Canada

Cruise Report
Hudson 2002-046

Scotian Slope

August 15 - September 5th 2002

Captain M. Hemeon

Geological Survey of Canada (Atlantic) project 980013

Natural Resources Canada   Ressources naturelles Canada

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Acknowledgements

We thank the Master and the entire ship's complement for their expertise and cooperation that ensured the success of the scientific program. This help included the full support of the Master for the science program, the professionalism of the deck crew under bosun Dave MacLean, excellent station keeping, assistance with rebuilding our equipment, and good food and service.

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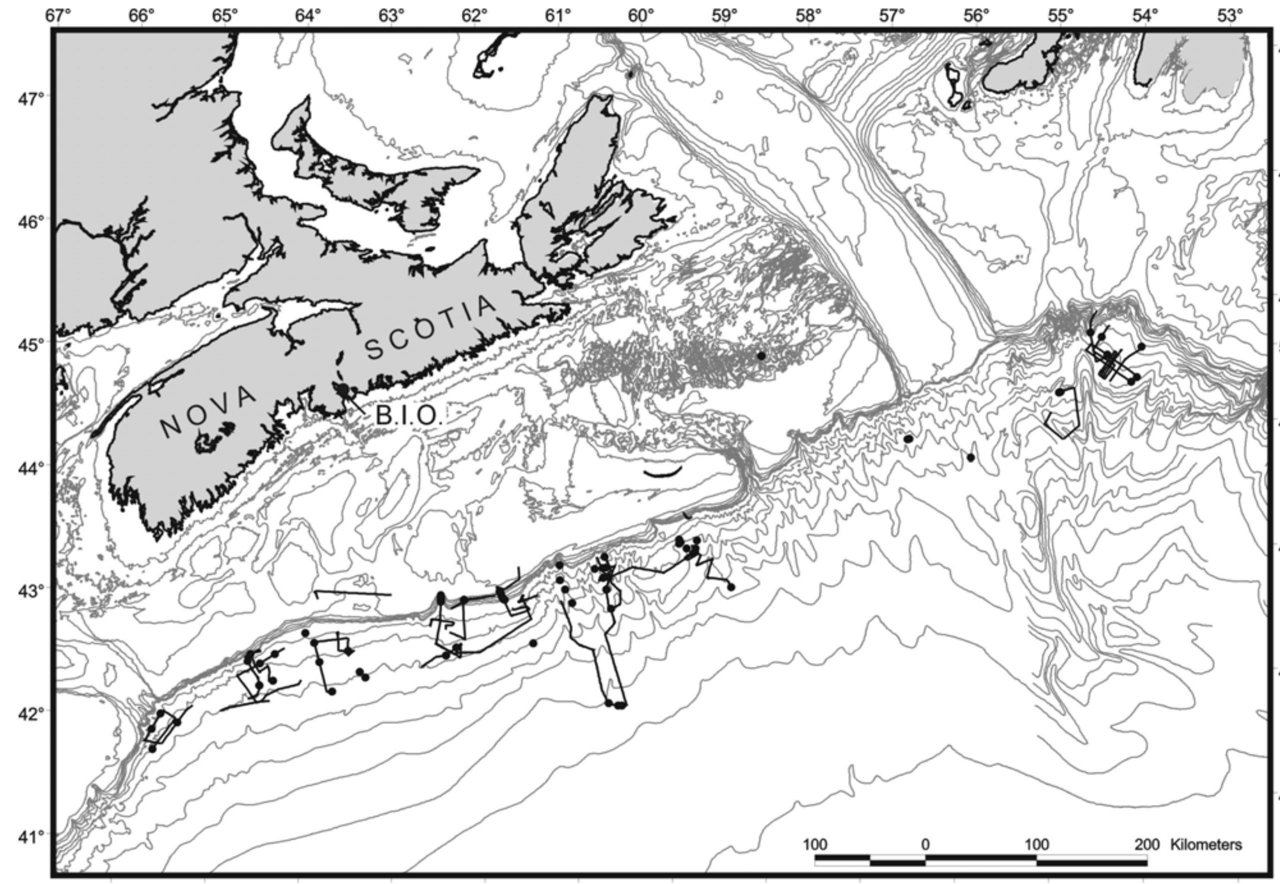
SUMMARY OF CRUISE

Date	JD	Area, activity	Purpose	PC	Stacor	IKU	Lines
15-Aug	227	steam from BIO, do upper slope seismic in Block 2	ACPI upper slope project; tie shelf to slope seismic stratigraphy				1-8
16-Aug	228	Deploy RALPH, upper slope IKUs	ACPI upper slope project			2-9	9-16
17-Aug	229	Additional IKU sampling, overnight MacRae seismic	ACPI project; Paleogene stratigraphy, Montagnais structure			10-22	17-19
18-Aug	230	Shelburne area: 3 cores and seismic at ODP sites, long dip line off LaHave Bank	ODP site survey; regional assessment of major ice outlet	23-24	25		20-26
19-Aug	231	off LaHave Bank. Long dip section of cores, then run blue lines in evening	Regional coverage of SW Scotian Slope including Barrington block; Thian Hundert M.Sc. project	26-29			27-35
20-Aug	232	Barrington block (west). Transect of cores, then run pink lines in evening		30-33			36-40
21-Aug	233	Barrington block (east). NE Channel seismic in evening	Regional coverage of major ice outlet; Thian Hundert M.Sc.	34, 36	35		41-45
22-Aug	234	NE Channel cores, then short seismic, then steam 10 hours to Torbrook	Regional coverage of major ice outlet; Thian Hundert M.Sc.	37-40			46
23-Aug	235	2 days gas hydrate area: day coring; late pm deploy OBS, overnight shoot lines including dip line off Mohican Channel	gas hydrate and long lines; geotech and gas in Torbrook block cores	41,43	42,44		47-52
24-Aug	236	am recover OBS, DDH over gas hydrate, strike line on lower slope, repeat 85001 - 81044 type section					53-58
25-Aug	237	upper-middle Dawson Canyon sampling, long dip line at night	Cores on canyon wall terraces to evaluate character of past flows	45-48			59
26-Aug	238	lower Dawson Canyon (on Rise)	as previous day, plus paleoceanographic core	49-51			60-61
27-Aug	239	Weymouth block: regional seismic line up from rise; core intercanyon areas and selected canyon floors.	Complete reconnaisance seismic and core coverage of a typical canyon - intercanyon area; investigate canyon floors.J. Chubbs B.Sc. hons. thesis.	52,53, 55,56	54		62-66
28-Aug	240	Further seismic and coring; DDH down canyon floor.		57, 58, 60	59		67-69
29-Aug	241	Annapolis block: 1 day young failure coring, overnight debris flow seismic; I day canyon floor coring, then overnight steam	Core sites for young failures	61-65			70-79
30-Aug	242		Reference deep-water core, cores for debris flow history	66-69			80-81
31-Aug	243	1 day L. Fan W. valley to slope off Banquereau	Geohazard assessment in the unknown BP-Anadarko block	70-72			87-91
1-Sep	244	3 days St Pierre Slope - salt tectonics-Halibut channel margin - St Pierre Slope - tie to Narwhal	Behaviour of shallow salt; complete regional understanding of Quaternary geology of this unknown part of Scotian basin	73-74			92-99
2-Sep	245			75-77			101-110
3-Sep	246			78-80			111-112
4-Sep	247	30 hour steam back to BIO; Stacor in Banquereau basin for Holocene			81-82		
5-Sep	248	arrive BIO 0800					



All survey lines and stations, 2002-046

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OBJECTIVES AND ACCOMPLISHMENTS

Scientific objectives

1. To obtain data on geohazards, geotechnical properties and shallow stratigraphy on selected areas of the Scotian Slope
2. To detect the presence and distribution of gas hydrates on the Scotian Slope
3. To investigate salt tectonics south of St Pierre slope and the top Wyandot and Acadia chalk surfaces on the central Scotian Shelf
4. To deploy RALPH and investigate the seabed on the upper slope to understand the impact of internal waves on sediment transport on the upper slope
5. To carry out an ODP site-survey
6. To obtain thick Holocene cores on an opportunity basis

Scientific accomplishments

1. ***Data for geohazards, geotechnics and shallow stratigraphy***

Collected 51 piston cores and 5 Stacors, together with 2200 line-km of Huntec and airgun seismic over an area from off Northeast Channel to the SW Grand Banks slope. This data will be evaluated in the lab for geotechnical properties, evaluation of geohazards, and development of a regional geological model. The work included previously unknown areas of the West Scotian Slope, the extreme East Scotian Slope and the area between St Pierre Slope and the SW Grand Banks Slope. Additional understanding was gained of previously investigated areas on the central Scotian Slope.

Spent four days on the West Scotian Slope to the west of the Shelburne well, including two days in the Barrington block and one day seaward of Northeast Channel. Ran regional seismic lines, including Huntec across all the best TDI Brooks cores in the region. In Barrington block, 50-100 ms of stratified sediment overlies a very thick succession of stacked debris flow deposits, pointing to a major change in depositional style perhaps at marine isotope stage 6. Investigated major debris-flow corridor in Barrington block and its evacuation area on the middle slope. Three strike lines across slope seaward of Northeast Channel show evolution of slope with similarities to the upper part of Laurentian Fan. Obtained 14 piston cores and one Stacor on West Scotian Slope that will provide chronology for shallow failures and baseline geotechnical data..

In the Torbrook block, collected two piston cores and two Stacors for gas samples and baseline geotechnical information. Collected some regional seismic profiles, in particular a long dip line in Mohican Channel, a long strike line in southern Thrumcap block coincident with a TGS line, and reshot the type section for the late Cenozoic of the Scotian Slope at the intersection of 85001 and 81044 lines north of the Shubenacadie well.

Obtained two long seismic lines, avoiding shallow salt, that tie slope to rise stratigraphy to the west and east of Dawson Canyon. Obtained four piston cores on small terraces on the walls of Dawson Canyon to evaluate changes in flow character down the canyon over the last glacial cycle and three additional piston cores in lower Dawson Canyon at 4000 mbsl at varying heights above talweg channel to evaluate past flows.

Spent two days in Weymouth block, with one Stacor and 9 piston cores over a range of water depths and geologic environments. Ran digital deep hydrophone line down canyon floor, plus regular seismic both on canyon floors and intercanyon areas.

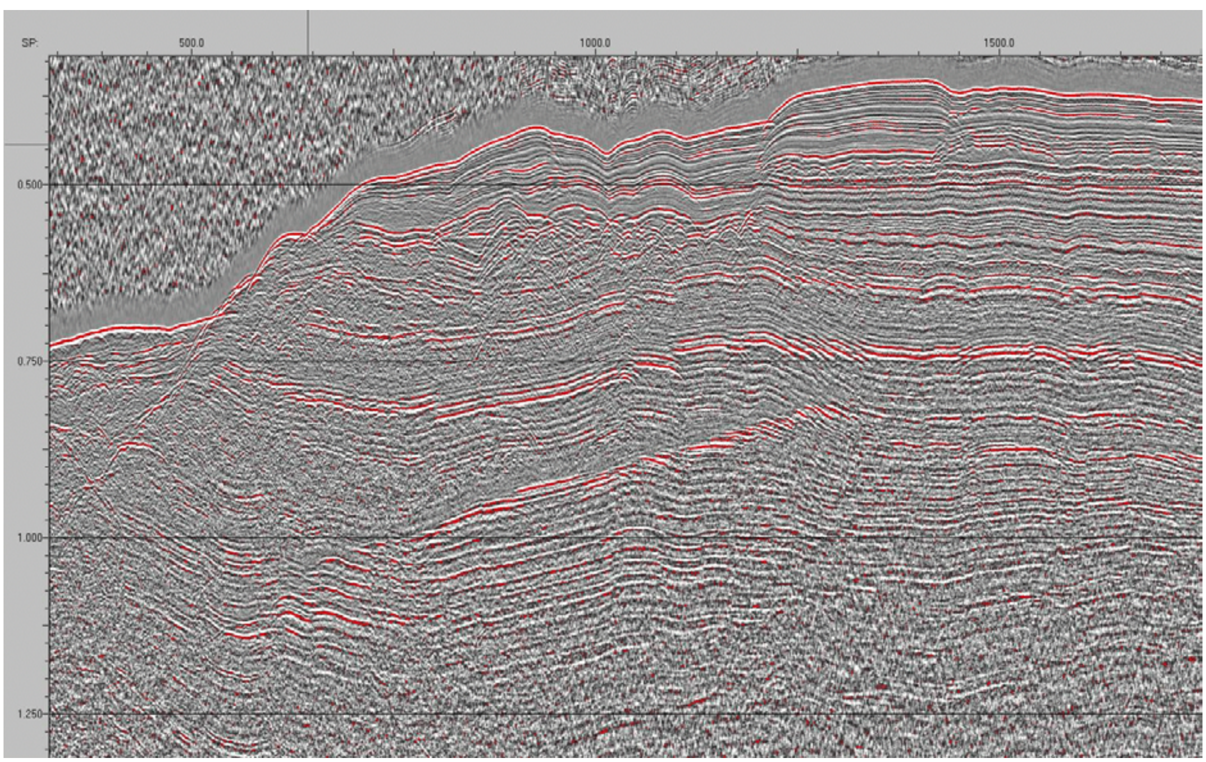
Spent two days in Annapolis block. Collected 9 piston cores to evaluate the age of failures on rough canyon wall topography at 1500 - 2000 mbsl and the history of events on canyon floors. Overnight seismic across debris-flow deposits in Logan Canyon was hindered by repeated airgun failures. Ran a short digital deep hydrophone survey in a canyon head.

In one day in the BP-Anadarko block south of eastern Banquereau, we collected three piston cores in the highly dissected topography in poor weather; lost one barrel in recovering only a few centimeters of possible Pliocene shale at one site.

Spent three days in area between Eastern Valley of Laurentian Fan and the SW Grand Banks slope, a previously unknown area that receives drainage from St Pierre Slope, Halibut and Haddock Channels, and the slope off Whale Bank. Achieved seismic ties to previous surveys on Laurentian Fan levees, St Pierre Slope, and the slope around the Narwhal well. Collected 5+ piston cores to calibrate Huntec records in this area.

2. ***Gas hydrates*** [DCM]

Gas hydrates have long been suspected of being present on the Scotian Margin because conditions are correct for their stability. It is only within the past year, however, that evidence for them has been uncovered, and that evidence exists only within proprietary industry seismic reflection data. Based on this industry observation of Bottom Simulating Reflectors (BSR's), which are indicators of the presence of gas hydrate, an objective of this cruise was to attempt to image and quantitatively characterize the BSR's with GSC seismic equipment, through both seismic reflection and wide-angle seismic reflection techniques. To accomplish this objective, it was felt that appropriate survey equipment was necessary, such as a hydrophone streamer that was capable of acquiring low-frequency (< 100 Hz) data, and high resolution Ocean Bottom Seismometers (OBS). Sites were picked to survey from the industry 3D seismic reflection data. Three OBS' were deployed over these sites and survey lines were shot across these. Although the OBS data has not yet been examined in detail, the coincident seismic reflection data show strong evidence of the BSR's, which means that for the first time, public data exists showing the presence of hydrates on the Scotian Margin. An additional, well-defined BSR was unexpectedly found to the east of Laurentian Fan during this expedition.



Seismic reflection profile showing BSR at 0.8 - 1.0 s in the area of the OBS experiment

3. ***Salt tectonics and Paleogene stratigraphy*** [JS]

Three days were spent acquiring seismic data and cores within a 1000 km^2 region south of Green Bank in water depths of 600 to 2200 metres. Hydrographic charts of the region depict a seafloor that is deeply eroded by seaward extensions of the shelf-cutting Halibut and Haddock channels but little else is known about this part of the continental slope in comparison with Laurentian Fan, to the west, or the area around the Narwhal well, to the east. Interpretation of 1998/1999 industry multichannel seismic reflection data indicates the presence of salt diapirs that penetrate to within about 300 metres of the seafloor, which is shallower than nearly all other known mid to upper slope diapirs in the Scotian Basin. A 6 kilometre-wide block slide, involving ?Pliocene and younger sediments, is also imaged by the industry data. Piston cores and single-channel seismic data were acquired to assess whether the block slide, which is more extensive than previous data indicated, is related to deformation of the nearby salt diapirs and whether the diapirs are still active. The seismic data also reveal a bottom simulating reflector, not previously identified with existing datasets, over an area of approximately 50 km^2 that may indicate the existence of gas hydrate. The 5 to 10 metre vertical resolution of the single-channel data will allow detailed investigation of the interaction between sedimentation and salt tectonics in this region of the slope, which may serve as an analogue for more deeply buried units of significance to the petroleum industry.

A long seismic line was run across "Scotian Gulf" south of Emerald Basin and Sambro Bank, to tie the Acadia Chalk from the type area to the Montagnais structure and also to confirm the glacial history of this major ice outlet.

4. ***Upper slope project***

Spent two days in vicinity of Ralph deployment site on upper slope west of Verrill Canyon. Successfully deployed Ralph and guard buoy. Obtained sidescan of bedforms in 150 to 300 m, showing both straight sediment waves and linguoid forms of two sizes. Ran Huntec DTS sparker profiles over the upper slope. Obtained about 20 IKU grabs of upper slope sands, both in sediment wave fields and in areas inferred to be thin sand over till. Living macrofauna saved for Kostylev, foraminiferal samples taken for Hawkes, and mollusc shell samples for Best.

5. ***ODP site survey***

Upon departure of the Hudson 2002-046 expedition, there was a good possibility that a joint industry-government collaboration might employ the *Joides Resolution* to conduct a scientific, ODP-style, corehole in the west-central Scotian Slope region, near the location of the Shelburne G-29 well. In preparation for this possibility, it was an objective of this cruise to run several survey lines near the proposed site and collect several Piston and/or Stacor cores to contribute to the corehole site survey requirements as part of the geohazard assessment. Seven sleeve gun seismic reflection lines (Lines 20-26) were run in the vicinity of the proposed site, along with coincident high-resolution Huntec sparker reflection profiles. The seismic reflection records provide up to 1.5 s subbottom imaging with vertical resolution on the order of 2 m. The Huntec sparker system provides depth imaging to about 100 ms subbottom with vertical resolution on the order of 0.25 m. Six piston cores were collected within the vicinity and 1 Stacor core. Two Piston cores and the Stacor core are at the proposed drill site and auxiliary site. These cores total 61 m of sediment.

6. ***Holocene cores***

Two Stacors were collected in a basin north of Banquereau as records of Holocene paleoceanographic changes.

Technological objectives

1. To improve procedures for obtaining high quality, low frequency, digital seismic reflection profiles.
2. To further develop the digital deep hydrophone (DDH) system
3. To further develop the upside down long baseline system

Technological accomplishments

1. ***Quality seismics***

A number of steps were taken to ensure acquisition of better quality seismic reflection records for Hudson 2002-046. Better quality, in this context, means broader bandwidth, higher signal to noise ratio, and fewer missed shots. As has been shown on previous expeditions, signal is drastically improved with the use of two synchronized sleeve guns. A two-gun array was kept operational for most of the cruise while surveying, although this proved logistically quite difficult to do. An appropriate streamer with acceleration-canceling hydrophones was borrowed from GSC-Pacific to provide the ability to acquire lower frequency (broader bandwidth) data and filter settings were constantly monitored to ensure appropriate acquisition settings. The data were extracted from tape each day at the end of surveying to inspect for quality control and adjustments were made as necessary to ensure high quality records. This step required the constant attention of at least one researcher, which often on our cruises is not the case. The new GSCDIG digitizing system, although prototype on this cruise, shows great potential for maximizing data quality and minimizing risk of misuse.

2. ***DDH***

Improvements for this year included a new hydrophone streamer using 10 elements of acceleration-canceling hydrophones (AQ-4) and recognition of absolute shot time to help calculate the geometry of the seafloor. In earlier years, shot times were relative, thus it was not possible to calculate layback distances to the deep-tow body. Three DDH tests were run comprising nearly 73 km of track and 1 Gbyte of data. Unfortunately, the new streamer showed very poor signal-to-noise ratio and we were unable to explain the reason. The new streamer was swapped for the old one used in previous tests and good quality records were obtained. Many problems with the digitizer and the telemetry and sorting out the geometry were solved.

3. ***ULBL***

The Upside-down Long Baseline system is being developed by Dave Heffler to help locate very accurately a position of an instrument, such as a core, on the sea bottom in deep water. The system uses floating buoys each with a GPS receiver, a hydrophone and a radio to transmit the information back to the ship. With this configuration, it is possible to triangulate on a pinger attached to the core head. The pinger arrivals (direct, bottom and multiple), needed to triangulate on the position, are easily visible on the ship's sounder but have proved difficult to track automatically. The instrument was unsuccessful as a consequence, but it is felt that the solution is close at hand. Real data has been logged that can be used in developing the system.

NARRATIVE

Note: positions in this narrative are those originally planned and may not correspond to actual positions.

Thursday August 15th
Sailed at 1030 ADT. Steamed at 14-15 kts towards "Mosher area" on the upper Scotian Slope. At 1900, deployed air gun array (2 40 cu in sleeve guns), Teledyne eel, GF30 eel, Huntec with 500 kJ sparker. Ran a series of lines (001-008) that were seriously curtailed by sword fishing, requiring us to abandon the upper slope and move out into deeper water.

Friday August 16th
Brought seismic gear in at 0600. Steamed to nearby Ralph site, deployed Ralph and guard buoy uneventfully. Then started IKU sampling about 0900. Considerable problems with IKU not tripping; at station 004 ground down the lugs.
IKU samples were taken as follows: surface sand sample, push core, surface foram sample (for A. Hawkes, Dalhousie), mollusc samples including sieved sample (for Dr Mairi Best, McGill).

Took IKU grabs at the following stations (depths are actual, positions are planned)

002	237m	42° 59.4714'	-61° 47.2866'	12R
003	286m	42° 58.7496'	-61° 46.7916'	36R
004	337m	42° 58.1532'	-61° 46.3788'	2.5R
005	383m	42° 57.651'	-61° 46.0242'	36R
006	431m	42° 57.1806'	-61° 45.72'	5 x 5R

if time permits

007	140m	43° 1.1904'	-61E° 48.4326'	12R
008	158 m	43° 0.2052'	-61E° 47.7726'	no recovery on 4 attempts
009	165 m			no recovery on 2 attempts

At stations 002 and 003, appeared to be about 12 cm sand over something very hard. In 003, recovered some cobbles that might be at the top of that hard surface. Similar sand in 004 and 005, both partially washed out. 006 was full of silty mud.

in mid afternoon, ran sidescan and Huntec only on a line westward in about 350 m water depth, until early evening, to image sediment wave field.
Deployed sidescan and Huntec 1 mile before point G
G 42E 59.2512' -61E 51.9984'
towed at 4.5 knots
Line 9 to point H
H 42E 57.2526' -62E 12.3204'

then retrieved sidescan and deployed airgun array and Teledyne and GF-30 eels and ran the following lines
Line 10 from I to J

I	42E 57.2052'	-62E 12.7776'
J	42E 38.3052',	-62E 11.5362'
Line 11 to K	42E 42.5364'	-62E 24.2256'
Line 12 to L	42E 45.1896'	-62E 24.1158'

Line 13 to M	42E 45.039'	-62E 19.4142'
Line 14 to N	42E 46.4712'	-62E 18.7206'
Line 15 to O	42E 47.4648'	-62E 27.8382'
Line 16 to P	42E 58.7574'	-62E 27.3012'

some problems near N with fishing vessel; gear brought in and then put out again

Saturday August 17th

On recovery of seismic gear, it was found that airgun towing frame was beaten up; damage caused firing circuit to burn out. Considerable effort spent fixing these problems during the day.

planned to take IKU grabs at the following stations in Mohican Channel (depths actual, positions are planned not actual - see table for details)

010	42E 59.7696'	-62E 27.3168'		142 m	36R
011	42E 58.8486'	-62E 27.3'		190 m	4 x 20R
012	42E 58.2378'	-62E 27.318'		196 m	3 x 15R
013	42E 57.7182'	-62E 27.3474'		241 m	2R
014				289 m	10R
015	42E 57.3078'	-62E 27.363'		330 m	15R
016			3	25 m	no recovery
017	42E 56.8704'	-62E 27.3918'		384 m	trace
018	42E 56.3874'	-62E 27.4086'		424 m	10R

actual station numbers may be different because of multiple attempts. In general, shallower water grabs successful, those in deeper water had small recovery, as if there were something very hard a short distance below the surface, just like the previous day.

over lunch, steamed to the following grab sites in the sidescan imagery of line 9 (depths actual, positions are planned not actual, see table for details).

020	42E 57.4122'	-62E 12.1392'	205	15R
021	42E 57.33'	-62E 12.1254'	216	25R
019	42E 57.2208'	-62E 12.1044'	223	15R
022	42E 57.1386'	-62E 12.0828'	223	no recovery

When grabs completed, steamed to 1 mile before point Q and deployed Simrad sidescan on ice-island winch and Huntec

Ran line 17 from Q towards R

Q	42E 58.2498'	-62E 7.2228'
R	42E 52.2654'	-62E 23.1684'

Brought in gear before end of line because it was not obvious that more would be learned and we were running out of time.

Then steamed to point S

1 mile before S deployed Huntec and airgun. Ran line 18 from S to T

S	43E 0.0252'	-63E 0.0576'

T 43E 1.7892' -63E 51.03'
early in the line, airgun hose broke. Brough in airgun and fixed it. Reduced speed during this time.
then ran line 19 towards U for about 30 minutes.
U 42E 51.5166' -63E 45.6894

Sunday August 18th

brought in seismic gear at 0630 approx and steamed to core site

Core station 023 40 ft piston core ODP site near Shelburne well
42E 37.266 -63E 35.334'

Core station 024 40 ft piston core alternate ODP site south of Shelburne well
42E 32.604' -63E 28.86'

core up by lunch time
then took Stacor 025 at same site. Completed by 1500 ADT

Steamed north to deploy gear. Problems with compressor led to circling for 30 minutes after seismic gear was deployed. Deployed Huntec, airgun, Teledyne eel and GF-30.

sol 20	42E 41.9796'	-63E 35.568'
sol 21	42E 32.6262'	-63E 35.082'
sol 22	42E 32.5704'	-63E 25.2948'
sol 23	42E 30.189'	-63E 28.8816'
sol 24	42E 38.9382'	-63E 28.8138'
sol 25	42E 36.6744'	-63E 51.1512'
sol 26	42E 12.5904'	-63E 42.6636'

line 26 runs E for 3 mi

Monday August 19th

transect of piston cores approximately along line 25, from deep to shallow

Core 26	40 ft piston core		
Core 27	50 ft piston core		
Core 28	50 ft piston core	42E 36.2224	63E 51.3273
Core 29	50 ft piston core	42E 40.974	63E 57.276

once core 29 was completed, steamed to 1 mile before sol 27 and deploy airguns, eels and Huntec. Ran the following lines at 5 knots (through the water).

Barbeque in evening

sol 27	42E 34.593'	-64E 8.607'
sol 28	42E 23.7882'	-64E 31.4748'
sol 29	42E 29.253'	-64E 36.006'

sol 30	42E 32.3484'	-64E 27.9006'
sol 31	42E 33.2652'	-64E 28.83'
sol 32a	42E 30.5652'	-64E 34.1646'
sol 32b	42E 26.9298'	-64E 30.765'
sol 32c	42E 26.0352'	-64E 30.744'
sol 33	42E 21.7956'	-64E 27.2328'
sol 34a	42E 24.774'	-64E 21.564'
sol 34b	42E 22.3926'	-64E 20.4864'
sol 35	42E 17.6148'	-64E 20.5356'
eol 35	42E 17.5014'	-64E 17.7306'

Only one gun firing most of night and further damage to aluminum plate. Decided to replace the plate with something that would let the water through better and to add a protective bolt on the aft end of each gun.

Tuesday August 20th

Bring gear in at 0615 and take core 30 near end of line.

Core 31

Core 32	50 ft	42E 30.3289	64E 33.2119
Core 33	50 ft	42E 30.4770	64E 17.3217

once core 33 is completed, steam to 1 mile before sol 36a and deploy airguns, eels and Huntec. Run the following lines at 5 knots (through the water)

sol 36a	42E 19.1808'	-63E 58.8384'
sol 36b	42E 16.0776'	-64E 1.0098'
sol 36c	42E 13.344'	-64E 14.6334'
sol 36d	42E 10.4034'	-64E 22.482'
sol 36e	42E 7.5882'	-64E 25.1808'
sol 37	42E 6.732'	-64E 28.2996'
sol 38	42E 19.7754'	-64E 41.6328'
sol 39a	42E 23.3394'	-64E 32.52'
sol 39b	42E 19.107'	-64E 27.981'
sol 39c	42E 14.712'	-64E 26.7726'
sol 40	42E 10.4652'	-64E 27.8808'
eol 40	42E 8.4792'	-64E 34.3134'

Wednesday August 21st

Brought in gear at end of line at 0610. Steamed to core site.
50 ft piston core 34 42E 15.0985 64E 26.8766
Stacor 35 at the same site

40 ft piston core 36 42E 26.9474 64E 34.9390

then steamed to 1 mile before seismic survey (at NSS001) and deployed airgun, two eels, and Huntec at 1600
Ran the following lines at 5 knots through the water

sol 41a	42E 04.9860'	-65E 10.0380'
sol 41b	42E 02.5476'	-65E 14.1276'
sol 42	41E 45.6408'	-65E 29.9700'
sol 43	41E 46.8660'	-65E 41.1006'
sol 44	42E 01.9668'	-65E 30.1422'
sol 45	41E 58.41'	-65E 21.324'
eol 45	41E 44.448'	-65E 34.47'

brought in gear just past end of line. No damage at all: modifications to towing sled appear to have been effective.

Thursday August 22nd
2 mile error on bridge over first core position but eventually returned to correct position.

Core 37	50 ft PC	41E 42.7981'	65E 35.9329'	
Core 38	40 ft PC	41E 52.5832'	65E 36.9586'	small spot
Core 39	50 ft PC	42E 00.2388'	65E 31.3960'	
Core 40	50 ft PC	41E 56.1149'	65E 20.1701'	

when core completed at 1500 ADT
Steam to sol 46a 42E 00.972' -64E 57.216'
and deploy DDH and airgun array

survey towards sol 46b at 3 knots
sol 46b 42E 03.9018' -64E 47.4132'

when DDH test complete (probably about 30 minutes) retrieve it and deploy Huntec and eels
then survey at 5 knots through until 11 pm ADT, then retrieve all gear:

sol 46c	42E 07.0032'	-64E 28.2336'
eol 46c	42E 09.2802'	-64E 04.4658'

After retrieving gear, steamed to core site 41

Friday August 23rd

core 41	50 ft piston core	42E 34.056	-62E 17.568
core 42	Stacor at same site		

then steamed to core site 43 & 44 42E 30.1680' -62E 24.2760'
50ft piston core

delayed because block read out failed again, put on pinger.
after lunch, Stacor 44.

then steamed to deploy OBS at the following points:

OBS 1	42E 33.4200'	-62E 24.3720'
OBS 2	42E 34.4760'	-62E 26.8740'
OBS 3	42E 28.4820'	-62E 33.0420'

some minor delays in getting OBS started.

When OBS deployed, steamed to 1 mile before sol 47a at about 1720 ADT and deployed airguns, eels and Huntec. Run the following lines at 5 knots through the water

sol 47a	42E 25.0908'	-62E 40.0812', with Huntec and 3.5 kHz off, firing at 5 sec.
sol 47b	42E 29.6886'	-62E 30.5064'
sol 47c	42E 30.2142'	-62E 23.7078'
sol 48	42E 36.1008'	-62E 14.3118'
sol 49	42E 29.2236'	-62E 14.349'
sol 50	42E 36.0384'	-62E 30.6336'
sol 51	42E 47.6874'	-62E 27.708'
sol 52	42E 48.1242'	-62E 33.444'
eol 52	42E 44.4786'	-62E 34.449'

Saturday August 24th

retrieved seismic gear at 0620 ADT and steamed to OBS 1 to recover.

All OBS successfully recovered by 1200 ADT

Then steam to 1.5 miles before start of line 53 and deploy DDH and gun array
Line 53 is the reciprocal of line 49 from last night

sol 53	42E 36.0384'	-62E 30.6336'
eol 53	42E 29.2236'	-62E 14.349'

tow gear at 2.5 knots or as requested by GP lab
Recovered DDH at 1700 ADT, but left airgun and surface streamer in the water and ran following lines
Line 54 from end of line 53 towards sol 55

sol 55	42E 31.6578'	-62E 1.9098'
sol 56	42E 47.5002'	-61E 27.684'
sol 57	42E 58.7514'	-61E 33.3036'
sol 58	42E 55.9848'	-61E 34.9494'
eol 58	42E 58.3482'	-61E 25.9368'

Weather deteriorated through the night, coming up to 45 knots in squalls. Had near-collision with US fishing boat on line 56, for a time gear was being towed at 7 knots.

Sunday August 25th

Brought gear in at 0615 ADT shortly after one airgun started leaking.

Collected the following cores in 25 knot southerly winds.

Core 45	43E 6.108'	-61E 8.322'	40 ft
Core 46	43E 13.578'	-61E 8.004'	40 ft
Core 47	43E 1.704	-61E 4.662'	40 ft
Core 48	42E 54.972	-61E 0.144'	40 ft

when core completed, steam to 1 mile north of sol 59a and deploy Huntec, airguns, and eels. Run the following lines at 5 knots through the water. Weather gradually improved through the night.

sol 59a	42E 56.4744'	-61E 7.794'
sol 59b	42E 43.3872'	-61E 1.1544'
sol 59c	42E 38.3052'	-61E 1.9158'
sol 59d	42E 34.3956'	-60E 55.89'
sol 59e	42E 31.8678'	-60E 47.1'
sol 59f	42E 11.9958'	-60E 41.9484'
eol 60	41E 59.6562'	-60E 34.0896'

Monday August 26th

brought in gear before eol 60 at 0615, after crossing line 93026. Then survey to the east at 8 knots using 3.5 kHz.

Core 49	50ft	42E 04.1828'	60E 31.6422'
Core 50	50ft	42E 05.396'	60E 37.7452'
Core 51	40ft	42E 04.1492'	60E 29.4719'

when core completed, steamed to 1.5 miles W of sol 60a and deployed airguns, eels and Huntec. Ran the following lines at 5 knots through the water. Light wind, almost no sea.

sol 60a	42E 5.5128'	-60E 38.2854'
sol 60b	42E 4.1868'	-60E 32.0544'
sol 61a	42E 4.1034'	-60E 25.9992'
sol 61b	42E 39.2958'	-60E 38.8704'
sol 61c	42E 44.8602'	-60E 32.1918'
eol 61c	43E 1.8732'	-60E 38.4372'

Tuesday August 27th

Line 61 terminated early at 0615 ADT at core site 52.

Core 52	50 ft	42E 51.6057'	60E 34.6641'
Core 53	50 ft	43E 01.002'	60E 37.248'
Core 54	Stacor at same position		

Hit pebble, recovered only 80 cm.

when Stacor 54 completed, steam to core site 55. Pass 1 mile beyond site and come back onto it.

Core 55	40 ft	43E 06.978'	60E 35.502'

Piston corer hit trigger weight corer, sheared off barrel.

Core 56	50 ft	43E 11.202'	60E 44.808'

When coring completed, steamed to 1.5 miles beyond start of line and deployed Huntec, airguns and eels. Ran the following lines at 5 knots through the water. Light wind, almost no sea.

sol 62	43E 11.0676'	-60E 46.2168'
sol 63	43E 12.5358'	-60E 31.2318'
sol 64	43E 2.0766'	-60E 37.4118'
sol 65	42E 51.4764'	-60E 35.823'
sol 66a	42E 53.658'	-60E 28.3938'
sol 66b	43E 0.1704'	-60E 28.017'
sol 66c	43E 3.8526'	-60E 33.4824'
sol 66d	43E 7.4082'	-60E 35.7816'
sol 66e	43E 9.8088'	-60E 38.7888'
eol 66e	43E 17.2866'	-60E 43.1988'

Wednesday August 28th

Brought in gear at eol 66e at 0615 ADT

Core 57	40 ft	in talweg on valley floor	
Core 58	50 ft	43E 11.946'	60E 37.284'
Core 59	Stacor	43E 06.932'	60E 39.212' at site of 2000-036-39
Core 60	40 ft	43E 17.046'	60E 37.836'

then deploy DDH and airguns 1.5 miles from sol 67a and tow at 2.5 knots

sol 67a	43E 17.6676'	-60E 36.6702'
sol 67b	43E 14.9028'	-60E 36.2856'
sol 67c	43E 12.5064'	-60E 34.7736'
sol 68	43E 10.0446'	-60E 33.9078'
eol 68	43E 7.2036'	-60E 39.6222'

Bring in DDH, but leave airguns in the water and run the following lines at 5 knots through the water.

sol 69a	43E 6.885'	-60E 35.8878'
sol 69b	43E 11.6994'	-60E 19.0848'
sol 69c	43E 8.4978'	-59E 58.8054'
eol 69c	43E 19.2456'	-59E 34.1724'

Thursday August 29th

Line 69c terminated a little early at the edge of the valley at 0635 ADT

then took the following cores to investigate variation in distribution of the 6 ka event with local gradient.

Core 61	40 ft	43E 19.9482'	-59E 43.0518'
Core 62	40 ft	43E 24.4722'	-59E 47.7054'
Core 63	40 ft	43E 23.049'	-59E 47.04'
Core 64	40 ft	43E 22.266'	-59E 48.0072'
Core 65	40 ft	43E 23.5368'	-59E 35.9022'

then steamed to 1.5 miles from sol 70 and deployed airguns, eels and deep towed streamer. Towed at 2 knots to check the acceleration cancelling streamer without the rigid backing. Still problems. Brought in DDH and deployed Huntec. Ran the following lines at 5 knots through the water

sol 70	43E 21.105'	-59E 39.9024'
sol 71	43E 20.6172'	-59E 34.704'
sol 72	43E 15.3804'	-59E 44.3802'
sol 73	43E 14.1198'	-59E 42.4344'
sol 74	43E 17.3952'	-59E 35.4798'
sol 75	43E 16.137'	-59E 33.6732'

three successive airgun failures overnight. Finally brought it in at midnight and ran only Huntec.

sol 76	43E 11.5188'	-59E 36.9966'
sol 77	43E 14.1678'	-59E 26.1888'
sol 78	43E 5.3196'	-59E 29.9898'
sol 79	43E 3.7584'	-59E 16.5738'
eol 79	42E 57.1362'	-59E 12.5562'

Friday August 30th

Bring in gear at 0615 shortly before end of line:

core 66	50 ft	42E 59.052'	-59E 13.806'

then steam north and take the following three cores

core 67	50 ft	43E 17.3101'	-59E 38.6021'
core 68	40 ft	43E 17.8109'	-59E 37.4676'
core 69	40 ft	43E 19.8072'	-59E 37.1856'

when core 69 completed, steamed to 1 mile N of sol 80 and deployed DDH and airguns.
Then ran the following lines at 2.5 knots

sol 80	43E 36.2526'	-59E 42.9636'
sol 81	43E 34.3074'	-59E 41.4132'
eol 81	43E 35.4834'	-59E 37.8708'

Retrieved gear at 2030 ADT, and steamed the following lines at full speed. GP lab maintained sounder watch.

sol 83	start at end of deep tow survey	
sol 84	43E 31.6104'	-59E 25.0314'
sol 85	44E 7.8624'	-57E 29.823'

slow to 7 knots before sol 86a.

sol 86a	44E 5.0934'	-57E 23.9556'
sol 86b	44E 7.1874'	-57E 7.8816'
eol 86b	44E 6.006'	-56E 58.7844'

Saturday August 31st

Moderate NE winds and seas.

came back to first core position at 0700 ADT

Core 70	40 ft	44E 06.7937	57E 10.8727

when core on deck, ran across possible core site at 44E 06.7022 57E 11.6182

No suitable core site in this vicinity, so steamed to core site at

Core 71	40 ft	44E 07.0035	57E 09.3126

Then two hour steam over lunch to:

Core 72	40 ft	43E 55.728	56E 29.172

lost bottom barrel

When core 72 secured, steamed at full speed into the wind to 1.5 mi north of sol 87 and deployed airgun array, eels and Huntec. Winds still NE 20 knots, rather confused sea, some whitecaps.

Ran the following lines at 4 to 4.5 knots

sol 87	44E 14.6748'	-55E 32.3988'
sol 88	44E 9.1194'	-55E 37.5924'
sol 89	44E 0.8718'	-55E 26.0808'
sol 90	44E 6.7074'	-55E 14.5128'
sol 91	44E 25.5222'	-55E 15.366'
eol 91	44E 22.2564'	-55E 33.5466'

Sunday September 1st

Brought in gear 4 miles before eol 91, where line intersects 99036 dip line, at 0630 ADT

Light winds, calm seas

Core 73	50 ft	44E 23.7779'	55E 25.0988'

Core 74	50 ft	44E 23.5655'	55E 26.2363'

Pengo spooling gear failed, wire wrapped badly. Abandoned coring for the day while repairs made.

Deployed Huntec, airgun array and two eels 1 mile before sol 92

Run the following lines at 5 knots

sol 92	44E 26.688	-54E 51.078'
sol 93	44E 31.0914'	-54E 45.7626'
sol 94	44E 42.8862'	-55E 4.8732'
sol 95	44E 45.9072'	-55E 1.0602'
sol 96	44E 27.9222'	-54E 32.0454'
sol 97	44E 24.8448'	-54E 35.8674'
sol 98	44E 31.0458'	-54E 45.987'
sol 99	44E 36.7482'	-54E 39.072'
sol 100	44E 41.0226'	-54E 27.1908'

Line 100 ran due north for a short distance

Monday September 2nd

Brought seismic gear in at 0625 ADT. Excellent quality data all night.

Steam to deep-water core site to get bad wraps out of wire.

Core 75	50 ft	44E 25.4414'	54E 36.8356'

put out wire slowly, solved the wrap problem, with a few overturns

Core 76	50 ft	44E 27.4065'	54E 32.6608'
Core 77	50 ft	44E 41.8121'	54E 27.2141'

Then steam to 1.5 miles from sol 101 and deploy Huntec, airgun array and two eels

Run the following lines at 5 knots through the water

sol 101	44E 41.667'	-54E 40.8684'
sol 102	44E 28.917'	-54E 55.4904'
sol 103	44E 30.5712'	-54E 58.0602'
sol 104	44E 41.0358'	-54E 45.8196'

airgun failure at about 1900 ADT

remaining lines changed to the following based on results to date

sol 105	44E 40.2804'	-54E 44.382'
sol 106	44E 29.7258'	-54E 56.7708'
sol 107	44E 28.1946'	-54E 54.1194'
sol 108	44E 34.5108'	-54E 46.5612'
sol 109a	44E 41.5524'	-54E 58.9914'
sol 109b	44E 54.0282'	-54E 47.6748'

Tuesday September 3rd

continued seismic until 0915 ADT. Near sol 109b, turned onto line 100, due east, looking for coring site. No suitable sites in the last hour and a half of seismic.

Core 78	50 ft	44E 48.5780'	54E 53.7698'

when core retrieved, steamed towards

		44E 51.558'	55E 02.136'

picked core site from sounder in GP lab

Core 79	50 ft	44E 51.1800'	55E 01.0690'
Core 80	50 ft	44E 39.618'	54E 50.904'

deployed seismic gear 1.5 miles north of sol 111 and ran the following lines at 5 knots through the water

sol 111	44E 39.2664'	-54E 48.8802'
sol 112a	44E 36.8718'	-54E 58.9104'
sol 112b	44E 51.6384'	-55E 1.1388'
sol 112c	44E 57.8184'	-54E 59.1258'
sol 112d	45E 1.5756'	-54E 54.912'
eol 112d	45E 5.0958'	-54E 54.021'

When seismic gear secured, steamed for Halifax and ended GP lab watches

Wednesday September 4th

Steamed towards core station 81 at approximately

44E 51.732' 58E 47.154'

Reduced speed to run 3.5 kHz and 12 kHz line across small basin. Found precise station positions on the basis of 3.5 kHz sounder records.

Core 81	Stacor
Core 82	Stacor

when completed at 1230 ADT, resume steaming to Halifax.

SUMMARY OF SEISMIC AND SIDESCAN LINES

001-003	Series of lines on outer shelf west of Verrill Canyon. Planning of lines influenced by presence of swordfishers.
004	Dip lines from shelf to mid slope. Appears to be thick sand in <150 mbsl; outer shelf units can be traced out to upper slope on Huntec.
005	Strike line clipping a series of scarps
006	Short dip line
007	Strike line just up slope from 005
008	Short dip line up slope
009	Contour-parallel line at about 250 m through the middle of the sediment wave field seen in multibeam bathymetry. Only Huntec and sidescan run. Appeared to be large scale linguoid sand waves with heights of 2-5 m and on them smaller linguoid forms 1-2 m high. Huntec shows mostly acoustically amorphous material.
010	Long dip line through the numerous strike lines in Block 1 (cf. B.-J. Gauley thesis).
011-015	Series of lines north of Torbrook to define the western limits of debris flow deposits.
016	Dip line up Mohican Channel.
017	Sidescan and Huntec oblique strike line. Small straight sandwaves at 150 m, then the main sand wave field that abruptly ended downslope, passing into a zone with large pits and scours, with boulders on moats around pits, otherwise smooth. This presumably corresponds to the zone in which it was difficult to get IKU samples.
018	Strike line across “Scotian Gulf”. Huntec shows mostly till. Airgun penetrated to Acadia Chalk horizon.
019	Short dip line on western side of “Scotian Gulf”.
020-024	Series of dip and strike lines through Shelburne well and two proposed ODP sites.
025	Long dip line at 63E45'W. Numerous debris flow deposits on rise, draped facies on the slope.
026	Short strike line showing pinching out of some debris-flow deposits.
027	Long strike line at 1400 mbsl in Barrington block.
028	Dip line up ridge in Barrington block.
029-031	Lines on mid-upper slope in Barrington block. Position influenced by fishing. Just got into apparent till at end of line 029.
032	Long dip line through Barrington block
033-035	Series of strike and dip lines on upper rise in Barrington block
036	Long strike line at 2000 mbsl in Barrington block, tying together numerous TDI Brooks cores.
037	Dip line up the major debris flow corridor in the Barrington block
038	Strike line across the upper debris flow corridor at 1500 mbsl
039	Dip line east of the debris flow corridor.
040	Strike line across lower part of debris flow corridor.
041	Long strike line in 1700 m seaward of Northeast Channel. Shows leveed channel, low areas of debris flow with thin stratified above, and areas of dissected topography.

042	Dip line off western Northeast Channel. Generally highly dissected.
043	Long strike line in 1000 m seaward of Northeast Channel. Highly dissected, only rare spots of stratified sediment on ridges.
044	Dip line off eastern Northeast Channel
045	Long strike line in 1500 m seaward of Northeast Channel. More dissected than 041.
046	Long strike line at 2000 m south of the Barrington block. Ties some TDI Brooks cores. Beginning of line was test of Heffler DDH only, then airgun and Huntec deployed.
047a	Line over OBS 3. Salt diapir at SOL, then very prominent BSR.
047b-049a	Lines over lower slope - upper rise
049b	Line over OBS 1 and 2. Poor BSR at each end of line.
050	Long dip line to connect with line 16 in Mohican Channel
051	Strike line across Mohican Channel in 1200 m
052	Dip line down west side of Mohican Channel
053	DDH line at 2.5 knots duplicating line 049b. Excellent data in surface streamers also. No Huntec run until line 55, because operator needed sleep.
054	Short strike line through Torbrook block
055	Long strike line at 1900 m along a TGS line.
056	Dip line duplicating 85001 line through Shubenacadie H-100 well and the type section intersection with 81044. Increased speed at one point to 7 knots to avoid collision with US fishing boat.
057	short tie line
058	Strike line duplicating 81044 near type section.
059	Long dip line on west side of Dawson Canyon, from 2000 m to 4000 m, largely avoiding salt diapirs.
060	Strike line across lower Dawson Canyon, also through core sites 49, 50 and 51
061	Long dip line up east side of Dawson Canyon to Weymouth block, completely avoiding salt diapirs.
062-066	Miscellaneous lines in the Weymouth block, focussing on running lines through core sites and over canyons.
067	DDH survey down canyon in Weymouth block
068	DDH survey across canyon walls in Weymouth block
069	Long strike line from Weymouth block to Annapolis block
070-079	Series of crossings of debris flow deposits in lower Logan Canyon
080-081	DDH at canyon head in Annapolis block. No Huntec.
082-086	No seismic or Huuntec: only 3.5 kHz. On line 086, looking for core sites. With drifting around during coring, there are several parallel lines near core sites 70 and 71.
087	Strike line across valley to confirm TGS correlations.

088	Dip line down eastern levee of Eastern Valley. Rather disturbed surface, sediment waves at depth. Huntec shows stripped off core location at 0120/244.
089	Strike line across Grand Banks valley.
090	Good dip line to connect to 99036 dip line on St Pierre slope.
091	Strike line to duplicate poor quality 99036 strike line, but a little farther upslope.
092-112	Series of lines over shallow salt (for John Shimeld)
092	short dip line
093	long strike line, goes over shallow salt
094	short dip tie line
095	long strike line
096	short dip tie line
097	continuation of line 093 to the SE
098	dip line, continuation of line 092
099-100	lines up continental slope to 1000 m; rather dissected, common debris flows
101-107	series of long dip lines and short connecting strike lines; shows prominent gas hydrate, tilted blocks, salt.
108	long strike line
109	dip line up towards Haddock Channel, highly dissected
110	short strike line, highly dissected
111	oblique line over shallowest salt
112	long dip line up to Halibut Channel, ending at 300 m

PURPOSE OF STATIONS

Includes miscellaneous notes and preliminary observations. Check against detailed descriptions (when available).

4. RALPH station on upper slope.
5. Grab at 237 mbsl, transect near RALPH. Thin sand over inferred till.
6. Grab at 286 mbsl, transect near RALPH. Large sample fine sand.
7. Grab at 337 mbsl, transect near RALPH. Trace fine sand.
8. Grab at 383 mbsl, transect near RALPH. Large sample fine sand.
9. Grab at 431mbsl, transect near RALPH. Silty mud.
10. Grab at 140 mbsl, transect near RALPH. Large sample sand.
11. Grab at 158 mbsl, transect near RALPH, no recovery.
12. Grab at 165 mbsl, transect near RALPH, no recovery.
13. Grab at 142 mbsl in head of Mohican Channel. Large sample fine sand.
14. Grab at 190 mbsl in head of Mohican Channel. Large sample fine sand.
15. Grab at 196 mbsl in head of Mohican Channel. Large sample fine sand.
16. Grab at 241 mbsl in head of Mohican Channel. Trace fine sand.
17. Grab at 289 mbsl in head of Mohican Channel. Large sample fine sand.
18. Grab at 330 mbsl in head of Mohican Channel. Large sample fine sand.
19. Grab at 325 mbsl in head of Mohican Channel. No recovery.
20. Grab at 384 mbsl in head of Mohican Channel. Trace silty sand.
21. Grab at 424 mbsl in head of Mohican Channel. Silty sand.
22. Grab at 223 mbsl in sediment wave field east of Mohican Channel. Large sample gravelly sand.
23. Grab at 205 mbsl in sediment wave field east of Mohican Channel. Large sample gravelly sand.
24. Grab at 216 mbsl in sediment wave field east of Mohican Channel. Large sample gravelly sand.
25. Grab at 223 mbsl in sediment wave field east of Mohican Channel. No recovery despite several attempts.
26. 40 ft PC just west of Shelburne well site. Potential ODP site. 3.5 kHz suggests several metres stratified sediment over debris flow. Base of core stiff, as if in debris flow.
27. 40 ft PC south of Shelburne well site. Potential ODP site. 3.5 kHz suggests a few metres of transparent sediment over debris flow.
28. Stacor at same site as PC24. Recovered similar stratigraphy, > 6 m, including fine sorted gravel.
29. 40 ft PC. Low ridge beside debris flow. Probably penetrated an upper thin debris flow at 6 mbsf and stopped at top of lower debris flow at 9 mbsf.
30. 50 ft PC. Stratified sediment over pinchout of debris flow. Unlikely to have penetrated debris flow.
31. 50 ft PC. Stratified sediment.
32. 50 ft PC. Stratified sediment. May just have penetrated unconformity on local slope.
33. 50 ft PC. 2000 m in Barrington block. Stratified sediment with pinch-out of debris flow deposit at 6 mbsf, stopped at 10.5 mbsf just above second debris flow. Core recovered >1 m of sand and gravel at the base.
34. 50 ft PC. 1500 m in Barrington block. Low ridge beside debris flow channel. Some erosion near seabed.
35. 50 ft PC. 570 m in Barrington block. Upper slope stratigraphy; may be failure at top, otherwise well-stratified.
36. 50 ft PC. 1200 m east of Barrington block. Stratified high. Dates most recent debris flow event and small preceding event.

37. 50 ft PC. 1800 m in southwest Barrington block. Stratified sediment over thin shallow debris flow.
38. Stacor at same site.
39. 40 ft PC. 850 m on mid-slope ridge. Surface may have failed, but good stratified section deeper down. Is this surface failure related to apparent surface erosion by currents at core 31?
40. 50 ft PC. 1700 m on ridge west of Northeast Channel. Intended to get a record of plume sediments exiting the channel.
41. 40 ft PC. 800 m on ridge off the western part of Northeast Channel. Intended as a more proximal record than Core 37. Uncertain from Huntec whether there might be sediment missing. Quite sandy, including surface sand.
42. 50 ft PC. 900 m on ridge off eastern part of Northeast Channel. Intended to capture proximal sediment discharged from the eastern part of the channel.
43. 50 ft PC. 1600 m on high right hand levee of channel off eastern Northeast Channel. Intended to capture a record of sediment moving down the channel.
44. 50 ft PC. Torbrook block, area with gas hydrate, apparently into debris flow deposit. Detailed gas sampling.
45. Stacor at same site.
46. 50 ft PC. Torbrook block, area with gas hydrate. Apparently into stratified sediment. Detailed gas sampling. (Corer in rack over lunch).
47. Stacor at same site.
48. Core on terrace on wall of to Dawson Canyon - good flat sounder record as it went down.
49. Core on terrace 110 m above canyon floor. Unexpectedly gassy, some gas expansion.
50. Core on terrace.
51. Core on terrace.
52. Core on terrace at 4000 m
53. Core on levee, apparently undisturbed (end of Huntec profile). TWC appears to have pulled a lot of sediment out, since it went in up to the head. Thick red muds. (Note this facies in Huntec line 60 thickens towards the channel).
54. Core on channel floor (note that there appears to be a narrow talweg channel). Stiff grey clay overlain by several sand beds. No gas sample.
55. Undisturbed facies in 2390 m in Weymouth block.
56. Undisturbed facies in 1855 m.
57. Stacor at same site as PC53. Hit a cobble, cutter damaged, 80 cm recovery.
58. Canyon floor. PC hit TWC and sheared it off. Stiff mud in PC, overlain by muds with v.fn. sand. Nearby, a 15+ m deep talweg.
59. Flat ridge crest. No TWC - trace of sand and granule gravel in catcher. PC largely red mud. Probably an unconformity - Huntec and 3.5 kHz look “harder” than at core site 58.
60. Talweg in canyon floor. Stiff grey mud. A little silty sand at the extreme top.
61. Flat ridge crest.
62. Stacor at 2000-036-39.
63. Flat ridge crest at 650 mbsl. Good core. Red mud over very black mud.
64. Cutter had stiff red mud with abundant granule to fine pebble black dropstones (bagged sample, insufficient for geotechnical). Overlain by laminated red mud, which is all that was preserved in the cutter. Good TWC.
65. Good long core
66. Thick stratified section, good long core.
67. 10 ms mud drape over hard reflector in 3.5 kHz; outside of cutter had same hard red mud with black dropstones as in 61, but only red mud inside.

68. Thick stratified section, good long core.
69. Very thick red mud. Note that Huntec shows a 12 m thick amorphous section apparently corresponding to the thick red mud.
70. Local high on valley floor with long stratified section.
71. Small young debris flow
72. Core in debris flow (Kimberley Jenner site).
73. 10 m of Holocene over red mud with some sand beds. Looks transparent on 3.5 kHz, like a debris flow.
74. Hard bottom on 3.5 kHz. 2 m of stiff red mud. (Looked for a high around here, but none found).
75. Low intervalley high, 5 cable flat area. Recovered still grey shale in TWC, bottom barrel broke off PC, with no recovery.
76. 12.4 m long stratigraphic core at 2500 m south of St Pierre Slope. Trace of red mud inside liner. Gassy.
77. Core near core 73, where upper 3-4 m is stripped off.
78. Core in representative, slightly thinner section at 2100 mbsl
79. Core in local depression showing thickening of section. Rather gassy. 12 m recovery.
80. Representative section at 900 mbsl. Very gassy. Bottom dark mud, upper part has some silty mud.
81. Long grey mud core, base gassy.
82. Long grey mud core, some sand in middle.
83. Long grey mud core, red mud at extreme base of catcher.
84. At crest of mound of Holocene on east side of basin, just before moat. Gassy.
85. Between mound crest and apparent outcrop of Emerald Silt (harder return on 12 kHz). Gassy. Peculiar lithified interval about half way down at the end of one section. Sandy in places.

EQUIPMENT

Coring equipment [IAH]

The piston coring system used was the AGC Long Corer. This device obtains a core sample of ID 99.2 mm and an OD of 106 mm. Barrel lengths used on this cruise ranged from 30 to 50 ft. The core head is 3m long, 0.6m diameter and weighs approximately 2000 lb. The core pipe is in 10 ft. lengths, 4.25"ID, with 3/8" wall thickness, with exterior couplings secured by set screws. The liner was a CAB plastic extruded into 10 ft lengths. A catcher was used at all coring sites. The trip arm supported a 4.25" diameter gravity corer with a single 6ft 10" barrel and 300 lb head. The corer used ¾" wire cable on the Pengo winch. The corer was operated using a handling system including a rotating core-head cradle, outboard support brackets, a monorail transport system, a lifting winch and a processing half-height sea going container. The piston corer used the following dimensions for a 40 ft core: head 9', scope 10', barrels and cutter 41'; trip arm dip 3', wire 51'8", trigger weight core 12'6". The scope is appropriate for 6' penetration of the trigger weight core.

The AGC free fall gravity Stacor, with a stationary piston, consists of two 22 ft aluminum support columns welded to a base plate covering an approximate area of 147cmx150cm. A maximum penetration of 6.1m (20 ft) of undisturbed sediment can be obtained upon impact utilizing a 1200 lb ballast. The core pipe has the same dimensions as the AGC Long Corer described above. The same CAB plastic core liner was also used for coring, but in 20 ft lengths. The AGC Stacor provides an undisturbed sediment core sample, that can have up to 90% recovery using a stationary piston. The 8 cores obtained on this cruise will be used as reference cores for undisturbed sediment stratigraphy and comparison to piston cores, obtained at or near the site of penetration. These will be ideal cores for analysing slope stability and sedimentological features.

A 1 cubic metre IKU grab sampler was used for sampling surficial sediment on the upper slope.

Onboard sample processing and subsampling [IAH]

A total of some 107 cores (8 Stacors, 48 TWC's and 51 PC'S) or 582.95 m (508.91 m Piston cores; 46.34 TWC cores and 37.08m Stacor) of deep sea sediment were obtained from 81 sample stations. All cores were processed according to the standard GSC Atlantic core procedures manual (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. The bottom-most 1.5 m section of core was sampled for organic chemistry while physical properties (penetrometer and constant volume), and a 20ml sample were taken for subsequent porewater analyses, in the onboard GP core processing lab. Porewater samples obtained were then frozen. For the constant volume determination, stainless steel cylinders of known volume were introduced into the bottom and tops of each 1.5m section at a constant rate and then later removed in the GP lab onboard ship. At this time the sediment was extruded from the cylinder, placed within a 1oz screw-top glass bottle and sealed to prevent further dessication. The sample will be later weighed, dried at 105EC for 24 hours and re-weighed to determine bulk density, dry density and water content. Once the constant volume cylinder was removed, inert packing was placed within the created voids, and then the ends of each core section were subsequently waxed to prevent further oxidization and drying, until splitting at the GSC Atlantic core repository within the coming months.

Additional subsampling at the time of core acquisition onboard included 6cm whole round gas samples taken at specific core sites, and predominantly at the bottom of most cores (A-A' from section A/B).

The 1.5 metre core sections of whole round core, were individually stored onboard during this program within the confines of a modified 20ft refrigerated seagoing container (AGC #18), adapted for ease of core storage and transport. All core sections were logged as to their individual locations within the container. All core lengths were measured at the time of extrusion from the individual core barrels, labelled and stored upright within this container. Most of the core cutters and catchers were likewise measured and stored accordingly to preserve sediment integrity. Any and all extruded core sections due to sediment expansion or core processing methods, were likewise labelled and stored. All core sections , pieces and associated cutters/catchers have been documented on master field sheets as well as in the ED (Expedition) database.

The IKU grab samples were subsampled as follows: a) obtain a minimum 350ml surface sediment sample for grain size analyses; b) obtain one to two pushcores whenever possible for determination of grain size stratigraphy; c) sample till on an opportunity basis; d) sample and preserve living benthics in a seawater/formalin preservative; e) to process any remaining sediment sample from the IKU, by volume and penetration depth within the IKU in 5, 10cm increments to total depth of recovery, for any shells and/or shell debris. This material was sieved at a < 1.0mm fraction. Any living organisms obtained during sieving were also preserved in a formalin saltwater mix, and f) the upper IKU surface was also sampled for foraminifera and preserved in formalin. Physical sediment properties were measured with a shear vane and /or penetrometer. Constant volume samples were also obtained where appropriate.

The ED at Sea database was used throughout this cruise in order to document and edit cruise expedition sample data. While the data has been documented on paper field sheets, corresponding data was also entered into the ED database onboard. Data has been backed up and will be verified before downloading into the main ORACLE sample database. The station data will be made available in a timely manner on ***http:// margin.bio.ns.ca/geocol***

Navigation [PG]

Differential GPS navigation was provided by the ship's MX400 series receivers. NMEA sentences from these systems were combined with NMEA sentences from the ship's log and gyro through a Baytech MUX in the NAV centre. These sentences were then forwarded to a Black Box line splitter for distribution throughout the ship at 9800 baud. In addition, a separate data feed directly from the GPS receiver was distributed at 4800 baud to two a line splitter in the GP Lab and fed to the AGCDIG computers. The PMIPS strings were also sent to the Baytech MUX for inclusion in the daily log files.

The scientific navigation was viewed and logged on five REGULUS systems running the latest version of the program, Build 22266. These systems were set up in the Drawing Office, Computer Room, GP Lab, Forward Lab and Winch Room. The Drawing Room REGULUS system was used as the primary data logger. The data was copied over the network to the shipboard NT server on a daily basis, enabling access to the files from a variety of networked workstations. The data were cleaned and merged using a text editor and the standard GSCA programs ETOA, INTA and APLOT. Raw E-format, raw A-format and cleaned and edited 10 second A-format files were saved on a daily basis and transferred to CD for GSCA archiving.

The Regulus software performed well throughout although two of the systems had hardware conflicts which disabled their networking as well as their CD functions. Although this limited their usefulness for data backups and transfers, it did not impact the overall functionality of the scientific navigation as the other three systems were fully functional. The Bridge Regulus was equipped with a dual display video board enabling separate views of the navigation information for the watch officer and the quartermaster. This feature was a great improvement in functionality as it enabled the quartermaster to have a display customized to the functions he was performing while leaving a separate display showing a different set of data of use to the watch officer.

SHIPBOARD GEOPHYSICS PROGRAM [DCM]

Geophysical Survey Equipment

The shipboard geophysical program consisted of seismic reflection surveying and several geophysical experiments using seismic reflection with the Digital Deeptow Hydrophone (DDH) and an Ocean Bottom Seismometer (OBS) deployment. The typical configuration of seismic reflection profiling consisted of towing a Huntec DTS sparker system, and two, single channel hydrophone arrays in conjunction with a sleeve gun source array. 3.5 kHz subbottom records and 12 kHz bathymetric records were acquired in hardcopy only for most of the duration of the cruise using the hull-mounted systems on the Hudson.

Raytheon 12 kHz Echo Sounder

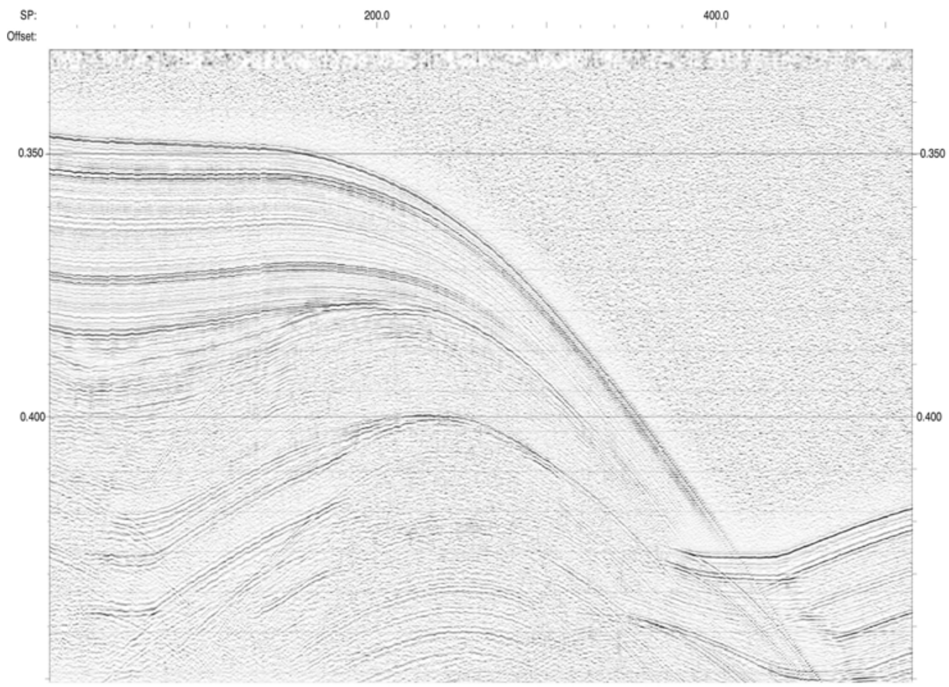
CCGS Hudson is equipped with a ram-mounted 12 kHz transducer. The system recorded water depths to paper chart throughout the cruise. Soundings were hand-digitized at 5 minute intervals.

ORE 3.5 kHz Profiler

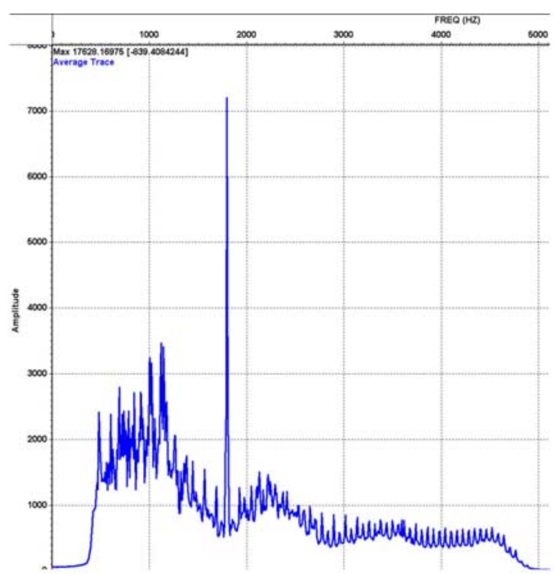
CCGS Hudson is outfitted with a hull-mounted Ore 3.5 kHz sonar system. Records were displayed on an EPC9800 chart recorder at a 250 ms sweep rate. Signals were not recorded otherwise. Delays to the chart recorder were provided by the MITS system. For the most part at 0.5 ms pulse width was used to provide acceptable records in deep water.

Huntec DTS

The Huntec DTS system used on this cruise was a 540 Joule, 20 tip sparker system, deep-towed through the A-frame off the centre-stern of the vessel. Tow depths typically varied between 60 and 100 m. The system consisted of a sparker source operated at 6 kVolt output and triggered with a shot interval between 750 and 1250 s. Signals were received with a single-element internal hydrophone and an external streamer towed from the Huntec fish. The streamer was a GF24/24 P2I; a 24', 24 element array of 2 interspliced channels of AQ-1 cartridges, shorted to provide a single channel output. Signals were filtered between 400 and 2500 Hz with spreading loss gain recovery applied. Shot traces were printed to hardcopy on an EPC 9800 thermal chart recorder with a 250 ms sweep rate. Analogue data were recorded on a Sony Dat Recorder (Channel 6 – trigger, Channel 7 – external hydrophone signal), and digitized to Exabyte tape (Channel 1 – internal hydrophone signal, Channel 2 – external hydrophone signal) by the AGC_DIG system (Version 2.40) on unit number 2. Digitization rates were 16.67 kHz (60 s interval), for 4000 samples, providing a sampling window of 240 ms. a 5 ms delay was implemented on the AGC_DIG recording to stabilize the digitizing. Deep water trigger delays were provided by the MITS system, which were recorded as part of the shipboard NMEA string. Data quality varied throughout the cruise. Signal to noise ratios are typically poor in deep water and on steep slopes for these high-resolution systems, and thus quality is affected by sea state, water depth, slope angle and other ship or ocean noise. Nonetheless, much of the data are of good to excellent quality.



Typical Huntec DTS Sparker profile, yielding 50-150 ms subbottom penetration with resolution of the 0.5 m scale



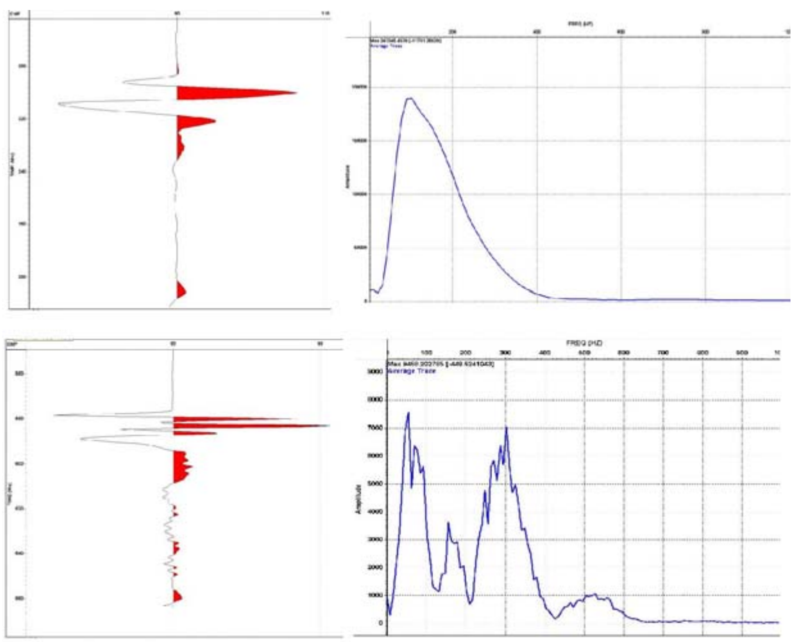
Frequency spectrum of Huntec DTS sparker data. Useable energy appears between about 500 and 2000 Hz, beyond which it is largely noise. This plot shows the marginal signal to noise ratio. The large spike is a harmonic of 60 cycle.

Sleeve Gun Seismics

Sources

Seismic reflection data were acquired with a 2 x 40 in^3 (0.655 *l*) Texas Instruments sleeve gun array and two hydrophone streamers. The guns were mounted beneath a tow sled suspended from a float. The guns are 0.75 m apart from their centres and hang 0.45 m below the top of the tow sled. Stationary depth of the guns is 3.75 m, but underway the system tended to surf and tow-depth is estimated to be 0.75 to 1 m. The array was towed from the port "ironing board", 20 m behind the stern. Air to the guns was provided by GSC-A's Price Gunmaster model w2 compressor. Air pressure was typically maintained between 1800 and 1850 psi (12.4-12.75 MPa). Shot point intervals were time-based and typically set between 3 and 6 seconds, depending on water depth.

Numerous problems were encountered with this gun array system. Upon initial setup, several firing circuits were found faulty. Ultimately, we had to fire both guns from the same circuit by wiring them in series. There was no ability to adjust the firing time of the two guns, and thereby tune them to be precisely



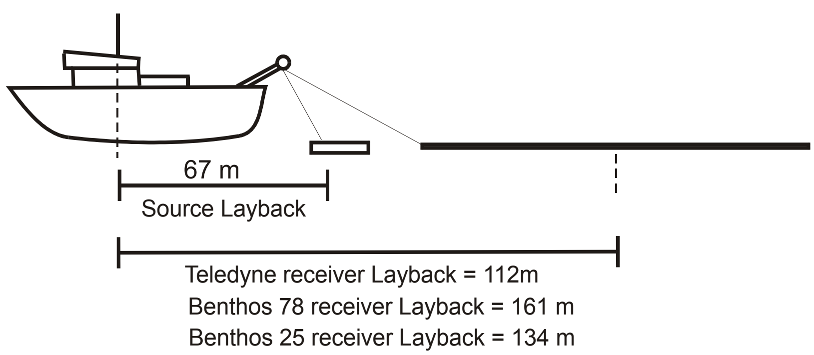
Signatures of the 2 x 40 in3 sleeve gun array during Hudson cruise 2002-046. The top shows a good signature with both guns firing in phase. The result is a relative broad frequency spectrum up to about 350 Hz. If the guns fire out of phase or one gun is faulty, the lower figure results, showing a complex source signature and a heavily notched frequency spectrum.

in phase. In addition, several solenoids failed. The solid plate of the tow sled, under which the guns were suspended encountered heavy damage due to the impact of repeated firing of the guns. This top plate was removed and two small ones were added, to open the middle of the sled for the release of air from the gun discharge. Frequent breakage of solenoids and airhose fittings to the guns were believed to be caused by the guns impacting against the tow frame. A protective bolt was added to the gun's harness. It was clear from the impacts on these bolts that they were hitting the frame, but air hose fittings continued to break. The brass fittings were replaced with stainless steel, which seemed to prevent further breakage. On one occasion, a hole punctured the main air hose to the guns, near the sled. The section was cut out and a fitting was put in to join the two pieces.

Receivers

Two hydrophone streamers were towed to record seismic reflection signals from the sleeve guns. A Teledyne model 178 streamer was borrowed from GSC- Pacific. It uses 50 T-1 acceleration-canceling hydrophone cartridges, spaced 0.5 m apart, to make an active section 25 m in length. This section followed a 10 m dead section. The streamer was towed from the starboard "ironing board". The front of the active section was 42.5 m behind the stern, which is a total of 50 m behind the location of the GPS receiving antenna on the ship.

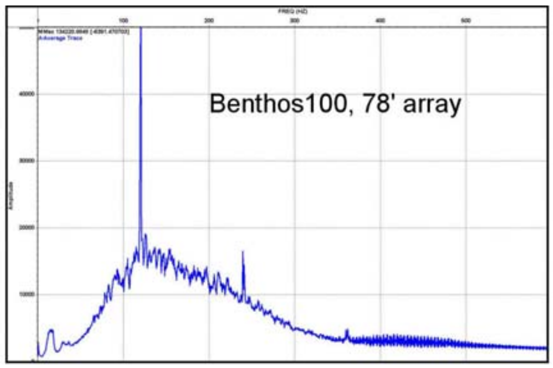
The second streamer was the GSC-A Benthos array, which comprises two channels. Both channels consist of AQ-1, non-acceleration-canceling hydrophone cartridges, spaced 2' (0.61 m) apart. The stern-most channel is a 78' (23.75 m) long active section of 40 hydrophones. It is preceded by a 25' (7.62 m) dead section and the front channel that is a 25' (7.62 m) active section of 13 hydrophone elements. This section is preceded by a 25' (7.62 m) dead section to the lead in cable. The front of the foremost dead section was 67.5 m from the stern, or 114.5 m from the Ship's GPS antenna.

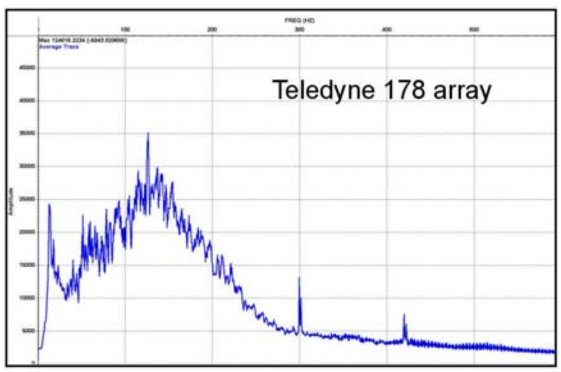


On the initial days for the survey, while in shallow water, the GF30 streamer was towed instead of the Benthos array. The GF30 is a 30' array (20' (6m) active section) of 21 AQ-16 hydrophone cartridges, spaced 1' (0.3 m) apart. It's shorter length made it more appropriate for shallow water but it was not deployed after day 231.

Signals from the streamers were split for digitization and EPC hardcopy recording. The Teledyne streamer was filtered between 15 and 800 Hz and 40 dB gain added through a Krohn-Hite filter before passing to the AGC_DIG digitizer. A variable gain adjustment pot was made to allow small adjustments in gain because the Krohn-Hite filter bank allows only adjustments in 20 dB increments. Gain adjustments are necessary for the AGC_DIG systems because they are 12 bit digitizers and it is necessary to maximize the dynamic range without clipping the signal. Teledyne data were digitized at 4 kHz sample rate (250 s sample interval) for a window length of 4000 samples (2 seconds). The 4 kHz sample rate implies a Nyquist sampling frequency of 2 kHz. The high cut of 500 Hz through the Krohn-Hite filters ensures no data aliasing. Inspection of the airgun signatures shows no significant power above 500 Hz. The same signal was recorded on the DAT recorder. On the hardcopy stream, the Teledyne streamer signal was filtered between 25 and 800 Hz before passing to the EPC chart recorder. In rough weather the low-end cut off for the Teledyne was brought up to 65 Hz. The GF30 and Benthos-100 data were bandpass filtered between 65 and 800 Hz and gained up 40 dB before digitization and to the chart recorder. Digital sampling was the same as for the Teledyne (4 kHz for 4000 samples). Benthos-25 data were filtered at 85-800 Hz before passing to the digitizer. No hardcopy record was kept of this signal. The variable gain amplifier that was recently constructed to allow incremental gain changes was found to be faulty, easily allowing to be overdriven and causing numerous spurious spikes in the data.

Streamer	Bandpass to digital	Bandpass EPC
Huntec DTS	500-2500 Hz	500-2500 Hz
PGC Teledyne 178	15-500 Hz	25(65)-500 Hz
Benthos100	65-500	65-500
Benthos25	85-800	85-800
GF30	65-800	65-800

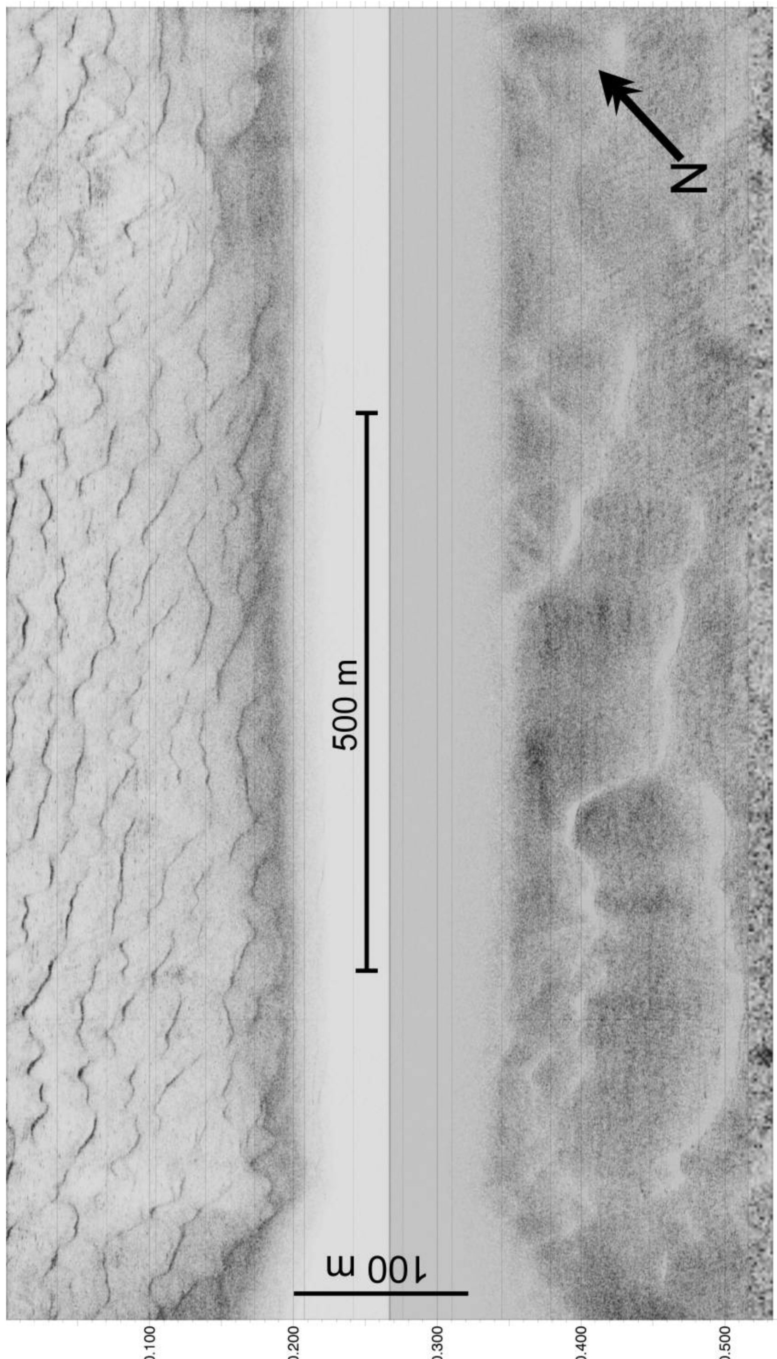




Frequency spectra of the 2x40 in^3 sleeve gun array receive signal on the two most commonly used seismic streamers, from identical sections. The Benthos array does not have acceleration-canceling hydrophones and so is filtered with a low cut of 65 Hz to remove streamer motion noise. Roll-off in power can be seen to commence about 120 Hz. More power in the low frequencies can be seen in the Teledyne array because of the acceleration-canceling hydrophones. There is still some power roll-off below 120 Hz, however, because of the source signature of the gun array at the shallow tow-depths used in this survey. The 120 Hz spike is electrical noise (60 cycle), perhaps introduced by the concurrent use of the sparker.

Sidescan

The Simrad 992 Sidescan sonar was run on Days 228 and 229 for Lines 9 and 17. It was deployed with the STABS system and a 550 Kg Alpine core head as the depressor from the Hawbolt winch. The winch was recently outfitted with 2200 m of new coaxial tow cable, through which the data were transferred. The system was set up with a 400 m. swath and recorded to Sony DAT and Exabyte tape. Hardcopy records were produced on an EPC Model 9800 dual channel chart recorder [120kHz], and higher resolution 330 kHz data to an Alden Model 9315CTP printer. The starboard channel of the system was found to have a DC-offset in the data, appearing as a different gain setting than the port channel. It proved impossible to correct this offset in real time and appears to be a function of the tow cable conductor.



Example record of the Simrad 992, 120 kHz sidescan sonar survey from Line 9, showing outer shelf sand waves. The DC-offset in gain on the starboard channel can be seen above as an overall darker hue to the starboard side.

Recording [DCM]

Seismic reflection, Huntec sparker and sidescan signals were recorded to Sony DAT tape as analogue backup and digitized by the AGC_DIGS. Tables in the appendices show correlative tapes, file numbers, day times and line numbers. The following tables show recording parameters.

DAT

Channel 1	Seismics Sleeve gun shot trigger	at 2 volt level
Channel 2	GF30 streamer signal	at 2 volt level
Channel 3	Teledyne 178 streamer signal	at 2 volt level
Channel 4	Benthos 25 foot signal	at 2 volt level
Channel 5	Benthos 78 foot signal	at 5 volt level
Channel 6	(not connected)	
Channel 7	Huntec Trigger	at 2 volt level
Channel 8	Huntec Ext.streamer signal	at 1 volt level

EXABYTE

Seismics

Channel 1	GF30 / Empty for much of cruise	500 μs/4000 samples
Channel 2	PGC Teledyne 178	500 μs/4000 samples
Channel 3	Benthos 25	500 μs/4000 samples
Channel 4	Benthos 100	500 μs/4000 samples

Huntec

Channel 1	Internal Streamer / External GF10 for last day	60 μs/4000 samples
Channel 2	External GF24/24	60 μs/4000 samples

Sidescan

Channel 1	120 kHz Port	80 s
Channel 2	120 kHz Stbd	80 s
Channel 3	330 kHz Port	80 s
Channel 4	330 kHz Stbd	80 s

CD-ROM

All seismic digital data from Exabyte tapes were extracted each day to monitor data quality. The data were parsed into streamer types as Segy files and the record delay times, extracted from the MITS string on the NMEA data stream, were inserted into the Segy trace headers. Shot times were merged with navigation data, converted to UTM coordinates and stored in an ascii file, such as Tape1.utm. These data were then saved to

CD, filed according to tape number and data type (e.g. Tapes 1 and 2, filenames e.g. Tape1_Teledyne_Raw_Delay.sgy).

CD-Title	Tape Files	Data type
02046_Seis_1	Tapes 1-3	Teledyne, GF30
02046_Seis_2	Tapes 4-7	Teledyne, GF30, Benthos100
02046_Seis_3	Tapes 7-9	Teledyne, Benthos25&100
02046_Seis_4	Tapes 10&11	Teledyne, Benthos25&100
02046_Seis_5	Tapes 1213	Teledyne, Benthos25&100
02046_Seis_6	Tapes 13 - 16	Teledyne, Benthos25&100
02046_Seis_7	Tapes 17&18	Teledyne, Benthos25&100
02046_Seis_8	Tapes 19&20	Teledyne, Benthos25&100

Huntec data were not extracted from tape except for spot checks on data quality. In this way, it was found that the first two days of surveying might not have been recorded to digital tape because of trigger interference problems.

Data issues

- variable gain amplifier required
- new filters required
- firing units…adjustable delays
- blast phones to monitor shot signal required

Ocean Bottom Seismometer Deployment [C LeB]

Purpose

Three high resolution Ocean Bottom Seismometers (OBS) were deployed in an area where a strong BSR (bottom simulating reflector) appears to occur. A BSR is believed to represent the contact between gas hydrate and an underlying free gas zone. Sediments containing gas hydrate should have an unusually high acoustic velocity and the free gas below the hydrate should produce a relatively low velocity. OBS' were deployed to obtain a detailed velocity structure of the sediment through recording wide-angle reflections and refractions. It is hoped that perhaps the data will yield shear wave velocity information as well, through such techniques as AVO (amplitude versus offset) analysis.

Operation

OBS' I, 2 and 4 were deployed off of the starboard beam of the ship at three separate locations. Following deployment of the OBSs, shot lines were run over the OBS', using the 2x40 in^3 sleeve gun array. These are Lines 47 and 49. Concurrent seismic reflection data were acquired with the surface streamers.

A Zyfer GPStar*plus* model 365 odetics clock controlled the shooting of the sleeve guns, which allowed the shots to be fired using GPS time. The firing rate was 5 seconds, starting exactly on the minute. The output pulse from the odetics box was a box curve with a pulse width of 0.01 seconds, and a maximum voltage of approximately 4 volts.

The output pulses from the odetics box were logged on a PC, using "shotlog.vi" (created at Dalhousie). This software logs the output pulses from the odetics system, and no information on gun firing delay was logged. Positions for each shot were obtained from the ships DGPS navigation system, and merged with the shot log information. Following recovery of the OBSs, the raw datafiles were downloaded to a PC, and written to CDR.

Problems encountered

The Zyfer odetics box stopped outputting pulses after approximately 1 to 2 hours of operation, necessitating a manual restart of the pulses. The shooting was interrupted 4 times during the shooting of the lines. These interruptions occurred far from the OBS drop locations, thus the shooting of the OBS lines was uninterrupted.

Data Quality

Preliminary analysis of the data from each OBS indicates that there are no data gaps, and there are few anomalous traces. Investigation of the frequency spectrum reveals that there is a very large spike at approximately 2 Hz. Above this spike, the data appear to have a normal frequency distribution. Display of the SEGY OBS data indicates that high amplitude reflections show up well, but small amplitude reflectors are generally weak or absent. The cause of this problem is not yet known, but may be related to a problem with the OBS software, or a display artifact related to the large spike near 2 Hz.

OBS ID	I (DAL)	2 (GSC)	4 (GSC)
OBS software version	2.51	2.51	2.51
Sampling rate (Hz)	558	558	558
Water depth (fm)	853	826	966
Deployed (day / time)	235/1824	235/1900	235/1952
Deployment Position (Lat / Long)	42° 33.4368 N / 62° 24.4072 W	42° 34.408 N / 62° 26.8886 W	42° 28.4639 N / 62° 33.0629 W
Recovered (day / time)	236/1154	236/1316	236/1503
Recovery Position (Lat / Long)	42° 33.4339 N / 62° 24.6336 W	42° 34.5928 N / 62° 26.8722 W	42° 28.6236 N / 62° 38.1906 W
Sleeve gun firing delay (ms)	6 ±1	6 ±1	6 ±1
Clock set (day / time:sec)	235 / 0315:58	235 / 0447:43	235 / 0534:30
Time of pre-drop offset check (day / time:sec)	235 / 0323:06	235 / 0451:16	235 / 0534:30
Pre-drop CPU clock offset (1.8 ms offset from GPS time)	1.000934	1.00212	1.001978
Time of post drop offset check (day / time:sec)	236 / 1256:06	236 / 1329:57	236 / 1530:42
Post drop CPU clock offset (1.8 ms offset from GPS time)	1.001642	1.002999	4593
Number of Datafiles	149	168	183

GSCDIGS – Seismic digitizer development [DEH]

A new seismic/sidescan digitizer is being developed by Dave Heffler, Bob Courtney and Dave Mosher to replace the aging AGCDIG systems. The acronym for this tool is GSCDIG (GSC Digitizer). The intent of the system is to make use of new technologies to improve many aspects of the digital recording component of seismic acquisition. This was the first sea trial of the developmental prototype. The digitizing component has been functioning well and much investment of Dave Heffler's time this trip has been spent to handle data properly and make user interfaces for acquisition parameter setting and quality control checking. Some of the improved features this tool offer include:

- Sigma Delta A/D conversion
- 24-bit sampling
- Large sample windows
- Deep water record delay handling
- QC capability
- Ship-wide data telemetry
- Improved file handling

Sigma delta converters use 1 bit sampling at very high rates to sample an analogue signal. The chip integrates the signal over the sample period, thus a subsample of the data stream reflects components of the signal over the sample interval, rather than a discrete and finite sample of the waveform typical of other A/D converters. A consequence of this form of digitization is that Nyquist frequency sampling is not a concern, i.e. there is no need for anti-alias filtering. The 24-bit samples provide high dynamic range, thus concerns about gain levels prevalent on the present 12-bit converters is no longer an issue. Even very small signals can be represented faithfully, so there is no need for low-cut filtering to remove streamer motion noise (ground roll). With these two conditions, truly raw data can be acquired, representing true signal bandwidth and amplitude, preventing the need for constant gain adjustments.

The present AGCDIG digitizers are limited to a sample window of 4096 samples, and so digitization parameters (sample rate) must be adjusted to fit the data within this window. No such restrictions exist on the GSCDIG system; a sample window can be large enough to avoid the need for frequent deep water delay changes, resulting in less data loss. The AGCDIG systems cannot handle deep water delay changes “on the fly”. A work-around has been the MITS system to handle delay changes, but the MITS system does not write delays into the headers of the Segy files. Much effort is spent to merge delay changes into the Segy headers at the appropriate times. In addition, with multiple shots in the water, the MITS system does not handle the true delay, but the delay to the arrival of the next signal. The GSCDIG system handles deep water delays in real time and writes the information to the Segy trace header. It can track multiple shots in the water, especially necessary for the Huntec system, and it is being developed to provide absolute water depth delay times for Huntec, rather than relative delay changes as is currently the case.

With the present AGCDIG systems, data are written to Exabyte tape in a multiplexed manner (interspliced channels) and cannot be examined until the tape is finished. With the GSCDIG system, the data are logged to hard drive. Each data type (streamer channel) is a separate file. These files can be examined in real time. In addition each shot is telemetered throughout the ship and software provides access to this data stream and displays traces on any computer/terminal connected to the ship’s intranet. This QC tool time and frequency domain plots of the data to monitor the signal.

In excess of 4.5 GBytes of data were acquired during this cruise as part of the prototyping of this new digitizer. The digitization aspect of the tool worked nearly flawlessly. Much of the effort this trip was spent on ensuring proper data formatting and creating parameter setting and QC software tools.

The vision for the near future is to implement the GSCDIG digitizer as part of our standard acquisition tools to replace the AGCDIG systems. The idea is to create one stream of data, rather than the present system of splitting the digital and analog streams and tuning the data so that it is ideal for one streams and not for the other. Further developments are required with respect to long term data storage media (tape, CD, DVD, DLT), hardcopy printing and real-time creation of compressed images of the data.

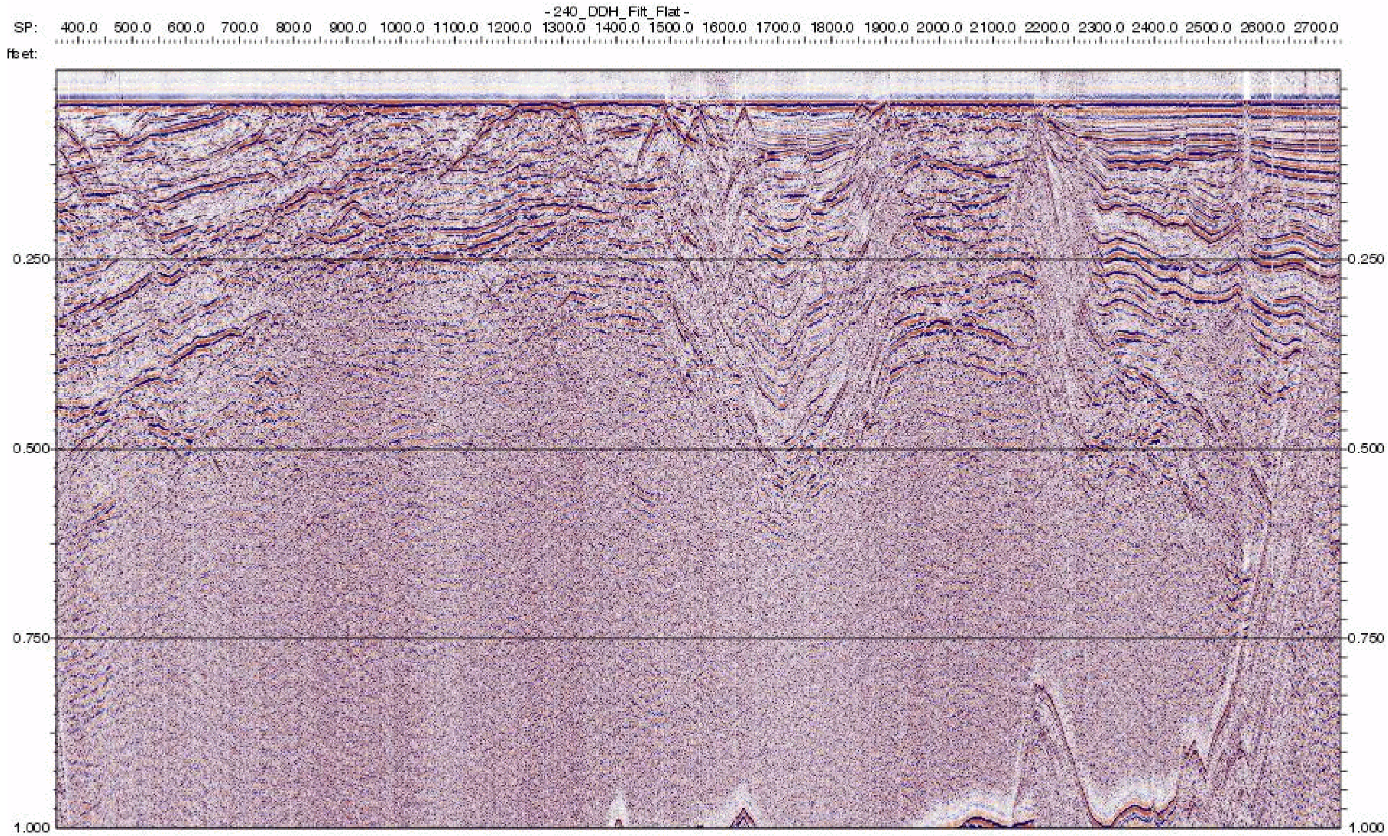
Digital Deep Tow Hydrophone [DEH]

This is the fourth year of testing of the digital deep-tow hydrophone (DDH) (see cruise reports for Hud2000-042 and 2001-048A). Heffler (this report) provides details of system performance and modifications. Improvements for this year included a new hydrophone streamer using 10 elements of acceleration-canceling hydrophones (AQ-4) and recognition of absolute shot time to help calculate the geometry of the seafloor. In earlier years, shot times were relative, thus it was not possible to calculate layback distances to the deep-tow body. 3 DDH tests were run comprising nearly 1 Gbyte of data.

DDH Test 1	Line 53	237/0201 – 237/0536	38695 m
DDH Test 2	Lines 67&68	240/1824 – 240/2313	25253 m
DDH Test 3	Lines 80&81	242/2123 – 242/2320	8556 m

One the first test, data quality was poor. The new streamer had very poor signal-to-noise ratio and numerous digitization or telemetry glitches caused many bad traces. Nonetheless, the data have been extensively edited to make use of the experiment. On the second test, many of the telemetry and digitization errors were solved and the data are much improved. Again, low signal strengths on the new hydrophone caused us to bring the system on board and replace the streamer with the old one from last year. Signals were found to require filtering to remove streamer motion, but otherwise signal strength is good. There were still issues with shot times and geometry configurations with this second test. By the third test, these issues were solved and appropriate delay and layback information are being written to the headers of the Segy files. Unfortunately, by cruise end time did not permit processing of this line.

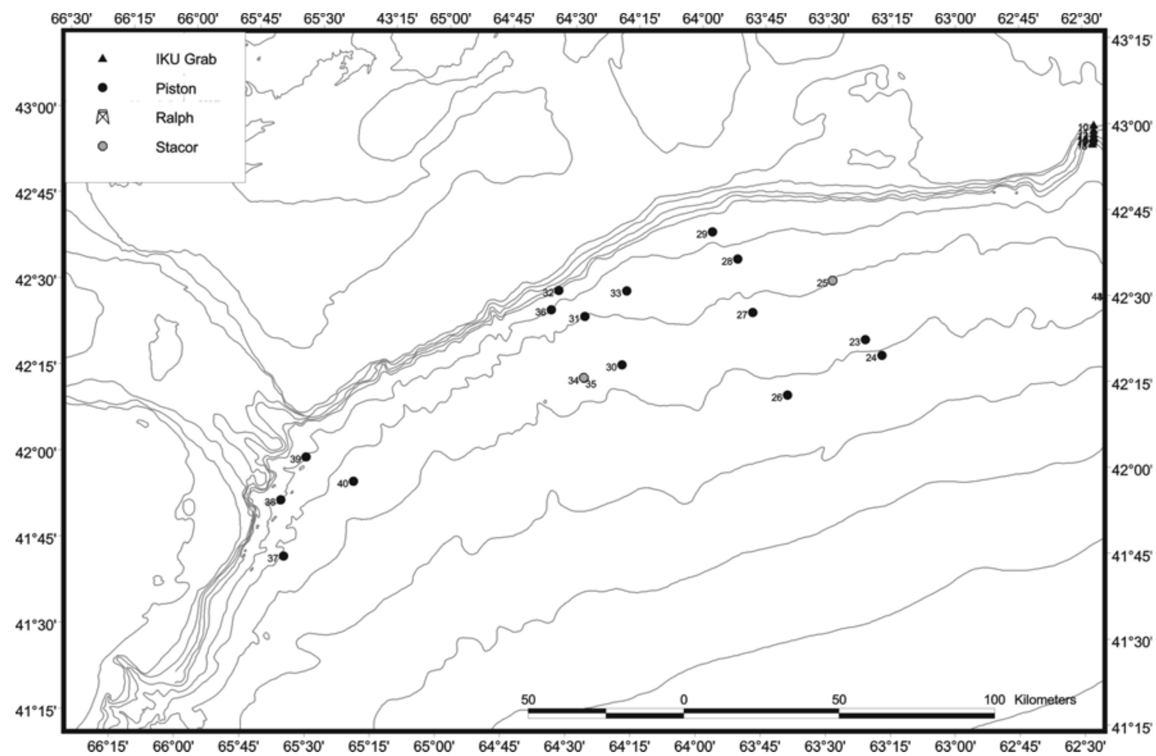
A further modification this year is that the direct arrival of the source and echo-return trace from subbottom are now split into separate files. Coincident acquisition of surface-towed seismic reflection data provides excellent data quality due to the slow tow speeds necessitated by the deep tow hydrophone.

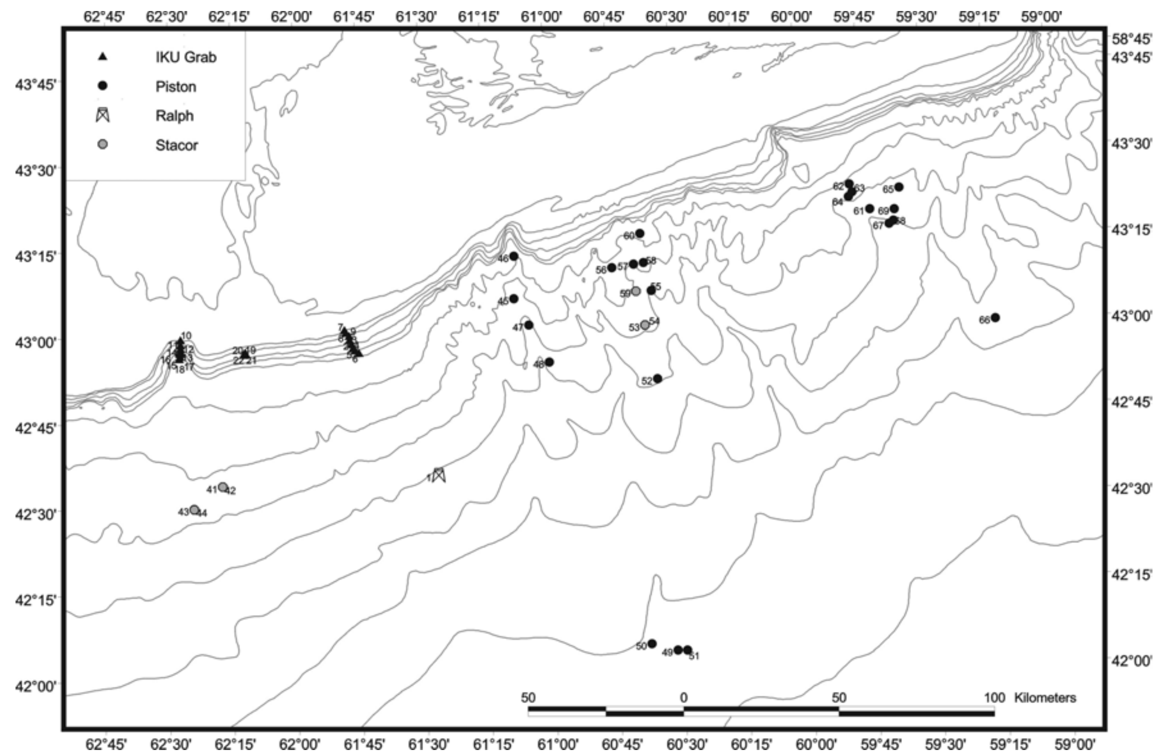


Results of DDH test 2, Lines 67 and 68, flattened to the seafloor. Reducd side-echoing can be noticed when compared with equivalent surface towed systems. Further analysis will require some detailed processing.

APPENDICES

On the following pages are detailed area maps of samples and seismic tracks. A general cruise map will be found on page 3.

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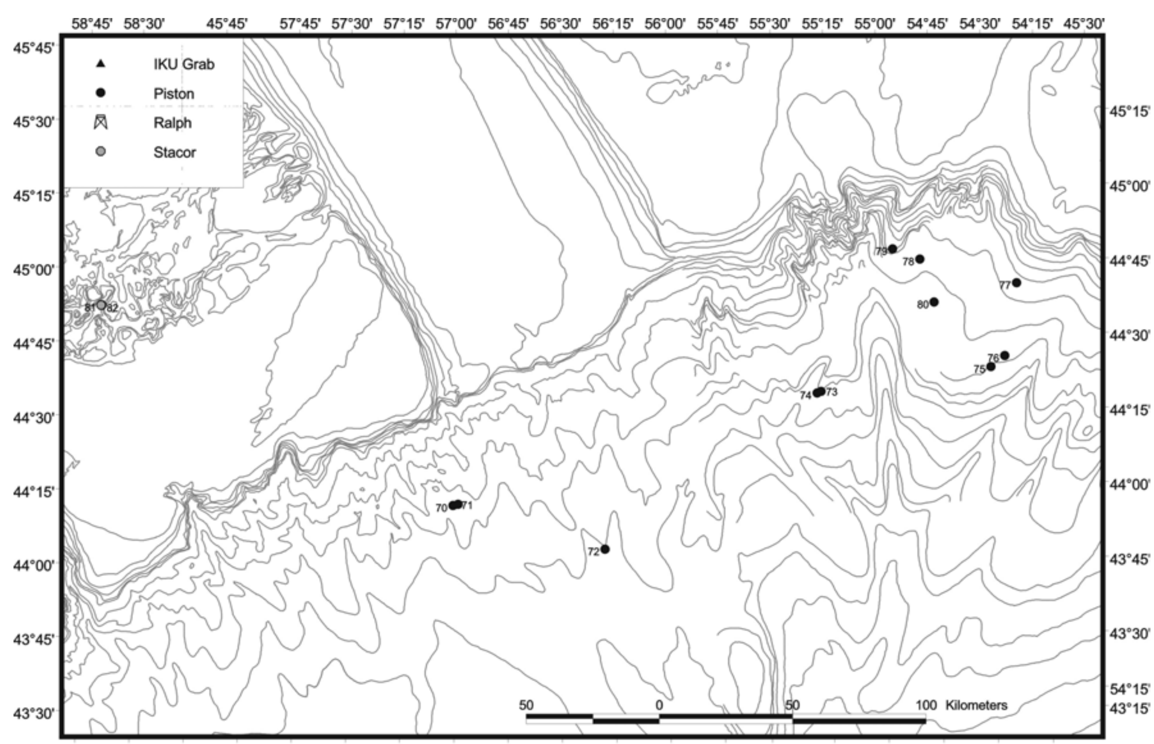
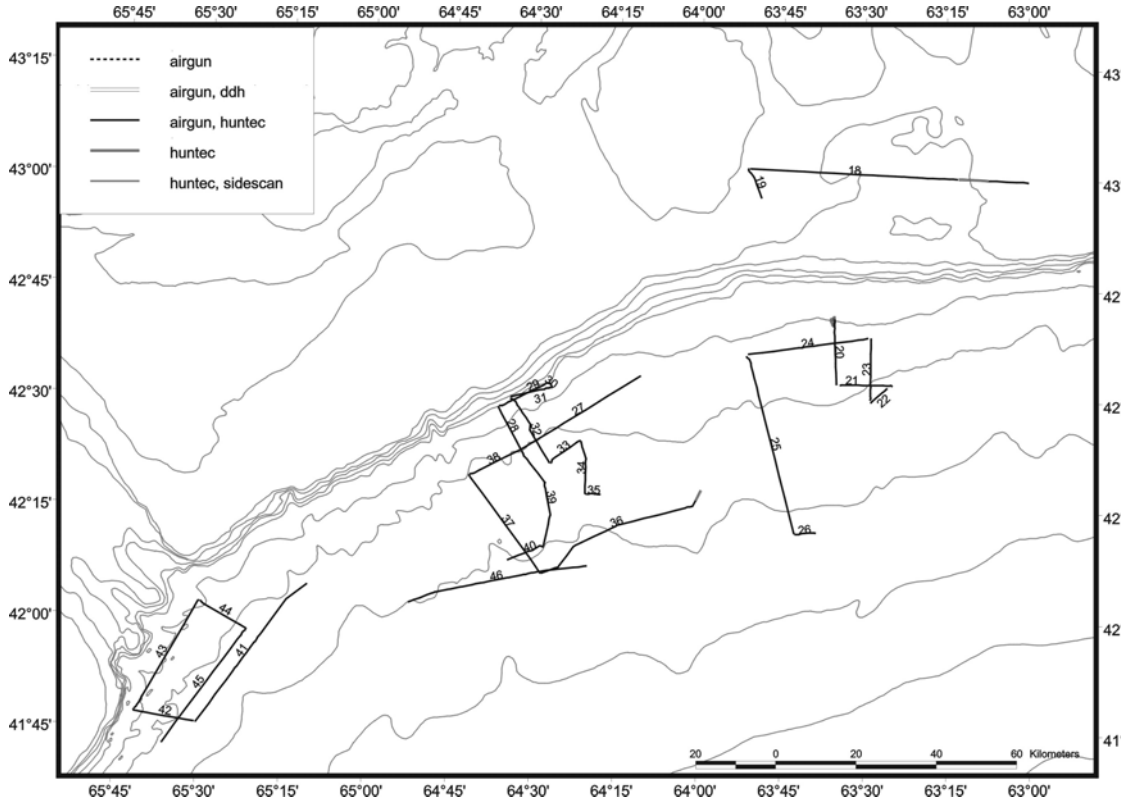
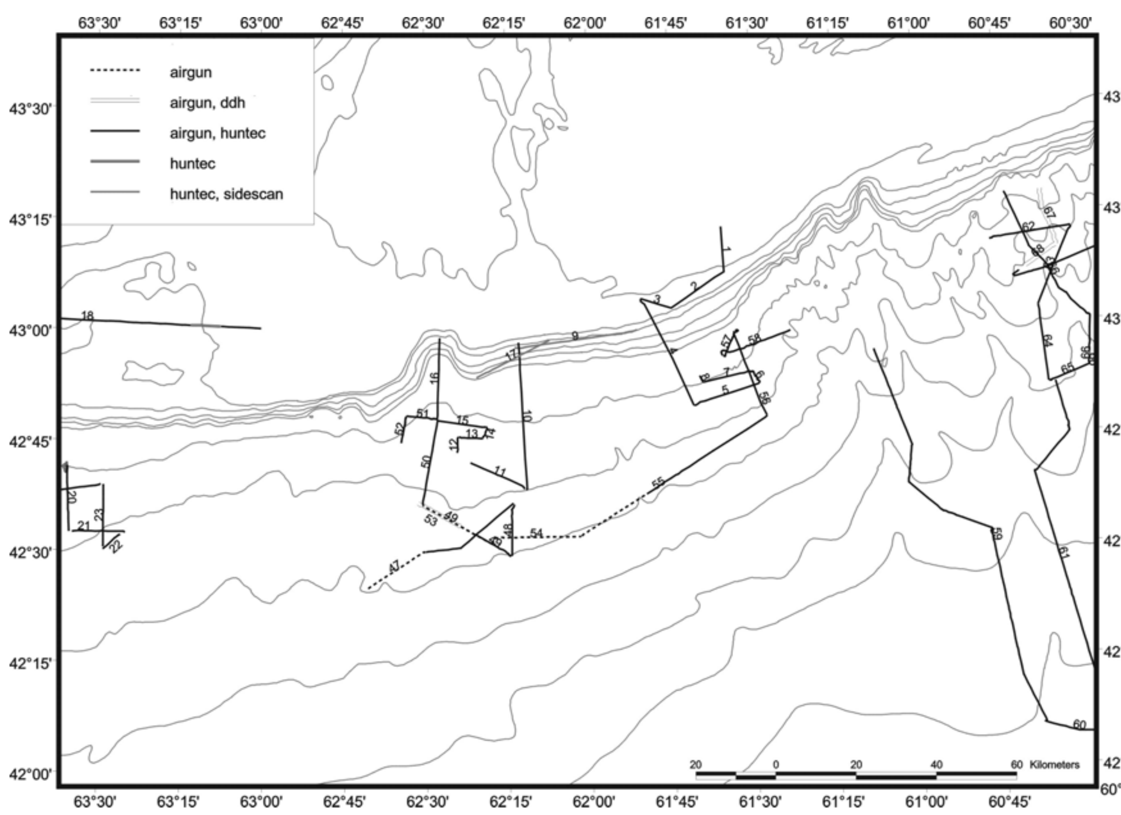
Ralph
Stacor
50
0
50
100 Kilometers


IKU Grab
Piston
Ralph
Stacor
50
0
50
100 Kilometers



airgun
airgun, ddh
airgun, huntec
huntec
huntec, sidescan
65°45'
65°30'
65°15'
65°00'
64°45'
64°30'
64°15'
64°00'
63°45'
63°30'
63°15'
63°00'
43°15'
43°00'
42°45'
42°30'
42°15'
42°00'
41°45'
20
0
20
40
60 Kilometers



airgun
airgun, ddh
airgun, huntec
huntec
huntec, sidescan
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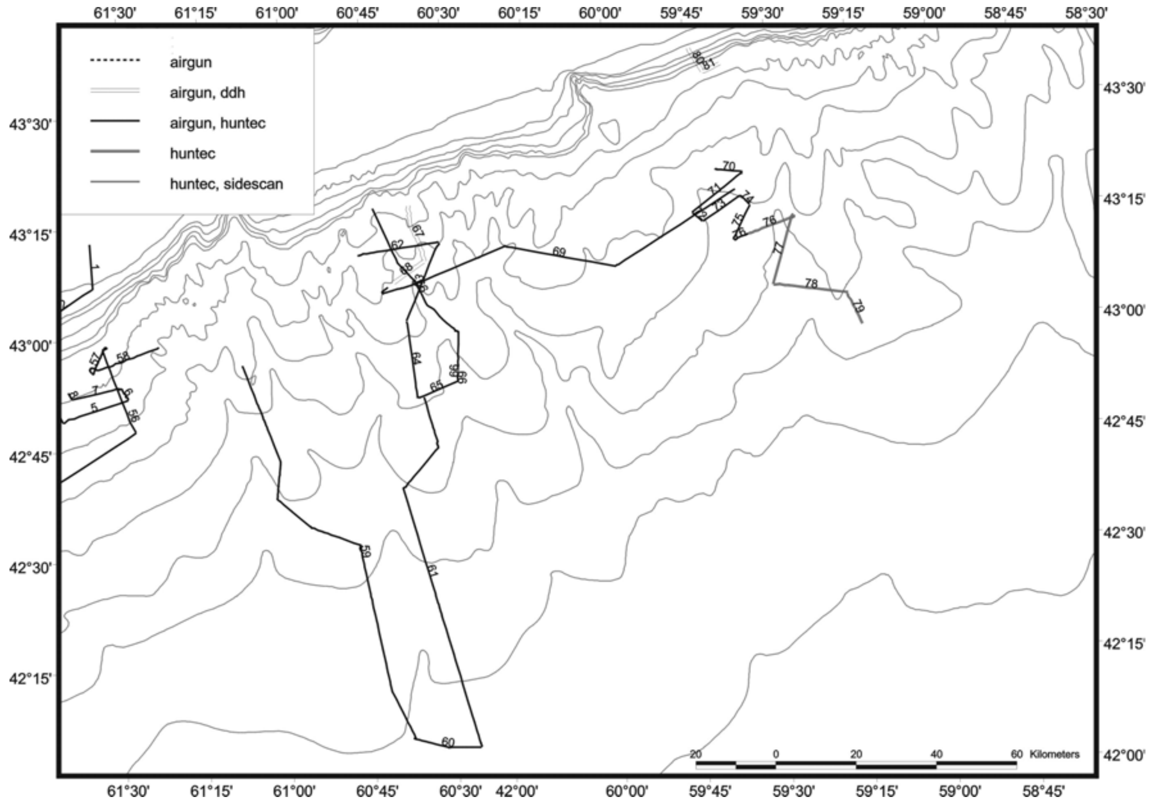
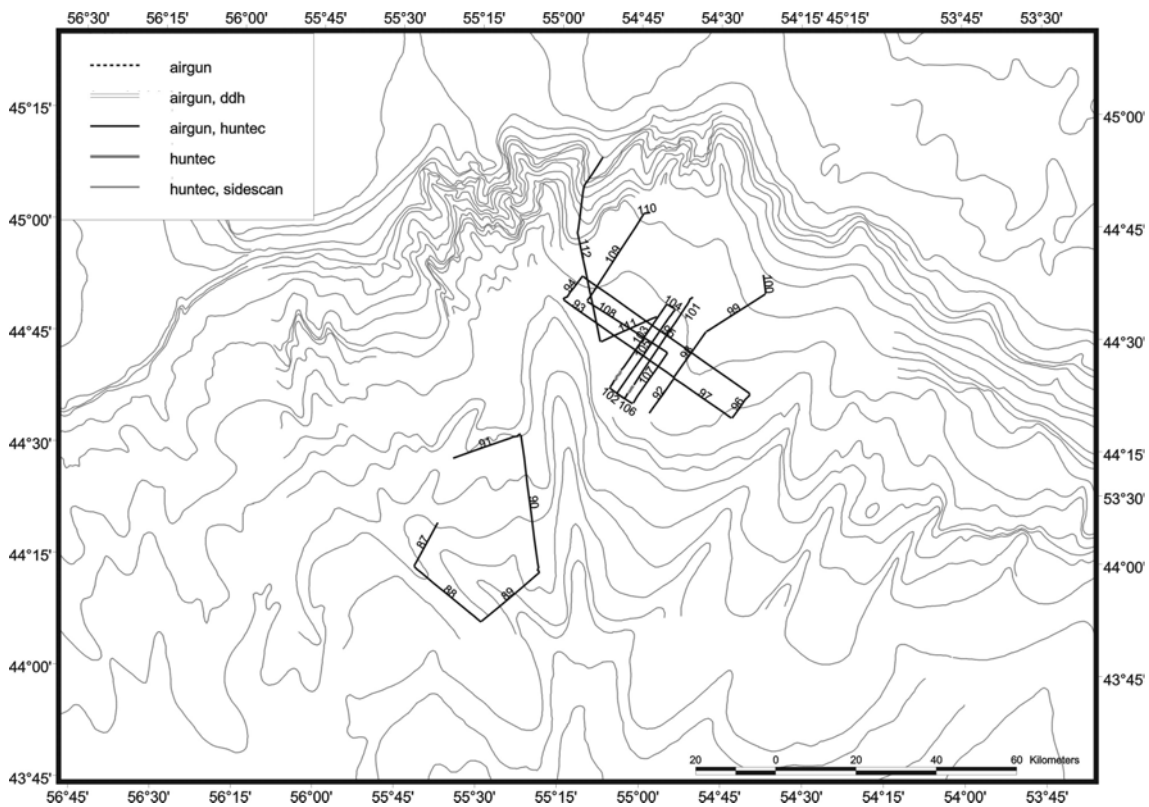
63°15'
63°00'
62°45'
62°30'
62°15'
62°00'
61°45'
61°30'
61°15'
61°00'
60°45'
60°30'
43°30'
43°15'
43°00'
42°45'
42°30'
42°15'
42°00'
20
0
20
40
60 Kilometers


airgun
airgun, ddh
airgun, huntec
huntec
huntec, sidescan
61°30' 61°15' 61°00' 60°45' 60°30' 60°15' 60°00' 59°45' 59°30' 59°15' 59°00' 58°45' 58°30'
43°30' 43°15' 43°00' 42°45' 42°30' 42°15'
43°30' 43°15' 43°00' 42°45' 42°30' 42°15' 42°00'
61°30' 61°15' 61°00' 60°45' 60°30' 42°00' 60°00' 59°45' 59°30' 59°15' 59°00' 58°45'
20 0 20 40 60 Kilometers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airgun, ddh
airgun, huntec
huntec
huntec, sidescan
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45°15' 45°00' 44°45' 44°30' 44°15' 44°00' 43°45'
45°00' 44°45' 44°30' 44°15' 53°30' 44°00' 43°45'
56°45' 56°30' 56°15' 56°00' 55°45' 55°30' 55°15' 55°00' 54°45' 54°30' 54°15' 54°00' 53°45'
20 0 20 40 60 Kilometers

Seismic Report (Mechanical)

Ken Asprey and Greg Middleton

The seismic program was similar to past years. This year we used the GSC-A Electric Price Gun Master Compressor, model W2. The sound source was two Haliburton Geophysical Services 40 cubic inch sleeve guns mounted on the GSC-A two-gun sled. For ease of operation and good separation of gear being towed the sled was towed from the Port Side iron board. A combination bundle and tugger winch along with the Hampton Crane was used to deploy and recover the sled. The guns were fired in series from the AGC firing box with the trigger being supplied by the GSC-A PMITS.

During the first few days of operation considerable problems were experienced with the sled itself. The aluminum plate on the top of the sled started to come loose. Several attempts were made to re-secure the plate. Finally when the plate was secure and could not work itself loose the plate began to crack. During a time the plate came loose a firing line was damaged and was replaced. The only answer was to remove the plate and replace it with a smaller steel plates welded on each side of the sled in order to mount firing lines and air hose termination blocks. This work was mostly down by the Senior and 1st Engineers and their efforts are greatly appreciated.

The next problem which developed was that the guns were coming back during firing and hitting the solenoids on the bottom of the sled. This was damaging the cables and the solenoids themselves. Again the Engine Room Staff came to the rescue. A 7/8” bolt was fastened to the top of each gun via the gun mount to protect the cabling and solenoids. (see photo) This fix seemed to do its job for the remainder of the cruise.

The last problem was the air fitting on the top of the guns tended to break. Although only a five minute fix it required the sled to be brought aboard and meant bring the crew out during the night. A similar bolt arrangement was made and attached to the bottom of the guns. The air house was secured to this extension which would immobilize the hose thus providing strain relief to the fitting. This configuration was tried. To everyone’s amazement one hose fitting loosen twice and the fitting broke on the other gun. The following day this lower support was removed and the cables and hose were taped together near the gun and remained this way during the rest of the expedition.

The compressor worked very well. One night the high-pressure relief valve failed at 400lbs. It was changed and no further problem experienced. Every now and then it would shut off for no apparent reason. In all cases it started right up again. Routine preventive maintainance was performed as per the manufacture's schedule. A logbook was kept showing the performance and maintenance during the trip.

From an operational point of view the Sleeve Guns worked perfect. One gun failed due to a damaged fire seal. Most problems experienced were always due to an external reason like the guns hitting the sled damaging the solenoids or hose fittings breaking. The guns and solenoids were rebuilt at the middle of the cruise based on the total number of shots recommended by the Manufacturer.

Problems with the sled will need to be addressed in the future. It might me necessary to construct a new sled that would constrain each gun by eight points. (See notes by Mosher)

In general all equipment performed to their expectations. We would like to thank the special efforts of the Chief, Senior and 1st Engineers who through their special efforts helped kept the equipment during this trip. We would also like to thank the Bosun Dave MacLean and Leading Seaman Murray Newcombe for the many times they were woken up and asked to bring the gear in during the night for repairs.

Electronic Systems

W. A. Boyce

Deployments:

Besides the Seismics Systems which will be reported on by Ken Asprey and Greg Middleton, various surface streamers, a deep towed 25 foot streamer, Huntec Deep Tow Sparker [500 J.], 3.5KHz Hull array profiler, and the Simrad992 STABS deep tow were deployed, and new digitizers tested [see report by D. Heffler, P.Eng.]

The Simrad Model 992 dual frequency Side Scan Sonar was deployed while rigged to an Open Seas "STABS", or **S**ubmercible **T**owed **A**pparatus **B**uoyancy **S**ystem and depressed by a 550 kg. core head, all attached to a 2200 meter coaxial towcable from the Hawbolt Model U43-068 winch. At 4.5 knots survey speed, sonar head depths of 200m. on Line # 9 and 400 m. or more on Line # 17 could be achieved. This allowed 400 m. swath, 120 and 330 kHz data to be recorded to exabyte tape and to an EPC Model 9800 dual channel recorder [120kHz], and higher quality 330 kHz data to an Alden Model 9315CTP printer to image various current generated bottom features over the edge of the Central Scotian Shelf.
This data was stored to exabyte tapes at 80 microsecond sampling rate and gain of 1, with the Channel setup as follows:

Channel 1 = 120kHz left side data;
Channel 2 = 120kHz right side data;
Channel 3 = 330kHz left side data;
Channel 4 = 330kHz right side data .

This 550 kg. Depressor and towcable were also used to deploy Benthos 25 foot linear 10 element streamers to a maximum depth of 1000 meters at 2.5 Knots. The trigger source for this experiment had to be the Heffler electronics which had no delay capability for the graphic recorder and AGC-Digitizer windows. So the TSS 312B annotator channel trigger outputs were used as adjustable delay and buffer sources using the Heffler electronics trigger as the master trigger. This experiment will be reported by D. Mosher and D. Heffler.

The Seismics surface streamers used this mission were the Teledyne Model 178 - 78 foot motion cancelling, non-tapered array on all lines, the Benthos dual 25 foot / 78 foot active linear array on most lines, and the Geoforce GF-30 - 30 foot linear, 21 element streamer, used only on the first few lines as it is a shallow water sensor. The internal Teledyne pre-amp. was powered by four 9 volt batteries inside the end of the streamer which were changed weekly, and the Benthos pre-amp by two 9 volt batteries in the Benthos lab deck unit also changed weekly.
The sound source was a dual HGS 40 cu.in. sleeve gun setup on a frame with a Norweign buoy floatation, running at 3 to 6 second firing rate at 1700 psi. pressure from a Price W2 Compressor. The 78 foot Teledyne and Benthos 78 foot section data were recorded to EPC 9800 recorders and to exabyte tape at a 500 microsecond sampling rate and gain of 2, triggered by the PMITS delayed trigger. The AGC Digitizer channel setup was as follows:

Channel 1 = GF30 streamer data
Channel 2 = Teledyne 178 array data, 20 db. gain, filtered 25-800 Hz
Channel 3 = Benthos 25 foot active seaction data, 40 db. gain, filter 65-800 Hz
Channel 4 = Benthos 78 foot active section data, 20 db. gain, filtered 65-800 Hz

The lab triggers for the 3.5 kHz hull profiler, Huntec sparker, and seismics guns and recorders were handled by the GSCA-PMITS trigger unit whose settings were simultaneously broadcasted to the nav. logging system for archiving. This kept systems from interfering with each other and allowed depth delaying to one millisecond accuracy.

The Huntec Deep Tow Seismics System [DTS] with the 500 joule sparker option and external 15 element linear streamer was deploy on most lines to a depth of 60 - 80 meters to produce high resolution surficial data to compliment the sleeve gun seismics. Information on the performance of this system can be found in the Geoforce Consultants contractor's Mission Report. The external streamer data of this system was recorded on an EPC 9802 graphic recorder at a ¼ second scan and stored to exabyte tape at 60 microseconds sampling, gain of 4, delay triggered with AGC Digitizer channel #1 = internal hydrophone data, and channel #2 = externally towed 25 foot Geoforce linear 10 element streamer data.

The Seismics and Huntec DTS data were also backup recorded to a Sony Model PC208A DAT cassette tape recorder with date, time and line # data with the following channel setup:

Channel 1 =	Seismics Sleeve gun shot trigger	at 2 volt level
Channel 2 =	GF30 streamer signal	at 2 volt level
Channel 3 =	Teledyne 178 streamer signal	at 2 volt level
Channel 4 =	Benthos 25 foot signal	at 2 volt level
Channel 5 =	Benthos 78 foot signal	at 5 volt level
Channel 6 =	(not connected)	
Channel 7 =	Huntec Trigger	at 2 volt level
Channel 8 =	Huntec Ext.streamer signal	at 1 volt level

Simultaneously, 12 KHz depth soundings and 3.5 KHz , 16 transducer Hull array profiles of the sea floor were taken and recorded to Raytheon LSR1811 and EPC 9800 recorders respectively. These two collected graphic data even while stopped on sample stations for continuity. The 3.5 KHz profiler was set to 0.5 and 1.0 millisecond pulse length and 1.5 to 2.0 khz bandwidth settings.

During core and grab stations either the Trawl Block sheave payout indicator [Totco LM2000 unit] or a 12 kHz pinger were used to indicate wire depth. The defective sensor on the Trawl Block was replaced with an improved right angle unit whose orientation is easily viewed, and one of the three 12 kHz pingers no longer works as the solder joint on the inside transducer face [pinger SN 5529]was broken. The other pingers worked well except SN 5528 had a broken inductor coil wire which was temporarily repaired but needs a new series inductor. The wire deployed from the Pingo winch was about 20 meters per 1000 meters water depth higher than the 12 kHz sounder depth as the sounder is calibrated for 1500 m/sec. sound velocity in a 1468 m./sec. survey area. Therefore the 12 kHz recorded depths needs to be proportionally decreased accordingly.

Performance:

All systems worked well and any failures were backed up by redundant units, or were not crucial to the data. Some lines were lost due to sleeve gun sled problems and deployment.

The dual sleeve gun sled had many problems mostly due to wiring/hosing arrangements and high survey speeds greater than 4.5 knots.
The dual gun sled was modified many times; removing the top panel and installing welded smaller securing panels allowing gun energy to vent up; adding steel bars to the gun chain mounts to prevent cable / hose damage; taping trigger and hose lines together and adding Huntec ribbon fairing to the trailing umbilical to decrease strumming, and to prevent air line JIC fittings from breaking which happened regularly. See below for details.

The AGC-built air gun multiple trigger source, two units consisting of four firing circuits each, had severe failures until only one firing channel remained, with only one old backup single channel unit left, which was not used. At the start of the mission, two of the eight channels were broken anyway, but more failed as the unprotected trigger lines at the dual gun array were damaged and shorted when the top panel broke away from the towed gun frame. The dead short taxed the 175 volt trigger source and tranformers over heated before fuses could blow, one to the point of smoking. Other channels locked up the SCR drive to a continuous 175 volts which heated up gun solenoids as well as that channels transformer. This trigger unit was very old and rusty inside which may have aggravated the problems. This unit could be replaced with the purchase of off-the-shelf seismics units which also incorporate 10 microsecond gun fire delaying to adjust for perfect bubble pulse cancelation. The bad gun lines were replaced and protected with securing tape, fairing, and the "wayward" top securing panel of the gun sled removed. The two 40 cubic inch sleeve gun solenoids were fired in series from the one remaining channel, which would protect that channel from further trigger line shorts assuming both lines would not short out at the same time. These changes worked the rest of the mission. Futher loosening or broken air line fittings occurred as well as usual gun failures to be expected, so some nights only one of the two guns were used, making an increased bubble pulse in the data that night.

One of the newer Krohn-Hite Bandpass filters had a power supply problem which faded in and out the data. This was replaced with a spare. The other units exhibited dc offsets which were re-adjusted on the fly. These units are usually calibrated by standing offer calibration labs but were not this year due to budget restraints.

The EPC 9800 recorders worked without a hitch. This was because before this mission, the lid fail safe switches were removed and new take-up pinch bar springs installed in all. This solved the paper motion problems of past years. A new print head was installed in the oldest one, as well as recalibration back to factory defaults with increase to 32 shades from the 8 default. This kept the strain off the print amps as the contrast did not have to be adjusted too high.

The streamers worked well. The shallow water GF30 short streamer was replaced with the Benthos 25 / 78 foot active sections streamer which had to be filtered 65 Hz and up to remove streamer low frequency motion noise in the data. The Teledyne 78 foot Model 178, motion canceling hydrophone streamer was more sensitive and could be filtered to 25 Hz and up producing more data with greater penetration.

The AGC-Digitizers worked properly after it was determined to use software version 2.40 with the auto saves turned off and a small delay added such as 5 milliseconds to increase trigger stability in both Seismics #5 and Huntec #2 units. This trigger instability must be looked into as it has not occurred in past years and may be a sign of failing digitizer boards. The Huntec #2 unit needs a new power supply which was in hand but the unit kept going as long as it was not turned off. This new power supply will be added later. The Seismics unit #5 with the older type exabyte drive has problems with the manual eject and cleaning tape ejection. The Sony PC208A DAT cassette backup recorder worked well as long as the heads are cleaned every second tape and a newly installed tape is fast forwarded a few seconds, past the dirty leader. This excess cleaning needed is a sign of worn out tape heads which may need replacement and recal.

The Seismics rack equipment and AGC-Digitizers are old and serious discussion on upgrading/replacement should occur. AGC Segmented TVG units would have helped in graphic displaying deeper seismics data at the long 2 second sweep speeds, but these are old also and failing and were not installed. The AGC-Digitizers are already considered for replacement and D. Heffler has been experimenting with such during this mission. But in the meantime, good working units must be maintained for immediate field use with spares, meaning immediate power supply and /or motherboard upgrade and/or exabyte replacement must happen now for the missions between now and when the new systems arrive, which could be years from now

[including the first proto type test year(s) when the new units are not reliable yet].

The display of one of the TSS312B four channel annotators failed also due to old age. The 20 year old unit still functions but one half of the display has gone out as it is a glass plasma vacuum unit, obsolete since the 1980's with no spare. Only two units remain, and though obsolete are very desireable for multiple record annotation and / or one millisecond seismics delay firing control. A single EPC labs single channel unit is in hand but new multi-channel units should be found and purchased if we are to continue using multiple analog graphic recorders which are suppose to be no longer required in a digital world. Efforts were made in the past to replace them with in house PC substitutes, but this effort failed.

The Hawbolt Model U43-068 winch with 2200 meters of 0.7 inch OD armoured coaxial conductor was used to deep deploy side scan sonars and streamers. The level wind on the winch is set for 60 cable wraps across and cannot be set more accurately. The cable however when allowed to pack itself tightly ends up with 61 wraps across meaning the level wind must be manually adjusted at least three times when hauling in all cable. The original 59 wrap spacing failed when the third layer up from the bottom collapsed into the loose first layer spacing and so the first layer had to be reset by hand to a tighter spacing, with a shim [half inch copper pipe] add to the cable exit area to the sliprings, keeping the first layer in line. In future, the first layer must therefore be spaced with some strong spacer between every second wrap and at a higher tension. [Possibly plastic coated clothes line wire spiraled around every second wrap. This would keep the first layer wraps spaced and tensioned with no room for collapse.

Deep Ralph

(Dave Heffler)

A modified version of GSCA's RALPH seabed monitor was developed under a joint Dalhousie/GSC program. RALPH is normally deployed in coastal and shelf water where bottom dynamics is dominated by wave and tide action, typically from a few metres to 30 m water depth. DeepRALPH was designed for much deeper water where a less dynamic seafloor could be expected. The instruments included on DeepRALPH were:

The Ralph computer with pressure sensor, compass and data logger.

A single ADVO sonic current meter and a logger developed at GSCA.

Two Mesotech 2.2 MHz Acoustic Backscatter Sensors (ABS) and the DODO logger

OBS6, an array of 6 Optical Backscatter Sensors

BurtsCam, a digital camcorder programmed for time lapse video of the seabed and its light source.

A new ADCP owned by Dalhousie. It is mounted on the DeepRALPH frame but is totally independent of the RALPH electronics and computers. It has its own power and data logger.

Three 12v battery packs and one 24 v pack. Each pack contains 90 Alkaline D cells.

DeepRALPH was programmed to log all sensors for 55 minutes of each hour and could be expected to have enough battery power for 30 - 50 days.

This was all mounted on the RALPH frame with is 3 m x 2.5 m and about 2 m high. It weights about 1 T.

DeepRALPH was moored with a single line going to a subsurface float connector to a small anchor weight with an acoustic release. DFO had previously moored some instruments and surrounded them with a triangle of three guard buoys. We deployed an extra guard buoy, giving us a 1 km triangle in which to deploy DeepRALPH.

DeepRALPH was deployed at 0711 on August 16, 2002 and on bottom at 0717:30 at position

42 59.499 N 61 44.726 W

The release was dropped to the SE at
42 59.3825 N 61 44.5342 W which is just NW of DFO's E guard buoy.

The other guard buoy was deployed to the north. All done by 0800.

DeepRALPH will be recovered on a DFO cruise to the area in October.

DDH - Digital Deep Hydrophone

(Dave Heffler)

The DDH was developed in 2000 in an attempt to improve the quality of high resolution seismic data in deep water. Particularity in areas of rough bottom, side echos obscure the signals from surface towed systems. By towing either the sound source or the receiver close to the seabed, side echos can be reduced. It is easier to tow the receiver deep. This configuration also has an advantage that the receiver is in the far field of the source and can record an outgoing pulse, which can be used to deconvolve the reflections from the sub-bottom.

I had built a system that digitizes the signal in the towed body and sends the data up the cable in digital packets, combined with data from a pressure (depth) sensor. The deck control computer can send signals down the cable to control parameters such as the sample rate and gain.

The wet end electronics are housed in an old pressure case built for a previous instrument (CHATS). It is bolted to one tail fin of an old Alpine core head, weighting about 1200 pounds. This is towed on an armored coax cable. We have about 2000 m of cable on the old "ice island winch". A new cable was installed on the winch in the week before the cruise and was in excellent condition. At 2.5 knots, we can tow the DDH at about 1000 m depth.

The system operated in 2000 and was used again in 2001 with some success. However, the hydrophone used was an spare 5 m eel from the Huntec DTS and had excessive acceleration response. We had a new array constructed using acceleration-canceling hydrophones.

I made some improvements to the telemetry receivers on both ends of the cable and could send data up the cable at 115 kbaud with almost no transmission errors. The digitizer in the towed body uses an 18 bit sigma delta converter and we send up 10,000 samples per shot with a sample rate of 170 microseconds or 5.7 kHz. This gives a 1.7-second sample window that we split into 150 ms for the direct (down going) pulse and the remainder to the seabed reflections. In deep water, where the hydrophone is high off the seabed, we can introduce a gap between the direct signal and the reflected signal. We can also vary the gain of the signal of a range of 1x to 32x.

The seabed signals from the new hydrophone array were curiously small and noisy. The signal from the direct pulse was high amplitude and had a suitable bandwidth. It showed very little low frequency noise from motion that had occurred on the older array. We are unsure why the reflected signal was so poor. We ran one line with the older array and it performed as it had done the previous year, large low frequency signal from motion that could be filtered out to give an acceptable seabed signal.

The new array had a rigid plastic split tube taped to the outside to keep it straight. We felt that this might be degrading the signal so we removed it and did one more deployment. It was no better.

I refined the program of the deck control computer and the system operates acceptably now. However, with out a suitable hydrophone array, it is probably not worth using. It is not clear to us what is wrong with the new array and what changes could be made. It is also difficult to test the performance of the array ashore.

ULBL - Upside Down Long Base Line navigation system

(Dave Heffler)

The normal technique to determine position in the deep ocean is to install a set of acoustic transponders on the seabed and then to attach a transponder to the camera or core which is being lowered. This is called a Long Base Line (LBL) system. It is expensive in terms of equipment and more so in terms of ship time. I have devised a system of floating buoys each with a GPS receiver, a hydrophone and a radio to transmit the information back to the ship. It should be possible to cast off two buoys and have them drift freely within a few kilometers of the ship as the corer is lowered and recovered. It is possible to triangulate on a pinger attached to the core head.

I developed this system in 2001 and tested the various components at sea. All parts seems to operated but I did not have time to write software to solve for pinger position in real time. This was my mission for this cruise.

Three ranges are required, one to the ship and one to each buoy. However, the exact time of the ping is also unknown and must be solved as well. This can be done by tracking the arrival from the pinger to the seabed and up if the water depth is known. It should also be possible to measure the water depth by tracking the arrival which goes from the pinger to the sea surface, down to the seabed and back to the ship. These three arrivals, direct, bottom and multiple, are easily visible on the ship's sounder but have proved difficult to track automatically.

I built an interface to send the signal received on the ship's sounder, via the network, to my computer. I wrote some software to track the arrivals and do a real time solution of the pinger time, and depth. I did not succeed in making this software work reliably. The solution is close to working but needs more development. I have logged some real data that can be used in developing code ashore.

The positioning of the buoys and detecting the arrival times at the buoys had worked well last year and was not tested again this year.

Some of these problems could be reduced if we used a transponder on the core head instead of a pinger. GSCA does not normally use transponders and I had initially hoped to make the system work with a pinger.

GscDig Seismic digitizer

(Dave Heffler)

We have started development of a new seismic digitizer system called GscDig. We plan to replace the older AgcDig system. AgcDig is based on DOS computers which cannot be connected to the ship's network. Also the code is old and we no longer have the expertise to upgrade it.

GscDig is based on a networked approach of separate modules. One module will sample the signal, another might save the data to a file and third could display the data or its spectrum in real time. The seismic data will be distributed around the ship in real time using standard network protocols.

Over the past year, we have acquired some high quality digitizer boards and written some software to sample dat and save it. This was the first test of the system at sea with real signals. It works and allowed us to log some data. However, it is clear that some changes are needed.

The digitizer module (called GDAim for GscDig Analog Input Module) is based on a 24 bit sigma delta A/D which can sample at 48 kHz of each of 4 channels. Sigma delta converters have very wide dynamic range and also eliminate the problems of aliasing caused by sampling signals. We bought two units from Innovative Integration.

Software to control these boards is developed in Borland C++ Builder, a powerful Windows development environment which I have used extensively. I had written a prototype digitizer which I refined during the cruise. I added features to log Huntec DTS signals and save the fish depth. I wrote a separate logging program which picks the packets from the network and writes to hard disk. This logger can run on any computer on the ship. In retrospect, it was inconvenient to have the logger separate, it should be part of the digitizer program.

There is great advantage to having the data distributed on the network so other programs can display and analyze the data in real time. Having the data logged to network hard drives also means that data integrity can be checked with in an hour, instead of days later.

Station summary Hudson 2002-046

Station number	Station type	Latitude	Longitude	Recovery (cm)	Julian day	Station gmt	Water depth (m)	Station sub-region	Cruise/ daytime for site selection
1	Ralph	42° 35.6295'	-61° 26.7205'		228	1017	276	U. slope, Western Bank	
2	IKU Grab	42° 59.4715'	-61° 47.2748'		228	1238	237	U. slope, Western Bank	
3	IKU Grab	42° 58.7616'	-61° 46.8621'		228	1238	286	U. slope, Western Bank	
4	IKU Grab	42° 58.1565'	-61° 46.4137'		228	1354	354	U. slope, Western Bank	
5	IKU Grab	42° 57.6551'	-61° 46.0186'		228	1410	383	U. slope, Western Bank	
6	IKU Grab	42° 57.2023'	-61° 45.0704'		228	1438	431	U. slope, Western Bank	
7	IKU Grab	43° 1.21428'	-61° 48.495'		228	1550	140	U. slope, Western Bank	
8	IKU Grab	43° 0.1749'	-61° 47.3863'	none	228	1640	158	U. slope, Western Bank	
9	IKU Grab	43° 0.73818'	-61° 48.1433'	none	228	1731	165	U. slope, Western Bank	
10	IKU Grab	42° 59.765'	-62° 27.2954'		229	1059	142	U. slope, Western Bank	
11	IKU Grab	42° 58.8498'	-62° 27.3041'		229	1128	190	U. slope, Western Bank	
12	IKU Grab	42° 58.2414'	-62° 27.3197'		229	1157	196	U. slope, Western Bank	
13	IKU Grab	42° 57.74'	-62° 27.3527'		229	1236	241	U. slope, Western Bank	
14	IKU Grab	42° 57.722'	-62° 27.3515'		229	1253	289	U. slope, Western Bank	
15	IKU Grab	42° 57.3459'	-62° 27.3674'		229	1317	330	U. slope, Western Bank	
16	IKU Grab	42° 57.3706'	-62° 27.5159'	none	229	1347	325	U. slope, Western Bank	
17	IKU Grab	42° 56.8827'	-62° 27.4284'		229	1413	385	U. slope, Western Bank	
18	IKU Grab	42° 56.4633'	-62° 27.618'		229	1443	424	U. slope, Western Bank	
19	IKU Grab	42° 57.286'	-62° 12.0636'		229	1628	223	U. slope, Western Bank	
20	IKU Grab	42° 57.4358'	-62° 12.0972'		229	1705	205	U. slope, Western Bank	
21	IKU Grab	42° 57.4232'	-62° 11.9622'		229	1742	216	U. slope, Western Bank	
22	IKU Grab	42° 57.1362'	-62° 12.0446'	none	229	1827	223	U. slope, Western Bank	
23	Piston	42° 22.3591'	-63° 21.2039'	912	230	1212	1178	Central Scotian Slope	
24	Piston	42° 19.5597'	-63° 17.3188'	727	230	1432	1482	Central Scotian Slope	
25	Stacor	42° 32.6064'	-63° 28.8772'	580	230	1717	1483	Central Scotian Slope	
26	Piston	42° 12.5981'	-63° 39.2876'	813	231	1107	2067	off Brown's Bank	2002046/2310938
27	Piston	42° 26.9463'	-63° 47.6551'	1132	231	1341	1591	off Brown's Bank	2002046/2310637
28	Piston	42° 36.2312'	-63° 51.3166'	1077	231	1649	1058	off Brown's Bank	2002046/2310455
29	Piston	42° 40.9647'	-63° 57.277'	1184	231	1858	860	off Brown's Bank	2000036/2170511
30	Piston	42° 17.5121'	-64° 18.1211'	1045	232	1053	1846	off Brown's Bank	2002046/2320903
31	Piston	42° 25.8764'	-64° 27.0122'	1099	232	1312	1518	off Brown's Bank	2002046/2312333
32	Piston	42° 30.3207'	-64° 33.2031'	1143	232	1626	570	off Brown's Bank	2002046/2320213
33	Piston	42° 30.4725'	-64° 17.32'	1162	232	1826	1270	off Brown's Bank	
34	Piston	42° 15.1011'	-64° 26.9693'	1020	233	1109	1864	off Brown's Bank	2002046/2830708
35	Stacor	42° 15.1786'	-64° 26.9604'	592	233	1313	1862	off Brown's Bank	2002046/2330708
36	Piston	42° 26.9473'	-64° 34.9159'	1015	233	1548	816	off Brown's Bank	2002046/2320113
37	Piston	41° 42.8053'	-65° 35.9654'	1208	234	1117	1506	off Northeast Channel	2002046/2340915
38	Piston	41° 52.6122'	-65° 36.9811'	1005	234	1322	783	off Northeast Channel	2002046/2340208
39	Piston	42° 0.24318'	-65° 31.3975'	1201	234	1549	971	off Northeast Channel	2002046/2340332

40	Piston	41° 56.2407'	-65° 20.2327'	974	234	1752	1604	off Northeast Channel	2002046/2332100
41	Piston	42° 34.0536'	-62° 17.5702'	977	235	944	1650	Central Scotian Slope	
42	Stacor	42° 34.0562'	-62° 17.572'	410	235	1202	1650	Central Scotian Slope	
43	Piston	42° 30.1734'	-62° 24.279'	1202	235	1411	1748	Central Scotian Slope	
44	Stacor	42° 30.1633'	-62° 24.283'	549	235	1651	1748	Central Scotian Slope	
45	Piston	43° 6.20346'	-61° 8.20068'	1112	237	1125	1735	off West Western Bank	
46	Piston	43° 13.586'	-61° 7.99236'	987	237	1325	823	off West Western Bank	
47	Piston	43° 1.52628'	-61° 4.76016'	962	237	1709	2072	off West Western Bank	
48	Piston	42° 54.9634'	-61° 0.14646'	1007	237	1928	2162	off West Western Bank	
49	Piston	42° 4.18356'	-60° 31.6501'	1418	238	1209	4124	Weymouth Block	
50	Piston	42° 5.39268'	-60° 37.7462'	1235	238	1522	3924	Weymouth Block	2002046/2380932
51	Piston	42° 4.15428'	-60° 29.4723'	560	238	1839	4238	Weymouth Block	2002046/2381036
52	Piston	42° 51.6067'	-60° 34.6577'	1258	239	1049	2390	Weymouth Block	2002046/2390915
53	Piston	43° 1.00578'	-60° 37.2474'	1189	239	1302	1855	Weymouth Block	core 2000-036-039
54	Stacor	43° 1.00356'	-60° 37.2383'	79	239	1517	1854	Weymouth Block	
55	Piston	43° 6.9783'	-60° 35.5029'	456	239	1712	1966	Weymouth Block	
56	Piston	43° 11.204'	-60° 44.7818'	635	239	1904	924	Weymouth Block	
57	Piston	43° 11.7156'	-60° 39.5534'	462	240	1055	1520	Weymouth Block	
58	Piston	43° 11.9217'	-60° 37.2617'	549	240	1237	1175	Weymouth Block	
59	Stacor	43° 6.933'	-60° 39.215'	560	240	1427	1544	Weymouth Block	
60	Piston	43° 17.0354'	-60° 37.8455'	948	240	1631	662	Weymouth Block	
61	Piston	43° 19.9657'	-59° 43.0578'	885	241	1101	2060	Annapolis Block	
62	Piston	43° 24.4695'	-59° 47.6982'	810	241	1300	1737	Annapolis Block	
63	Piston	43° 23.0516'	-59° 47.0546'	1064	241	1446	1740	Annapolis Block	
64	Piston	43° 22.2715'	-59° 48.0327'	950	241	1643	1794	Annapolis Block	
65	Piston	43° 23.5345'	-59° 35.9209'	1065	241	1911	2149	Annapolis Block	
66	Piston	43° 0.07356'	-59° 14.3481'	1256	242	1047	3132	Scotian Rise	
67	Piston	43° 17.3093'	-59° 38.5951'	1193	242	1420	2564	Logan Canyon	2002046/2410911
68	Piston	43° 17.8102'	-59° 37.4748'	245	242	1639	2579	Logan Canyon	2002046/2410921
69	Piston	43° 19.8046'	-59° 37.182'	429	242	1845	2494	Logan Canyon	
70	Piston	44° 6.79128'	-57° 10.8709'	881	243	1027	2314	South of Banquereau	2002046/2430855
71	Piston	44° 6.9792'	-57° 9.4275'	208	243	1232	2280	South of Banquereau	2002046/2430904
72	Piston	43° 55.726'	-56° 29.3047'	none	243	1629	2944	Laurentian Fan	
73	Piston	44° 23.7757'	-55° 25.1034'	1275	244	1041	2595	Laurentian Fan	2002046/2440853
74	Piston	44° 23.5631'	-55° 26.2372'	1306	244	1305	2672	Laurentian Fan	2002046/2440903
75	Piston	44° 25.4403'	-54° 36.8288'	1294	245	1207	2163	S. of St Pierre Bank	2002046/2450356
76	Piston	44° 27.4008'	-54° 32.6588'	1269	245	1418	2163	S. of St Pierre Bank	2002046/2450304
77	Piston	44° 41.8128'	-54° 27.2066'	1250	245	1645	988	S. of St Pierre Bank	2002046/2450857
78	Piston	44° 48.5765'	-54° 53.7667'	1292	246	1336	1865	S. of St Pierre Bank	2002046/2461045
79	Piston	44° 51.1849'	-55° 1.07088'	1277	246	1608	1447	S. of St Pierre Bank	2002046/2461457
80	Piston	44° 39.62'	-54° 50.8979'	1274	246	1816	2050	S. of St Pierre Bank	2002046/2442346
81	Stacor	44° 51.7673'	-58° 46.393'	376	247	1428	264	Banquereau	
82	Stacor	44° 51.768'	-58° 46.5465'	562	247	1511	265	Banquereau	

Log of seismic tapes

Tape	Start	End
1	227/2209	228/0156
2	228/0156	228/0459
3	228/0459	228/0802
4	228/0802	228/0904
5	228/1830	228/2144
6	228/2240	229/0147
7	229/0147	229/0455
8	229/0455	229/0801
9	229/0801	229/1013
10	229/1931	229/2149
11	230/0106	230/0407
12	230/0407	230/0709
13	230/0709	230/0924
14	230/1913	230/2217
15	230/2217	231/0120
16	231/0138	231/0443
17	231/0448	231/0752
18	231/0752	231/0944
19	231/2050	231/2346
20	231/2346	232/0230
21	232/0230	232/0556
22	232/0556	232/0900
23	232/0900	232/2341
24	232/2341	233/0244
25	233/0245	233/0546
26	233/0546	233/0855
27	233/0900	233/2200
28	233/2206	233/0104
29	234/0107	234/0400
30	234/0400	234/0655
31	234/0700	234/0918
32	234/2049	234/2351
33	234/2351	235/0159?
34	235/2053	236/0003
35	236/0003	236/0309
36	236/0309	236/0607
37	236/0607	236/0908
38	236/1615	236/1932
39	236/1932	236/2237
40	236/2237	237/0139
41	237/0139	237/0407
42	237/0408	237/0713
43	237/0714	237/0917
44	237/2120	238/0024
45	238/0024	238/0330
46	238/0330	238/0630
47	238/0630	238/0938
48	238/2112	239/0016
49	239/0016	239/0330
50	239/0330	239/0633
51	239/0633	239/0920
52	239/2018	239/2321
53	239/2321	240/0224
54	240/0224	240/0527
55	240/0527	240/0830
56	240/0830	240/0910
57	240/1758	240/2059
58	240/2100	241/0027
59	241/0027	241/332
60	241/0332	241/0633
61	241/0622	241/0934
62	241/2117	242/0020
63	242/0020	242/0320
64	242/0320	242/0617
65	242/0619	242/0916
66	242/2134	242/2323
67	243/2210	244/0111
68	244/0111	244/0415
69	244/0415	244/0718
70	244/0718	244/0927
71	244/1617	244/1930
72	244/1930	244/2234
73	244/2234	245/0136
74	245/0136	245/0430
75	245/0430	245/0740
76	245/0741	245/0916
77	245/1816	245/2122
78	245/2122	246/0030
79	246/0030	246/0324
80	246/0324	246/0556
81	246/0558	246/0900
82	246/0900	246/1204
83	246/1953	246/2250
84	246/2250	247/0157
85	247/0157	247/0213

DAT Tapes							
Tape #	Start Time	End Time	Line #	Tape #	Start Time	End Time	Line #
1	227/2209	228/0156	1 to 4	2	228/0156	228/0459	4, 5
3	228/0459	228/0802	5 to 8	4	228/0802	228/0904	8
5	228/1830	228/2144	9	6	228/2240	229/0147	10
7	229/0147	229/0455	10, 11	8	229/0455	229/0801	12 to 16
9	229/0801	229/1013	16	10	229/1931	229/2149	17
11	230/0106	230/0407	18	12	230/0407	230/0709	18
13	230/0709	230/0930	18,19	14	230/1913	230/2217	20,21
15	230/2217	231/0120	21 to 23	16	231/0120	231/0444	24
17	231/0444	231/0752	24,25	18	231/0752	231/0943	25,26
19	231/2050	231/2346	27	20	2312346	232/0250	27 to 29
21	232/0250	232/0556	29 to 32	22	232/0556	232/0900	32 to 35
23	232/0900	232/2341	35,36	24	232/2342	233/0244	36,37
25	233/0246	233/0547	37 to 39	26	233/0547	233/0855	39,40
27	233/1900	233/2206	41	28	233/2206	234/0107	41,42
29	234/0107	234/0405	43,44	30	234/0405	234/0657	44,45
31	234/0658	234/0918	45	32	234/2049	234/2351	46
33	234/2351	235/0157	46	34	235/2053	236/0003	47
35	236/0003	236/0309	47 to 49	36	236/0310	236/0607	49,50
37	236/0608	236/0912	50 to 52	38	236/1615	236/1932	53
39	236/1932	236/2237	53,54	40	236/2237	237/0139	54,55
41	237/0139	237/0407	55,56	42	237/0408	237/0714	56,57
43	237/0714	237/0917	57,58	44	237/2122	238/0027	59
45	238/0027	238/0331	59	46	238/0332	238/0633	59
47	238/0634	238/0938	59	48	238/2112	239/0016	60,61
49	239/0016	239/0320	61	50	239/0330	239/0632	61
51	239/0633	239/0920	61	52	239/2018	239/2321	62,63
53	239/2321	240/0224	63,64	54	240/0224	240/0535	65,66
55	240/0526	240/0830	66	56	240/0830	240/0910	66
57	240/1758	240/2059	67,69	58	240/2059	241/0027	68,69
59	241/0027	241/0331	69	60	241/0332	241/0633	69
61	241/0633	241/0934	69	62	241/2116	242/0020	70 to 72
63	242/0020	242/0326	72 to 76	64	242/0326	242/0618	76,77
65	242/0619	242/0916	78,79	66	242/2134	242/2323	80,81
67	243/2210	244/0111	87,88	68	244/0111	244/0414	88 to 90
69	244/0415	244/0718	90	70	244/0718	244/0927	90,91
71	244/1617	244/1930	92,93	72	244/1930	244/2234	93 to 95
73	244/2234	245/0136	95	74	245/0136	245/0439	95 to 97
75	245/0440	245/0740	97 to,99	76	245/0741	245/0916	99,100
77	245/1816	245/2122	101	78	245/2122	246/0021	101 to 103
79	246/0021	246/0325	103 to 105	80	246/0325	246/0557	105 to 107
81	246/0557	246/0906	107,108	82	246/0906	246/1204	108 to 110
83	246/1953	246/2250	111,112	84	246/2250	247/0157	112
85	247/0157	247/0213	112				

Seismics DIG Tapes

Tape #	Start Time	End Time	Line #	Tape #	Start Time	End Time	Line #
1	228/0002	228/0907	2 to 8	2	228/2248	229/0943	10 to 16
3	230/0052	230/0924	18,19	4	230/1913	231/0943	20 to 26
5	231/2043	232/0141	27,28	6	232/0150	232/0910	29 to 35
7	232/2054	233/0901	36 to 40	8	233/1858	234/0918	41 to 45
9	234/2048	236/0910	46 to 52	10	236/1610	237/0912	53 to 58
11	237/2123	238/0931	59	12	238/2112	239/0920	60,61
13	239/2019	240/0910	62 to 66	14	240/1759	241/0932	67 to 69
15	241/2117	242/0301	70 to 76	15	242/2131	242/2314	80,81
17	243/2210	244/0922	87 to 91	18	244/1619	245/0916	92 to 100
19	245/1819	246/1208	101 to 110	20	246/1952	247/0213	111,112

Huntec DIG Tapes

Tape #	Start Time	End Time	Line #	Tape #	Start Time	End Time	Line #
1	227/2210	228/0611	1 to 6	2	228/0621	228/0907	6 to 8
3	228/1816	229/0943	9 to 16	4	229/1925	230/0600	17,18
5	230/0611	230/0924	18,19	6	230/1923	231/0944	20 to 26
7	231/2051	232/0910	27 to 35	8	232/2044	233/0900	36 to 40
9	233/1859	234/0918	41 to 45	10	234/2058	236/0911	46 to 52
11	237/0047	238/0931	55 to 59	12	238/2112	239/0915	60,61
13	239/2018	240/0910	62 to 66	14	240/2323	241/0932	69
15	241/2119	242/0916	70 to 79	16	243/2208	244/0921	87 to 91
17	244/1619	245/0916	92 to 100	18	245/1823	246/1208	101 to 110
19	246/1952	247/0213	111,112				

Sidescan DIG Tapes

Tape #	Start Time	End Time	Line #	Tape #	Start Time	End Time	Line #
1	228/1828	228/2157	9	2	229/1923	229/2149	17

Line numbers

Line No.	Start Time	End Time	DAT	Seismics			Sidescan		Huntec		3.5	12
			Tape #	Record #		Tape #	Record #	Tape #	Record #	Tape #	KHZ	KHZ
				GF30	TELED.						Record #	Record #
				100' Bent.								
1	227/2209	227/2309	1						1	1	1	1
2	227/2312	228/0043	1	1	1	1			1	1	1	1
3	228/0045	228/0133	1	1	1	1			1	1	1	1
4	228/0142	228/0345	1,2	1	1	1			1	1	1	1
5	228/0345	228/0505	2,3	1	1	1			1	1	1	1
6	228/0505	228/0658	3	1	1	1			1	1,2	1	1
7	228/0658	228/0740	3	1	1	1			1	2	1	1
8	228/0740	228/0904	3,4	1	1	1			1	2	1	1
9	228/1814	228/2145	5				1	1	2	3	2	2
10	228/2246	229/0223	6,7	2	2	2			2	3	2	2
11	229/0234	229/0408	7	2	2	2			2	3	2	2
12	229/0451	229/0517	7,8	2		2			2	3	2	2
13	229/0524	229/0600	8	2	2	2			2	3	2	2
14	229/0608	229/0623	8	2	2	2			2	3	2	2
15	229/0629	229/0740	8	2	2	2			2	3	2	2
16	229/0743	229/0944	8,9	2	2	2			2	3	2	2
17	229/1931	229/2141	10				2	2	3	4	3	3,4
18	230/0054	230/0830	11,12,13	3	3	3			3	4,5	3	4
19	230/0843	230/0924	13	3	3	3			3	5	3	4
20	230/1949	230/2135	14	4	4	4			4	6	4	5
21	230/2140	230/2246	14,15	4	4	4			4	6	4	5
22	230/2300	230/2340	15	4	4	4			4	6	4	5
23	230/2345	231/0121	15	4	4	4			4	6	4	5
24	231/0138	231/0448	16,17	4	4	4			4	6	4,5	5
25	231/0458	231/0912	17,18	4	4	4			4	6	5	5
26	231/0912	231/0943	18	4	4	4			4	6	5	5
27	231/2030	232/0027	19,20	5	5	5			5	7	6	6
28	231/0027	232/0143	20	5	5	5			5	7	6	6
29	232/0148	232/0300	20,21	5	5	6			5	7	6	6
30	232/0300	232/0321	21	5	5	6			5	7	6	6
31	232/0321	232/0424	21	5	5	6			5	7	6	6
32	232/0424	232/0623	21,22	5	5	6			5	7	6	6
33	232/0632	232/0724	22	5	5	6			5	7	6	6
34	232/0724	232/0847	22	5	5	6			5	7	6	6
35	232/0847	232/0906	22,23	5	5	6			5	7	6	6
36	232/2032	233/0110	23,24	6	6	7			6	8	8	7
37	233/0110	233/0407	24,25	6	6	7			6	8	8	7
38	233/0410	233/0530	25	6	6	7			6	8	8	7
39	233/0537	233/0758	25,26	6	6	7			6	8	8	7
40	233/0758	233/0900	26	6	6	7			6	8	8	7

41	233/1856	233/2330	27,28	7	7	8			7	9	10	8
42	233/2331	234/0103	28	7	7	8			7	9	10	8
43	234/0110	234/0351	29	7	7	8			7	9	10	8
44	234/0351	234/0517	29,30	7	7	8			7	9	10	8
45	234/0518	234/0918	30,31	7	7	8			7	9	10	8
46	234/1955	235/0159	32,33	8	8	9			8	10	12	10
47	235/2100	236/0124	34,35	9	9	9			9	10	13	11
48	236/0135	236/0252	35	9	9	9			9	10	13	11
49	236/0252	236/0515	35,36	9	9	9			9	10	13	11
50	236/0520	236/0741	36,37	9	9	9			9	10	13	11
51	236/0741	236/0827	37	9	9	9			9	10	13	11
52	236/0827	236/0908	37	9	9	9			9	10	13	11
53	236/1615	236/2041	38,39	10	10	10					14	12
54	236/2059	236/2259	39,40	10	10	10					14	12
55	236/2302	237/0400	40,41	10	10	10			10	11	14	12
56	237/0400	237/0609	41,42	10	10	10			10	11	14	12
57	237/0629	237/0717	42,43	10	10	10			10	11	14	12
58	237/0744	237/0915	43	10	10	10			10	11	14	12
59	237/2120	238/0930	44 to 47	11	11	11			11	11	15	13
60	238/2112	238/2254	48	12	12	12			12	12	16	14
61	238/2254	239/0915	48 to 51	12	12	12			12	12	16	14
62	239/2020	239/2233	52	13	13	13			13	13	17	16
63	239/2241	240/0025	52,53	13	13	13			13	13	18	16
64	240/0025	240/0224	53	13	13	13			13	13	18	16
65	240/0224	240/0347	54	13	13	13			13	13	18	16
66	240/0347	240/0910	54 to 56	13	13	13			13	13	18	16
67	240/1758	240/2057	57	14	14	14					19	17
68	240/2057	240/2238	57,58	14	14	14					19	17
69	241/0023	241/0932	58 to 61	14	14	14			14	14	19	17
70	241/2118	241/2209	62	15	15	15			15	15	20	18
71	241/2230	242/0005	62	15	15	15			15	15	20	18
72	242/0008	242/0026	62,63	15	15	15			15	15	20	18
73	242/0026	242/0123	63	15	15	15			15	15	20	18
74	242/0123	242/0145	63	15	15	15			15	15	20	18
75	242/0147	242/0243	63	15	15	15			15	15	20	18
76	242/0243	242/0430	63,64		15	15			15	15	20	18
77	242/0443	242/0617	64						15	15	20	18
78	242/0617	242/0823	65						15	15	20	18
79	242/0823	242/0916	65						15	15	20	18
80	242/2138	242/2231	66	16	16	16					21	19
81	242/2233	242/2342	66	16	16	16					21	19
82	242/2342	242/2347									21	19
83	242/2347	243/0030									21	19
84	243/0030	243/0718									21	19
85	243/0718	243/0742									21	19
86	243/0747	243/0924									21	19
87	243/2130	243/2345	67	16	16	17			16	16	22	20
88	243/2345	244/0209	67,68	16	16	17			16	16	22	20
89	244/0209	244/0349	68	16	16	17			16	16	22	20

90	244/0349	244/0730	68 to 70	16	16	17			16	16	22	20
91	244/0730	244/0922	70	16	16	18			16	16	22	20
92	244/1629	244/1742	71	17	17	18			17	17	24	21
93	244/1742	244/2115	71,72	17	17	18			17	17	24	21
94	244/2115	244/2202	72	17	17	18			17	17	24	21
95	244/2202	245/0255	72 to 74	17	17	18			17	17	24	21
96	245/0255	245/0344	74	17	17	18			17	17	24	21
97	245/0344	245/0545	74,75	17	17	18			17	17	24	21
98	245/0545	245/0710	75	17	17	18			17	17	24	21
99	245/0710	245/0848	75,76	17	17	18			17	17	24	21
100	245/0848	245/0916	76	17	17	18			17	17	24	21
101	245/1837	245/2234	77,78	18	18	19			18	18	25	22
102	245/2234	245/2303	78	18	18	19			18	18	25	22
103	245/2303	246/0200	78,79	18	18	19			18	18	25	22
104	246/0200	246/0214	79	18	18	19			18	18	25	22
105	246/0214	246/0456	79,80	18	18	19			18	18	25	22
106	246/0456	246/0524	80	18	18	19			18	18	25	22
107	246/0524	246/0700	80,81	18	18	19			18	18	25	22
108	246/0700	246/0926	81,82	18	18	19			18	18	25	22
109	246/0926	246/1153	82	18	18	19			18	18	25	22
110	246/1153	246/1204	82	18	18	19			18	18	25	22
111	247/2003	247/2130	83	19	19	20			19	19	26	23
112	247/2130	247/0214	83 to 85	19	19	20			19	19	26	23

Huntec Analog Records

Record #	Start Time	End Time	Line #	Record #	Start Time	End Time	Line #
1	227/2217	228/0908	1 to 8	2	228/1815	228/2144	9 to 16
					228/2235	229/0405	
					229/0453	229/0943	
3	229/1925	229/2140	17 to 19	4	230/1917	231/0944	20 to 26
	230/0051	230/0924					
5	231/2052	232/0908	27 to 35	6	232/2044	233/0900	36 to 40
7	233/1859	234/0918	41 to 45	8	234/2056	235/0159	46
9	235/2246	236/0351	47 to 52	10	237/0047	237/0439	55 to 58
	236/0523	236/0931			237/0448	237/0916	
11	237/2120	238/0930	59	12	238/2117	239/0916	60,61
13	239/2016	240/0910	62 to 66	14	240/2331	241/0932	69
15	242/2122	242/0916	70 to 79	16	243/2206	244/0922	87 to 91
17	244/1621	245/0916	92 to 100	18	245/1827	246/1205	101 to 110
19	246/1952	247/0214	111,112				

3.5 kHz Analog Records

Record #	Start Time	End Time	Line #	Record #	Start Time	End Time	Line #
1	227/1746	228/1024	1 to 8	2	228/1029	229/1212	9 to 16
3	229/1215	230/0942	17 to 19	4	230/0948	231/0402	20 to 24
5	231/0408	231/1050	24 to 26	6	231/1055	231/2026	27 to 35
					231/2052	232/0935	
7	232/0953	232/1905	n/a	8	232/1913	233/0931	36 to 40
9	233/0934	233/1842	n/a	10	233/1849	234/0937	41 to 45
11	234/0941	234/1229	n/a	12	234/1235	235/1003	46
13	235/1005	235/2101	47 to 52	14			53 to 58
	235/2244	235/2311			236/0951	236/1057	
	235/2324	236/0351			236/1509	236/0948	
	236/0515	236/0948					
15	237/0955	238/0937	59	16	238/0940	238/1511	60,61
					238/1523	239/0925	
17	239/0928	239/2230	62	18	239/2233	240/0933	63 to 66
19	240/0941	240/1348	67 to 69	20	241/0957	242/1010	70 to 79
	240/1403	241/0930					
21	242/1014	242/1350	80 to 86	22	243/1031	244/1013	87 to 91
	242/1400	243/1028					
23	244/1017	244/1542	n/a	24	244/1545	245/0921	92 to 100
25	245/0925	246/1205	101 to 110	26	246/1214	247/0225	111,112
					247/1245	247/1542	