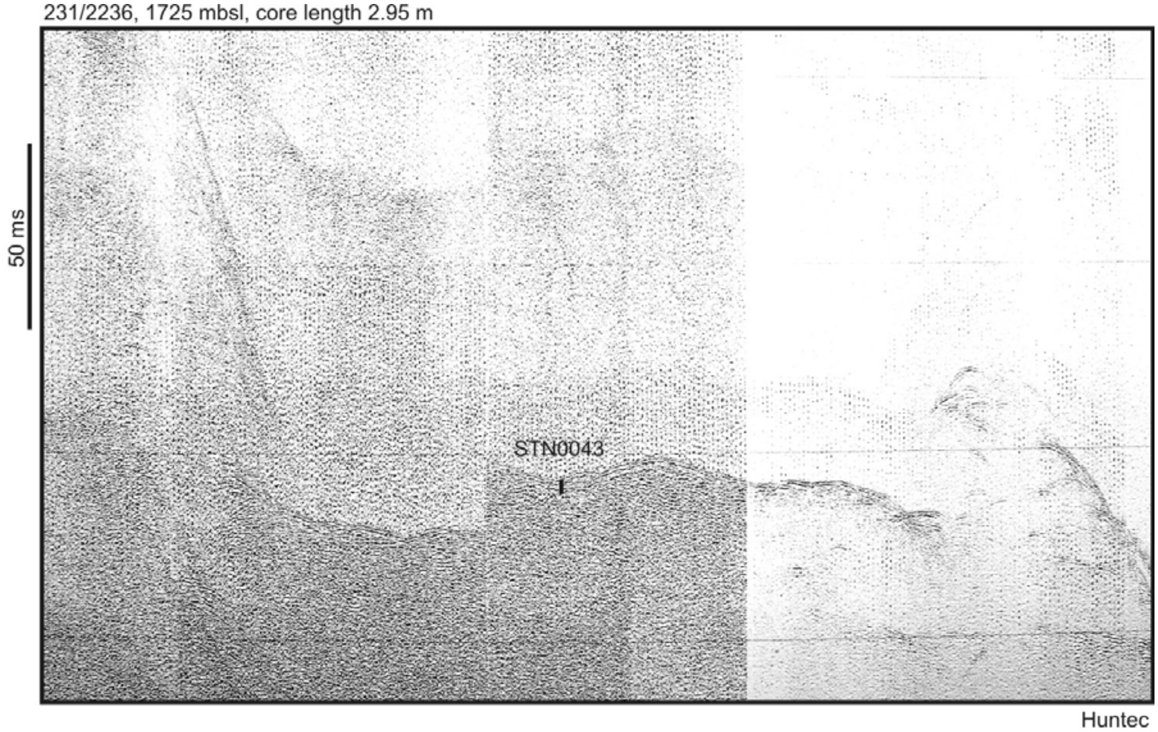
231/2310, 1524 mbsl, core length 5.29 m



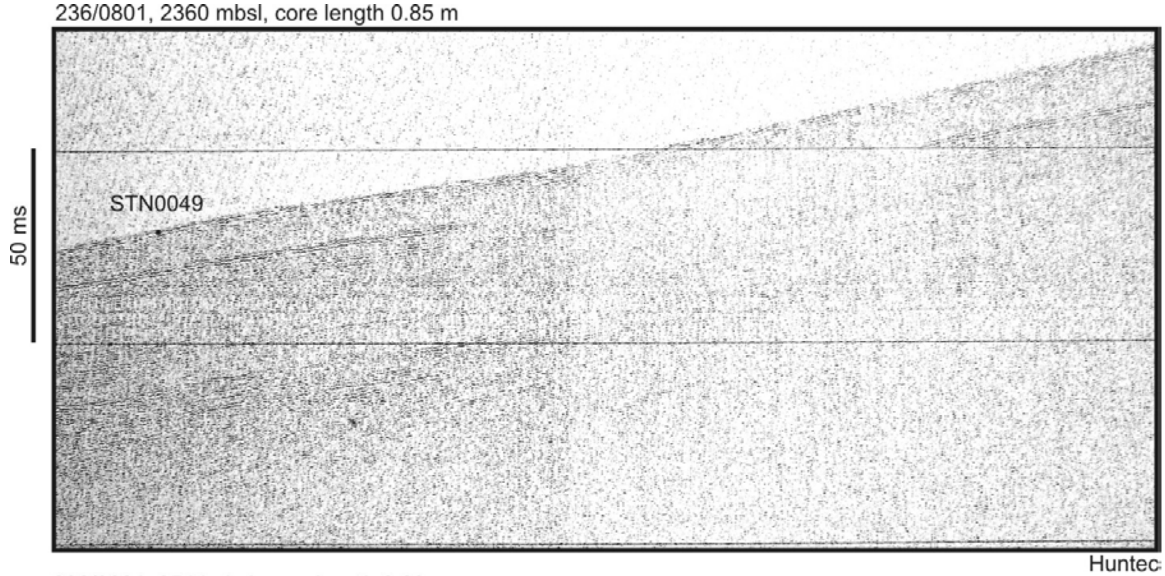
231/2334, 1720 mbsl, core length 1.83 m



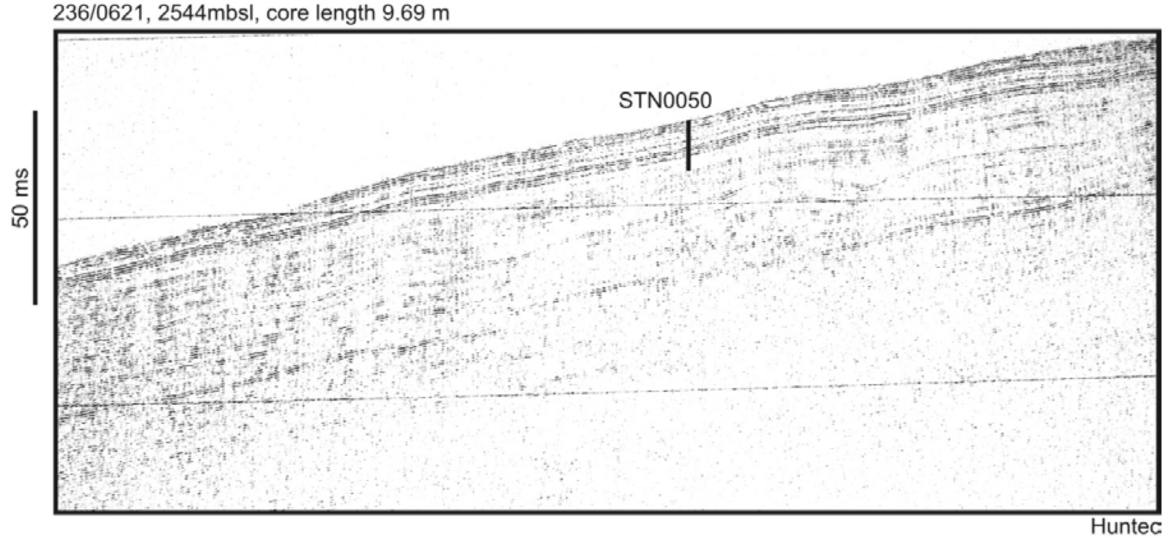
231/2236, 1725 mbsl, core length 2.95 m



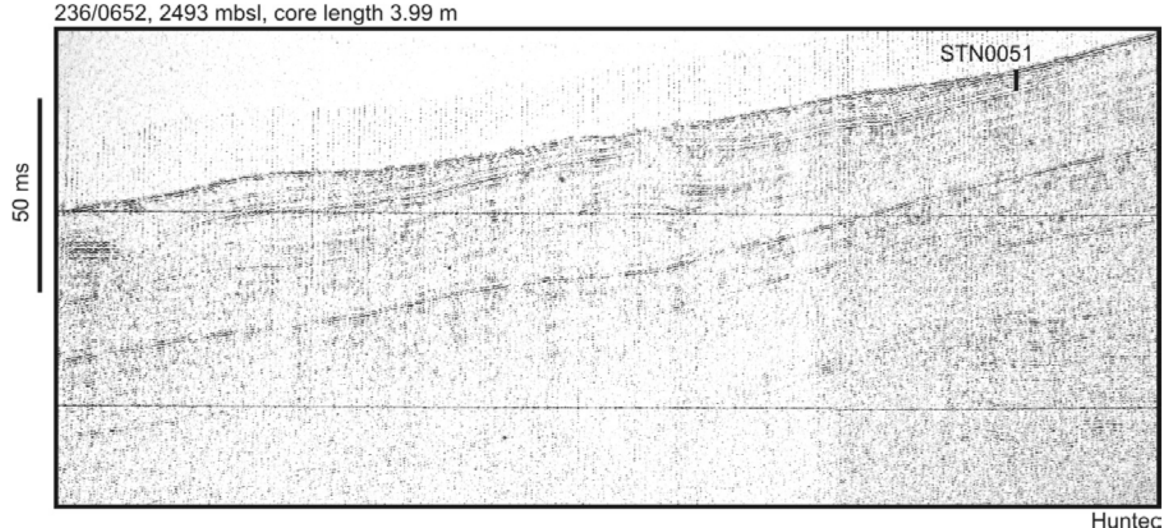
236/0801, 2360 mbsl, core length 0.85 m

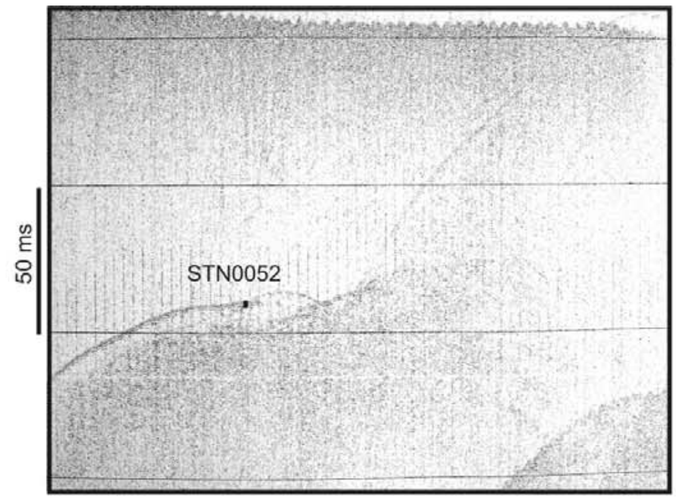


236/0621, 2544mbsl, core length 9.69 m



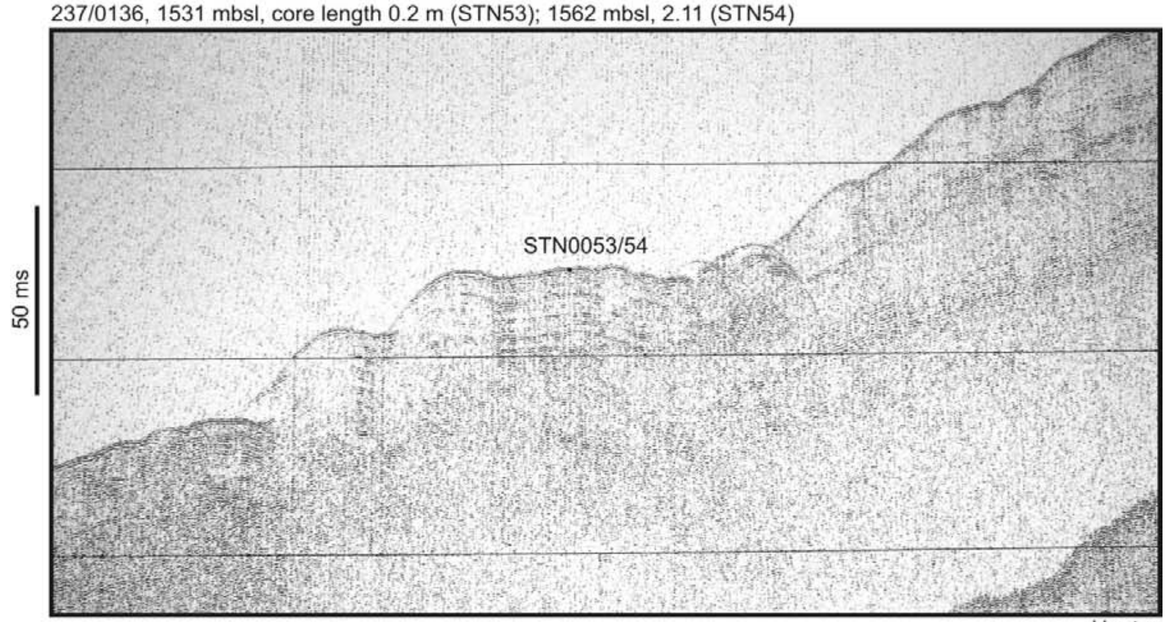
236/0652, 2493 mbsl, core length 3.99 m





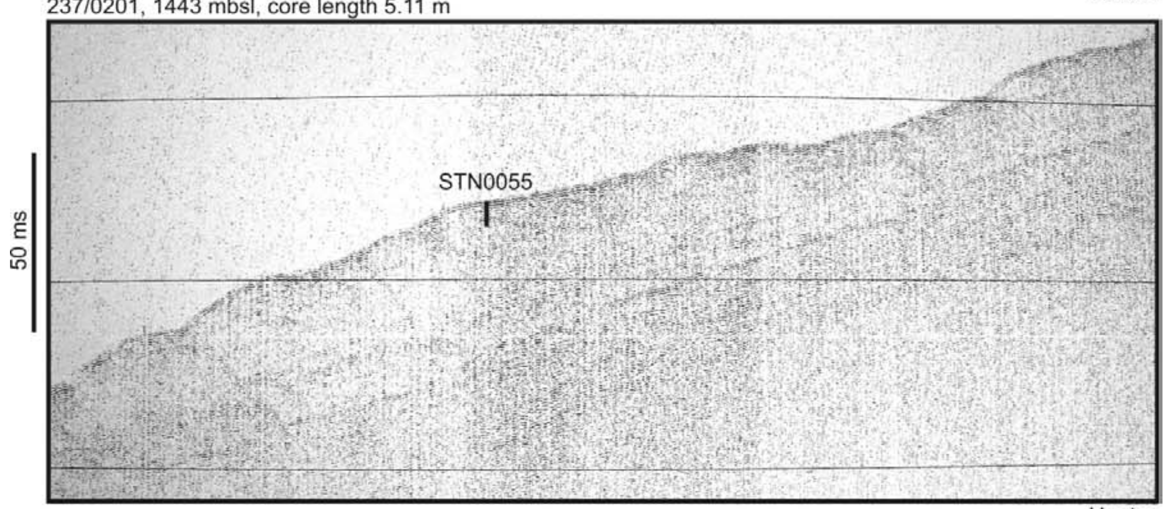
237/0331, 661 mbsl, core length 1.78 m
Huntec

237/0136, 1531 mbsl, core length 0.2 m (STN53); 1562 mbsl, 2.11 (STN54)



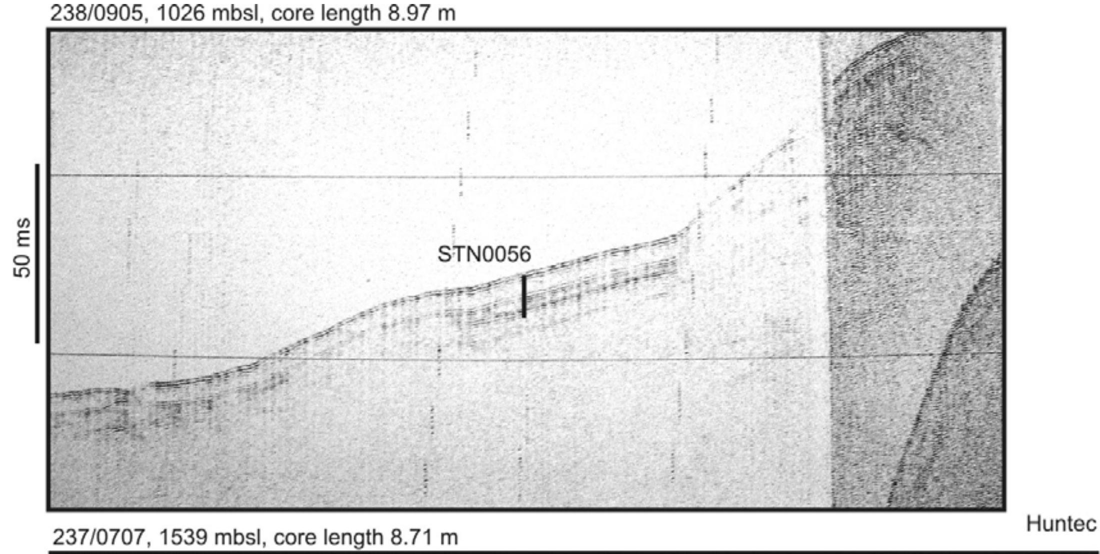
Huntec

237/0201, 1443 mbsl, core length 5.11 m

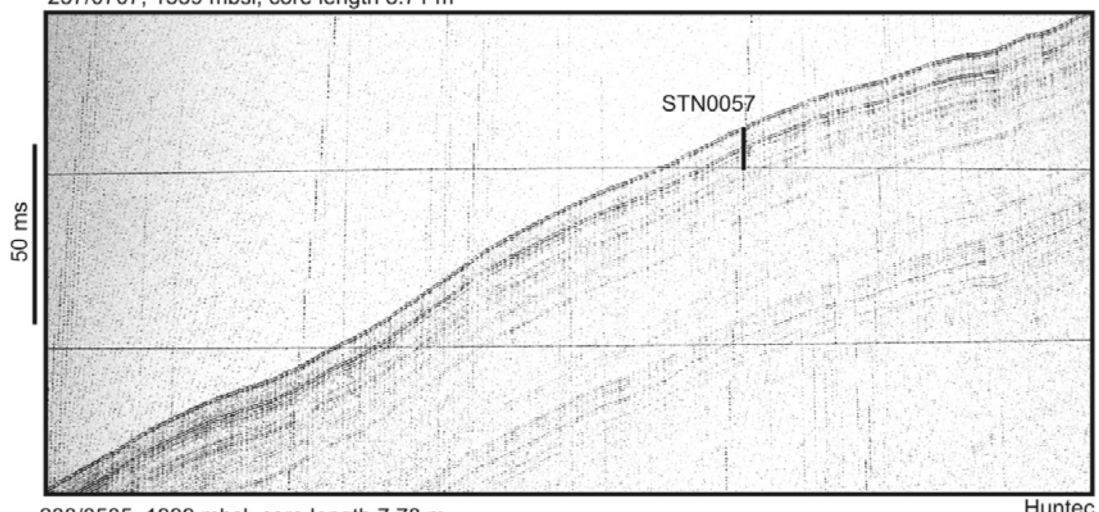


Huntec

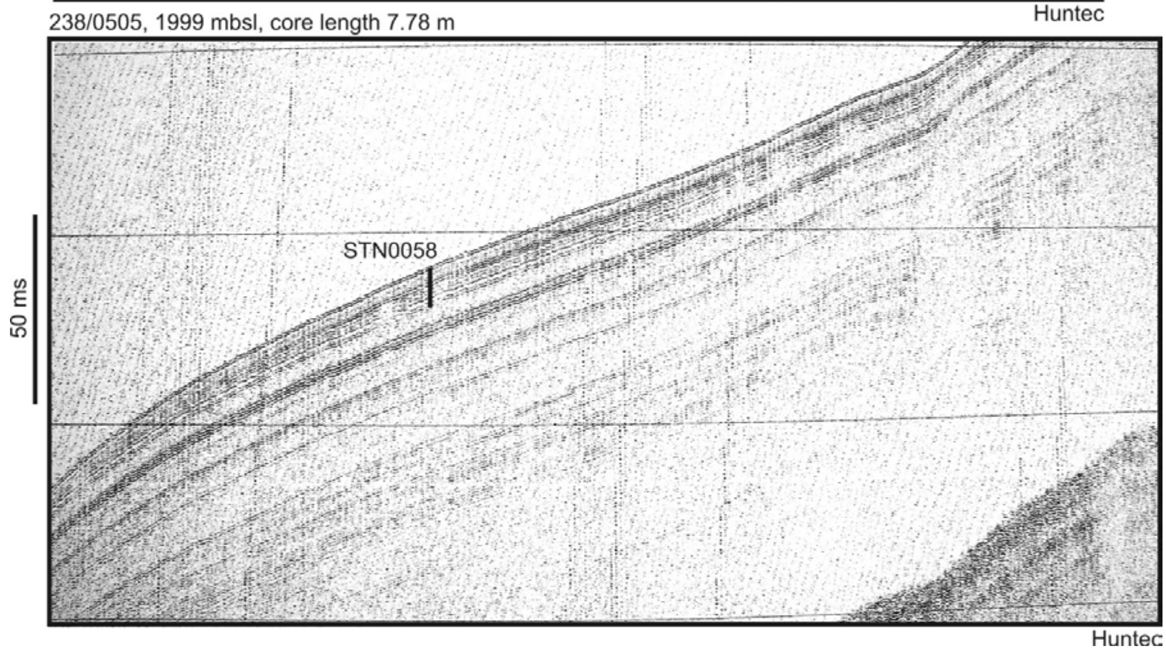
238/0905, 1026 mbsl, core length 8.97 m



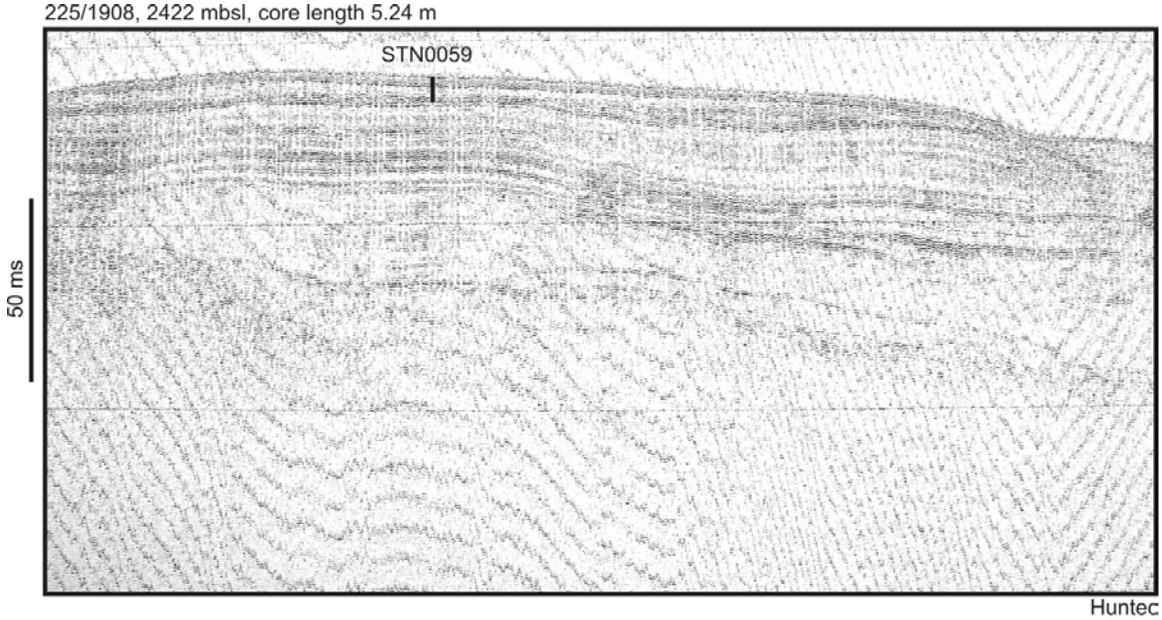
237/0707, 1539 mbsl, core length 8.71 m



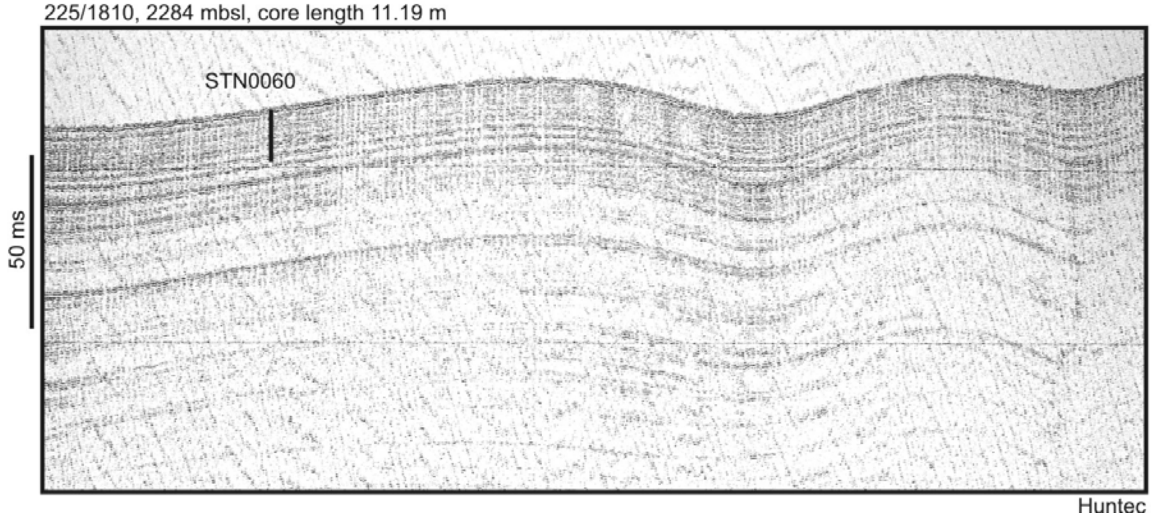
238/0505, 1999 mbsl, core length 7.78 m



225/1908, 2422 mbsl, core length 5.24 m



225/1810, 2284 mbsl, core length 11.19 m



Appendix 8- Makkovik Bank Survey work

Gary Sonnichsen

Objective 1 Geophysical/geological surveys over multibeam

Multibeam data were collected on and off western Makkovik Bank (Figure *) during Matthew 2006038 (Sonnichsen, 2006) to investigate seabed constraints to subsea development for future natural gas production. The data provide insight into seabed geomorphology, the distribution and severity of iceberg scouring, and the implications of both for pipeline routing and burial requirements. 3.5 kHz profiler data collected continuously during 2006038 multibeam survey operations allowed rough delineation of surficial sediments.

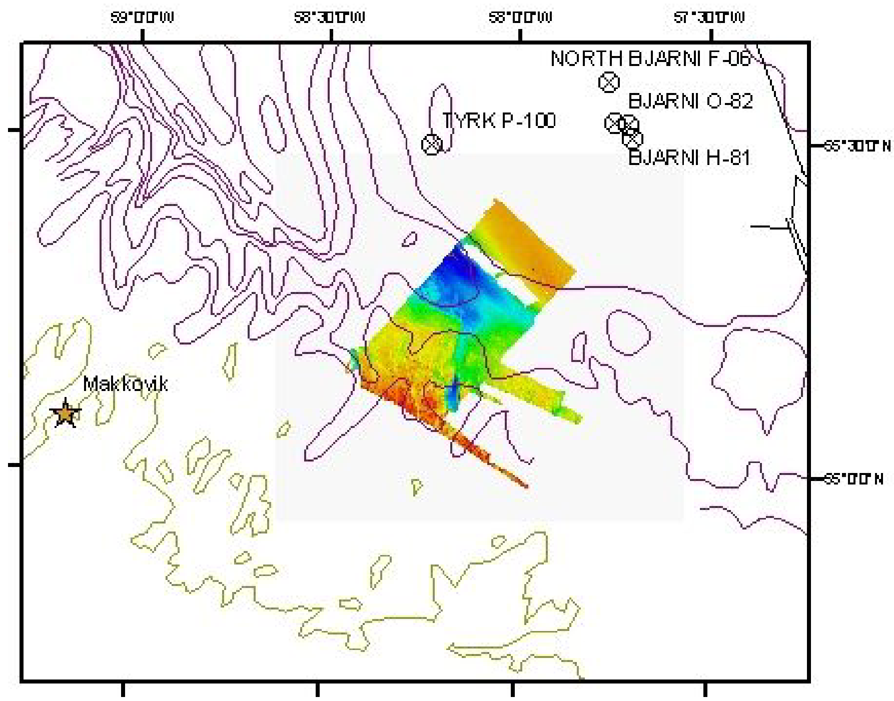


Figure 8: Multibeam data collected during NRCAN Expedition 2006038

Huntec, sleevegun seismic, and sidescan sonar data were collected during 2006040 to augment the Matthew 3.5 and multibeam data (Figure *).

- 10 cu inch sleevegun was the single channel reflection source (with 100 m Teledyne streamer)
- Huntec DTS was operated in boomer mode.
- Klein 3000 sidescan was operated at 400 m/channel (800 m total swath).
- Sleevegun data were post-processed in Kingdom Suite.
- Klein sidescan data were processed in Chesapeake SonarWhiz-Pro.

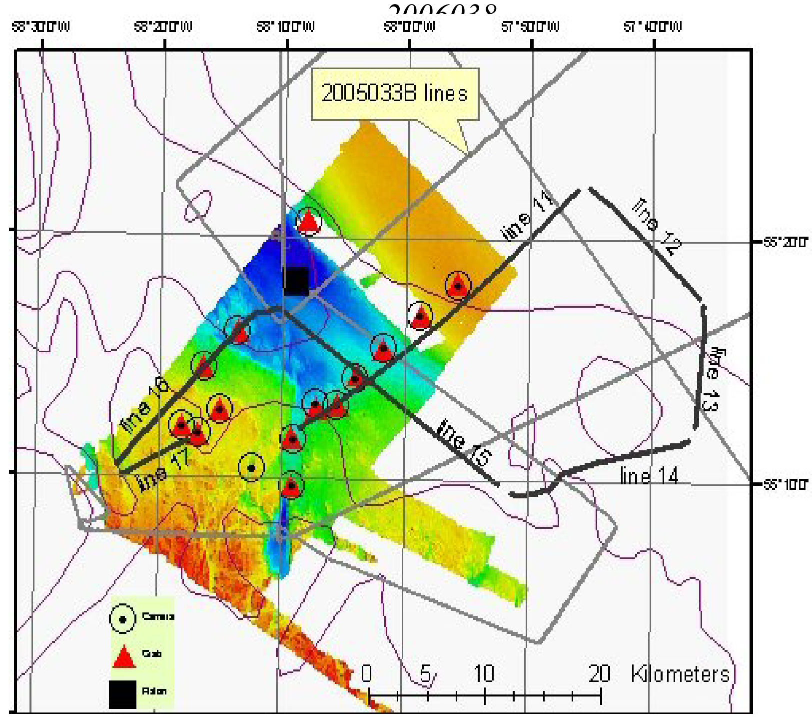


Figure 9 Makkovik Bank seismic reflection survey lines (2005033B and 2006040)

Bottom photos and small Van Veen grab samples were collected to groundtruth a preliminary 3.5 kHz sediment classification.

Grab and camera samples (Figure *) were targeted over sediment types identified from 3.5 kHz profiles (Matthew 2006038). Stations 7 to 23 were completed on Julian day 222, stations 24 to 36 on Day 223. The Van Veen grab samples were described, photographed and subsampled. At most stations, 6 to 10 bottom photos were taken using the GSCA Deepwater digital camera.

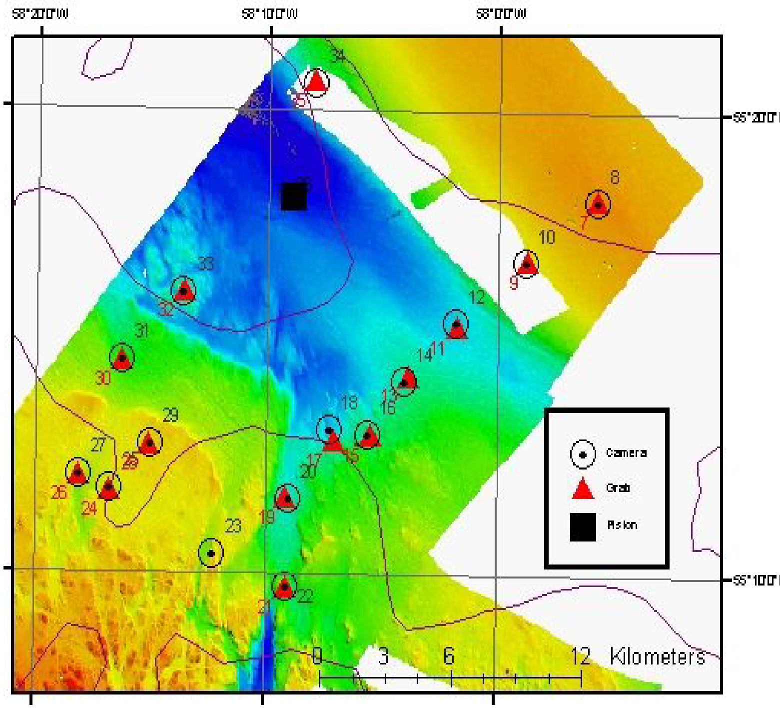


Figure 10: Camera, grab and piston core samples collected during 2006040 provide groundtruth of surficial sediments in the multibeam coverage.

At station 36, a 9.15 m piston core was recovered from stratified sediment over inferred glacial till (Figure *). A large rounded cobble was found lodged in the cutter.

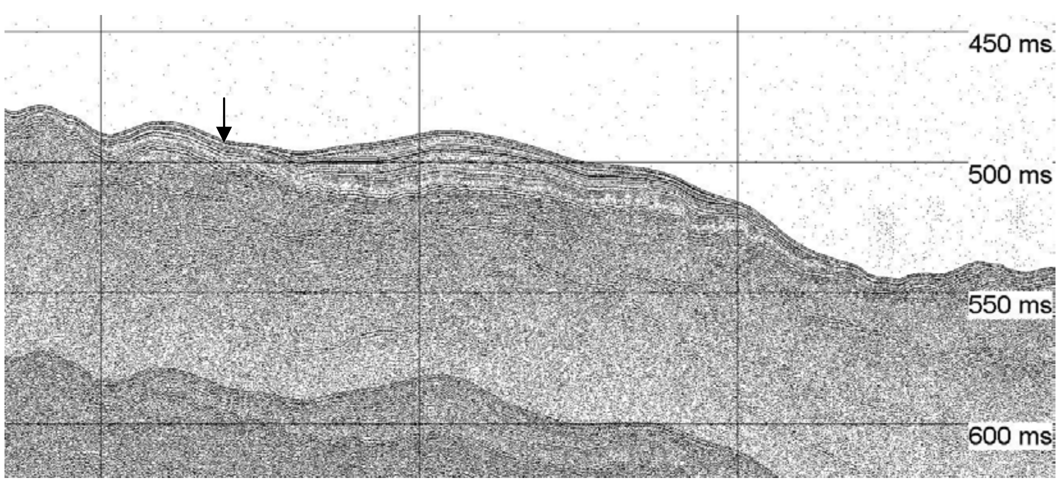


Figure 11 Arrow indicates the intended target on a 2005033B Huntec profile. 9.15 m were recovered at 2006040 Station 36. 84 cm were recovered in the trigger weight core.

Table 1 Makkovik Bank bottom samples from Hu 2006040

Stn	type	lat	long	w.d	Prediction	Recovered	Photos
7	Grab	55.30211	-57.9282	99	sand/gravel	Prly srted md-crse sand w/ pebbles	
8	Camera	55.30114	-57.9284	99	sand/gravel		6
9	Grab	55.28022	-57.9787	147	sand/mud?	2 attempts. v. prly srted f. sand to granules, angular pebbles to cobbles	
10	Camera	55.27941	-57.9798	139	sand/mud?		5
11	Grab	55.25592	-58.0293	282	glacial	2 attempts. Only ang-sub-rnd pebbles recovered	
12	Camera	55.25772	-58.0303	284	glacial		5
13	Grab	55.2384	-58.0635	267	mud	Grn-gy silty clay w/ fine sand. Ang-sub-rnd pebbles/cobbles on surface.	
14	Camera	55.23647	-58.0674	259	mud		4
15	Grab	55.21689	-58.0907	257	glacial	Grn-brn sl. silty clay. Numerous sub-ang- pebbles/cobbles. Subsurface mottled blck-green w/ odour	
16	Camera	55.21719	-58.0932	227	glacial		4
17	Grab	55.21512	-58.1176	274	sand/mud?	2-3 cm of Grn-brn soupy silty clay. Subsurface blkish-grn cohesive silty clay. only few ang- pebbles on surface	
18	Camera	55.2189	-58.1212	296	sand/mud?		6
19	Grab	55.19414	-58.1518	274	mud	3 cm of grn-brn soupy silty clay w/ fine sand. Numerous sub-ang-pebbles/cobbles. Subsurface blkish-grn sticky silty clay.	
20	Camera	55.19364	-58.1505	268	mud		6
21	Grab	55.16171	-58.1519	236	sand/mud?	Grn-brn prly srted sandy silty mud Numerous sub-ang to sub-rnded pebbles/cobbles.	
22	Camera	55.16174	-58.1519	227	sand/mud?		6
23	Camera	55.17331	-58.2047	120	bedrock	Flash battery died-no photos	0
24	Grab	55.19625	-58.2795	157	glacial?	Jaws open. Top surface minor worm tubes, grn-brn soft sandy silt with granules over prly-srted blck-grn sandy clay 3 sub-rnded cobbles	
25	Camera	55.19708	-58.2796	149	Glacial?		6
26	Grab	55.20167	-58.3017	156	mud	Grn-brn silty clay with crse-med sand. Sub-rnded pebbles/cobbles up to 15 cm. worm tubes.	
27	Camera	55.20164	-58.302	150	mud		9
28	Grab	55.21317	-58.2509	134	glacial	Surf venner of grn-brn fine sand, pebbles, worm tubes	
29	Camera	55.21312	-58.2503	127	glacial		9
30	Grab	55.24335	-58.2716	221	glacial_sm	Grn-brn sandy silt. Subsurface is blk-grn mottled siff, stinky mud. Small pebbles and cobbles (sub-rnded)	
31	Camera	55.24319	-58.2716	216	glacial_sm		9
32	Grab	55.26844	-58.2265	275	glacial	2 attempts (1s didn't trip; 2nd rock in jaws). Mostly pebbles/cobbles, but some grn-brn clay w/ silt and fine sand recovered. Cobbles-angulr, pebbles sub-rnded	
33	Camera	55.26751	-58.2271	263	glacial		7
34	Camera	55.3433	-58.1334	260	Silt/glacial		7
35	Grab	55.34466	-58.1333	254	glacial	Grn-brn muddy sand on top. Blk-grn clay w/ silt in subsurface-very plastic. Num. dropstones on surface	
36	Piston	55.30175	-58.1485	354	mud over till	TWC- grn-gy silty clay 0-40. 40 to base is gy silty clay- firm PC had lg rnded cobble jammed in cutter. App. penetration was ~12 m	

Objective 2 Resurveys of 1979 sidescan data/ regional geophysical profiles

One of few ways to determine the severity of iceberg scouring is to repetitively map the seabed over extended time periods to identify new scour events. During 2006040, reasonably good quality BIO sidescan collected on the southeastern flank of Makkovik Bank during Hudson 79019 were resurveyed with a Klein 5000 sidescan (Figure *). Sufficient lines were run to produce two small mosaics over sections of 1979 lines. The lines were spaced 600 m apart and run at 400 m per channel range (800 m total swath).

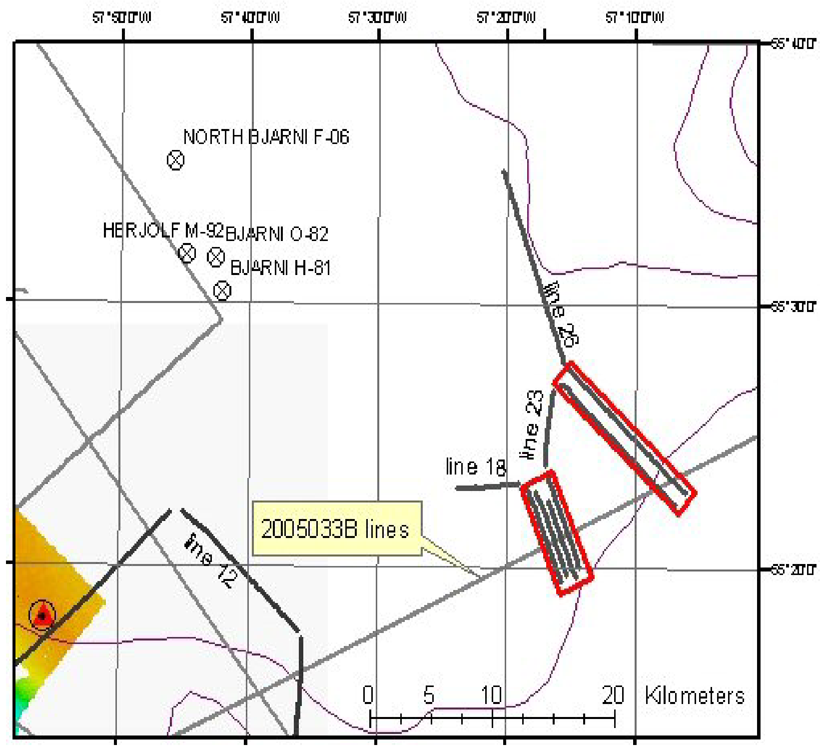


Figure 12 Geophysical lines run over SE Makkovik Bank during 2006040. Boxes are Mosaic 1 and Mosaic 2 over 79019 BIO sidescan coverage.

Transit lines to and between the mosaic and heading NE towards the bank edge were run with sleevegun, Huntec and Klein 3000 sidescan (Figure *).

Sidescan quality was excellent with full 800 m coverage (Figure). Difficulties reading the cable layback from the Kelin precluded production of final mosaics. Plans are to use ORE Trackpoint data to post-process the sidescan data for layback.

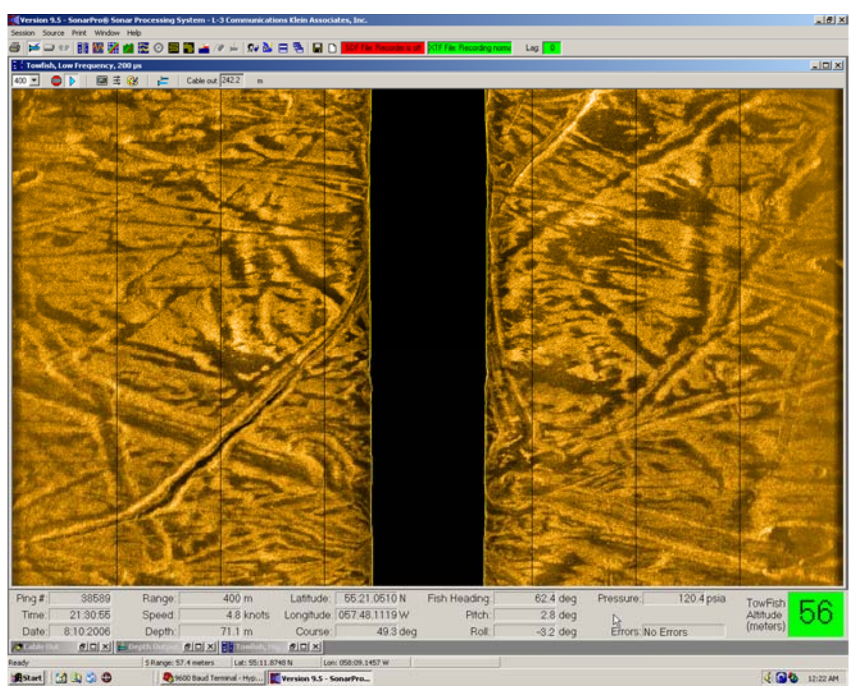


Figure 13 Klein 3000 sidescan data collected at 400m per channel range

Appendix 9- Technical Report, Huntec DTS operations

TECHNICAL REPORT
DEEP TOW OPERATIONS
Labrador Coast
C.C.G.S. HUDSON #2006-040
Aug 5th -Sept 1st 2006

Submitted by:

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Prepared for:

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Distribution: Calvin Campbell
B. Wile GSCA (Curation copy)
Project File #C195-? Dated: August 29, 2006

Introduction

This is a technical review of the Deep Tow Seismic (DTS) operations onboard the Canadian Coast Guard Ship Hudson, during Natural Resources Canada mission #HN2006-040 This marine geophysical and geological sampling survey was located off Labrador Shelf from Aug 5th 1st Sept 2006. The scientific objective of DTS operations was to provide high resolution sub-bottom information to assist in the ongoing regional geological investigation and mapping of the study area. The field program was directed by Senior Scientist, Calvin Campbell of the Geological Survey of Canada - Atlantic Region, Bedford Institute of Oceanography.

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

* Huntec Deep Tow Boomer/Sparker profiling system
* Klein 3000 side scan
* NRCan Seismic System (GI AIR GUNS and Teledyne Streamer)
* GSC DIG Digital Loggers (Klein Seismic and Deep Tow)

Overall, DTS operations went well with no problems to report. There was no system downtime and the DTS sub-bottom data quality was good to very good. The sparker and ED10 boomer source were changed out during the mission depending on water depths and bottom classifications.

Geoforce Consultants Limited provided technician, Graham Standen under the standing offer contract #23420-05S004/001/HAL to supervise the installation, operation and maintenance of the DTS system during the field program.

Daily Summary

A digital copy of the Deep Tow Watchkeeper's daily logs is included in Appendix A (Microsoft Excel file format).

The Digital OBS M, S, and Z were picked up on the 31st August in the Gully area. They were deployed on the 30th of July and no problems were encountered during the deployment.
After the recovery the vessel made for Halifax.

Description of Equipment

a) Deep Tow Seismic System

Geoforce Consultants Limited of Dartmouth, Nova Scotia is contracted under Standing Offer contract #23420-05S004/001/HAL to supervise the operation, maintenance and ongoing engineering development of the NRCan's DeepTow Seismic (DTS) systems. The DTS system, originally manufactured by Huntec (70) Limited, is a high resolution, sub-bottom profiler with the acoustic source, energy supply, motion sensor, and two receiving hydrophones housed in an underwater tow fish.

The AGC #3 DTS system was used on this mission. The maximum power output of this system is 1000 joules (60 mfd storage capacitance) with an ED10F/C Boomer and a multi tip sparker source. For this mission, the internal single element LC10 hydrophone was configured as Seismic #1. The externally towed Geoforce GF24/24P2i streamer hydrophone was connected as Seismic #2 (overall streamer length 24 feet, two inter-spliced channels with a combined fourteen foot active section, total of twenty-four AQ1 elements with an effective spacing of 12 inches).

The ED10 boomer source is depth compensated and outputs a highly repeatable broadband pulse, capable of resolving 10 centimetres. Peak output intensity is 118 db relative to 1 micro bar at 1 metre, with a pulse duration of 110 microseconds. The sparker source has twenty, #18 awg, solid core tips. Sparker peak amplitude and pulse width are depth dependant.

The deck equipment consists of a Haaglund 30000 Oceanographic winch, which includes a multi-way slip ring and a 900 metre, fourteen conductor, armoured tow cable. The winch is powered by a 440 VAC, 60 HP hydraulic pump unit. The tow cable is handled by a 36 inch diameter roller cluster rigged on the centre position of the aft A frame.

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

The new Geoforce /AGC developed Systems Console was used during the last three days of survey to evaluate. The unit worked very well and will be used during the remainder of the missions this year.

b) Graphic Display, Signal Processing and System Key

The two DTS seismic channels were displayed on a single EPC 9802 dual channel recorder (s/n184). Seismic #1 (internal LC10 hydrophone) was processed by the Systems Console's Adaptive Signal Processor (ASP) module then displayed on Channel A of the EPC recorder. Seismic #2 (external GF24/24P2i streamer) was band passed thru a Krohnhite 3700R filter with nominal settings of 900 to 4500 hertz. A TSS 312B graphic annotator provided time marks on the hard copy records. For the survey in deeper water on the last days of the mission, only the external GF24/24P2i streamer signal was displayed on channel A of the EPC recorder.

The PC based MITS system triggered the DTS and seismic systems. The MITS system allows several systems to be run using a common time base. The MITS masking feature significantly reduces acoustic interference by inhibiting the coincidental triggering of interfering system(s). Each source has two independent, adjustable delayed trigger outputs.

c) Data Recording

The two DTS signal channels were recorded on the PC based GSC DIG (# 9) digital four channel logger with hard drive storage and DVD disk writer. The data directory on the hard drive is C:/gscdigdata/hud2006039/day_xxx-xxx

AGC DIG Inputs	Description
Ch. #1	Seismic #1 - Internal LC10 hydrophone
Ch. #2	Seismic #2 - External GF24/24P2i streamer
Trigger	+5 volt MITS master trigger

d) Equipment List

Unit Description

Serial Number

Tow Fish Body

AGC #3

ED10F/C Boomer Source

2023

MK5-2 Attitude Sensor Unit

5005

S1000-4 Energy Storage Unit

1019

Internal LC10 Hydrophone

External GF24/24P2i Streamer
Haugland 3000 Winch and Power Pack

103

Roller Cluster 36" Dia.

Systems Console
Geoforce Systems Console *
* (used from day 238, line # 76)

125
109
001
EPC 9802 Graphic Recorder
184
MK 3 Power Control Unit 105
Krohnhite 3700R Filter 1760
GSC DIG Data Logger #9

Equipment Settings

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

Parameter	Setting
Fire rate	.5 second
PCU power setting	4 kv or 480 joules
ESU power setting	60 microfarad (1000 joules max.)
BMC (motion compensation)	Pressure Mode
Display Gain	Seismic #1- Fixed +20 Db. Seismic #2- Fixed +20 Db.
Filter Setting - Internal - External	Seismic #1 - 1000 - 5000 hertz Seismic #2 - 1000 - 4500 hertz
Processor Gain (System Console)	4 KV (both channels)
DTS source	See daily logs
GSC DIG trigger	master MITS trigger (Not used after Line # 76 for triggering Huntec)
GSC DIG sample rate	50 microsecond
GSC DIG samples per channel / range	5000 /500 microseconds

EPC 9802 sweep speed	(See daily logs for more info) 500 msec. channel A only 250 msec. channels A and B
EPC print polarity	positive

Equipment Performance

Overview

In general, the DTS system performance was good, with no system downtime to report. The tow fish was recovered during 36 hour operations every 12 hour to re-tip the sparker electrodes. There were no equipment related problems to report on this mission.

Data Quality

Overall, the data quality was very good. The sparker data using the new systems console was better than using the older model. However the new systems signal had to be filtered using the krohnhite's two 20db gain setting.

Status of Equipment

New tow fish cradle.

Although this is an improvement on the older type when it came to recovery it was difficult to line up and drop into the cradle. The front section of the cradle had to be cut away to allow easy placement for the bar to sit and the two locking pins in the back of the cradle will have to be opened up to allow the pins to be put in place.

Geoforce/AGC Systems Console

This is a great improvement on the older type when using the external EPC delay/trigger. But during the initial test of the external trigger signal was observed. The trigger would after a random number (depending on the fire rate from the MITS) of shots would double the trigger output from the Systems Console which in effect would cause the sparker to hangup and not fire

due to the duration of the second pulse of the double output. I do not believe this would effect the firing of the boomer if this occurred when in use.

<u>Parts Consumed</u>

2	- sparker tips (installed at start of mission)
10m	- zipper tube fairing
1	- 93 bushing

Recommendations

The new systems console work very well. During development of the digitizing of the signal with the DIGS it would be advantageous to be able to change the EPC delay using the interfaced with the console. Also to be able to change filters setting and gain (20db or greater for display on the EPC). This would mean having a stand alone processor which would not only record the data, but display as a hard copy output to the EPC recorder with a waterfall display and to be able to synchronise the delay of the DIGS with the delay of the data display.