Cruise Report
Hudson 2003-033

Geohazards on the Continental Margin off Newfoundland

Geological Survey of Canada
Open File 5081

June 15 - July 6th 2003
Captain R. Ashton

2006

Geological Survey of Canada (Atlantic) project X27
Report compiled by
David J.W. Piper

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GEOLOGICAL SURVEY OF CANADA

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D.J.W. Piper

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1 Challenger Drive,
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Acknowledgements

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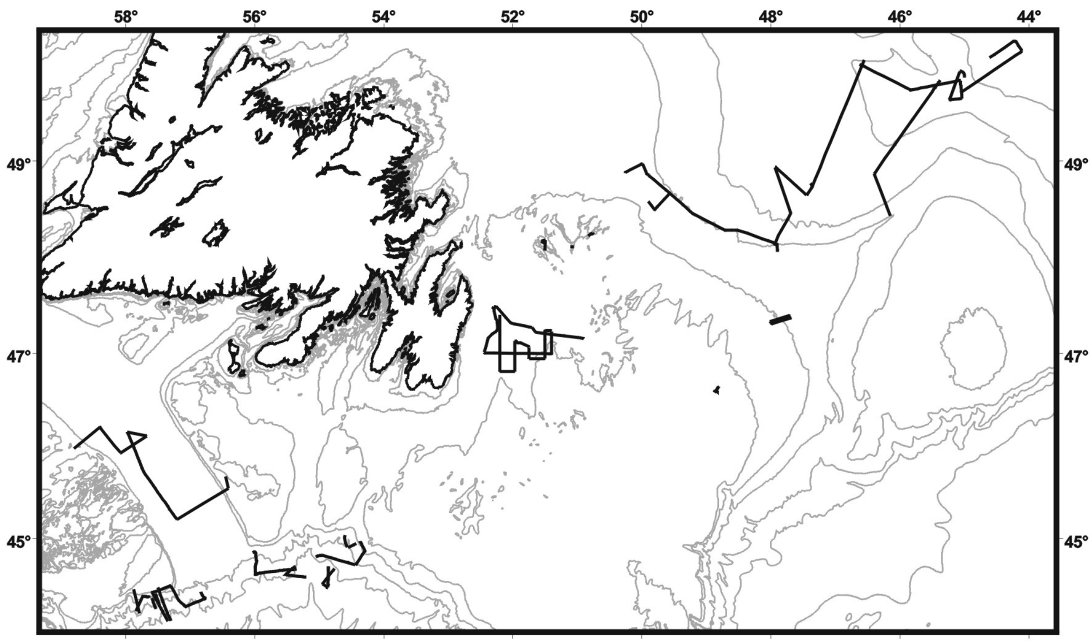
For further information, please contact David J.W. Piper dpiper@NRCan.gc.ca (902) 426 6580 or David C. Mosher dmosher@NRCan.gc.ca (902) 426 3149
Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, N.S., B2Y 4A2

SUMMARY OF CRUISE

HUDSON 2003-033		SUMMARY		Samples			Lines		
Date	JD	Area, activity	Purpose	PC	Stacor	IKU	Seismic	Sidescan	3.5 kHz
15-Jun	166	Steam BIO to Banquereau margin	1. Seismic testing; 2. OBS experiment for gas hydrates. 3. Critical seismic lines on St Pierre slope. Secondary objective of ice history and slope stability off SW Nfld.						
16-Jun	167	Steaming. Old seismic gear out 1900 on east Banquereau margin							
17-Jun	168	Two mid slope cores, test new seismic.		1, 2			1-5		
18-Jun	169	Two mid slope cores, seismic on St Pierre slope		3,4			6-11		
19-Jun	170	OBS experiment, overnight seismic					12-17		
20-Jun	171	seismic and coring, St Pierre Slope and Haddock/Halibut margin, then steam to St Johns overnight.		5-8		9	18-26		
21-Jun	172	St Johns, offshore overnight	Pipeline routes: good cover over bedrock, what is scour regime?						
22-Jun	173	offshore St Johns					27-36		
23-Jun	174	offshore St Johns					37-41		
24-Jun	175	One piston core, 4 Stacors (2 failed) in basins on northern Grand Bank	Holocene history of icebergs, for interpreting scoured sea floor	10	11, 12				38-47
25-Jun	176	Seismic and cores, SW slope of Orphan basin	1. Hazard assessment and shallow drilling conditions in Orphan basin 2. History of Labrador Current and WBUC. Secondary objective: Overall sedimentary architecture of the Quaternary of Orphan basin.	15-18			48-51		
26-Jun	177	Seismic and cores, S. slope of Orphan basin		19-21			52-53		
27-Jun	178	Seismic and cores, southern Orphan basin		22-24			54-58		
28-Jun	179	Seismic and cores, SW of Orphan Knoll		25, 26			59		
29-Jun	180	Seismic and cores S of Orphan Knoll. Grove crane out of service in am.		27			60-65		
30-Jun	181	Core east of Orphan Knoll, then seismic on SE margin Orphan basin		28, 29			66-68		
1-Jul	182	Seismic till noon, steam to outer shelf sidescan area, run sidescan and Huntec	Ice scour repetitive surveys				69-70		
2-Jul	183	Complete outer shelf sidescan, transit to Rankin iceberg scour, depart 2000 for Laurentian Channel						71-82	
3-Jul	184	Transit, seismic at 2100						83-84	
4-Jul	185	Laurentian Channel	Foundation conditions and fault hazards	30				85-86	
5-Jul	186	Laurentian Channel, steam at 1100						87-89	
6-Jul	187	arrive BIO							



SCIENTIFIC STAFF

David J.W. Piper
David Mosher (to June 21)
Calvin Campbell
Paul Girouard
Austin Boyce
Fred Jodrey
Ken Asprey
Bill Leblanc
Borden Chapman (to June 21)
Greg Middleton (to June 21)
Angus Robertson (to June 21)
Curtis McCall
Rebecca Brunt
Aaron Vaughn
Shannon Ledger-Piercey

all the above are GSCA staff or student employees

Martin Uyesugi	Geoforce Consultants
Adam MacDonald	contractor
Angela Ford	GSC volunteer
Sara Benetti	Southampton Oceanography Centre
Caroline Plain	UQAM
Maxime Paiement	UQAM
Jennifer Henderson	University of Rhode Island

OBJECTIVES AND ACCOMPLISHMENTS

Program framework

This cruise meets requirements of GSC Project X-27 8004 East Coast Offshore Geohazards, within the Geoscience for Ocean Management program, specifically:
B1.1 Reconnaissance assessment of foundation conditions and hazards, Laurentian sub-basin
B3.2 Scour frequency estimates on Grand Bank
C1.1 Deep-water geological risk factors, Scotian Slope
C2.2 Geological framework and hazard assessment, slopes of northern Grand Banks

Specific objectives

1. Seismic trials with new seismic equipment
2. Investigation by seismic and cores of major failures and BSRs on East Scotian Slope – W. Grand Banks Slope
3. Regional seismic profile and cores on eastern edge of Laurentian Channel and E. Scotian Shelf.
4. Repetitive sidescan surveys of ice scours on Grand Bank and assessment of regional pipeline routes near St John's.
5. Regional geohazard assessment by coring and seismic in Orphan Basin.
6. Sampling for geochemical analysis of transport by Western Boundary Undercurrent and acquisition of core-top dinoflagellate samples

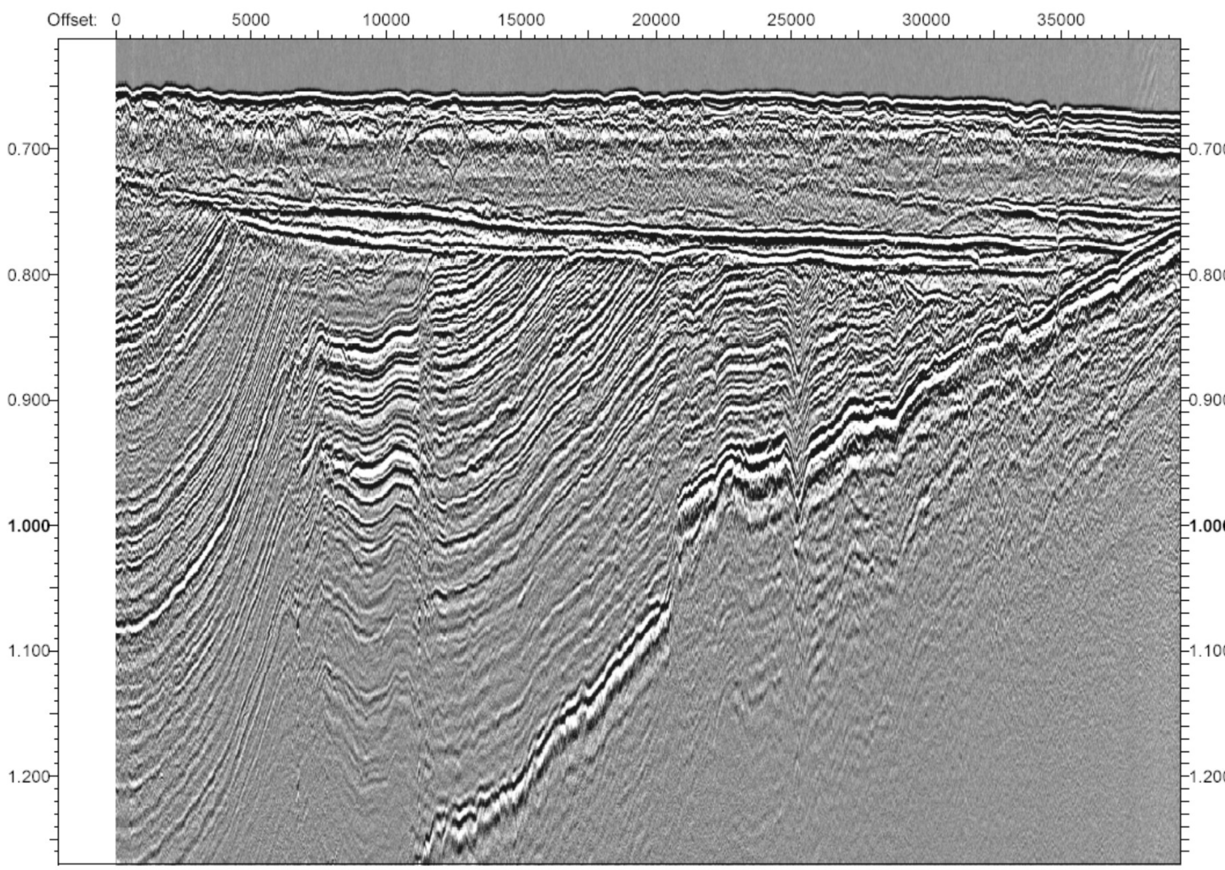
Accomplishments

1. Tested the new GI gun and Teledyne eel with the GSCDIGS system. There is general satisfaction with the improvement in data quality, although depth of penetration is not as good as anticipated. Handling the single gun requires little effort.
2. Seismic and Huntec data, supplemented by 8 piston cores, were obtained on the upper slope off eastern Banquereau and on the slope off Haddock Channel. These indicate that till extends to water depths of several hundred metres, terminating at scarps that imply failure along stratified proglacial sediment. Flow tills extend to water depths of 1500 m on steep slopes. An ocean-bottom seismometer wide angle reflection/refraction experiment was carried out in the area south of Halibut Channel over a gas hydrate BSR discovered in 2002. 100 line-km of Huntec and seismic were obtained on St Pierre Slope around the epicentre of the 1929 earthquake to improve seismic correlation in the area and to estimate volume and failure areas. New data in this area and of Haddock Channel supports our earlier suspicion that salt tectonics plays a much more important role in promoting failure than on the central Scotian Slope.
3. Collected 320 line km of Huntec and airgun profiles in Laurentian Channel, crossing the late 20^{th} century earthquake swarm., revealing new details about the glacial stratigraphy and showing several possible fault offsets.
4. Collected 500 line-km of Huntec, sidescan and small airgun profiles on the inner Grand Banks offshore St Johns for regional information for pipeline route assessment. The entire western part of the survey area appeared to have very shallow bedrock. Collected 1 piston and 2 Stacor cores from small basins on northern Grand Bank for assessing changes in iceberg flux in the late Holocene. Surveyed with sidescan 80 km^2 of outer Grand Banks for

style of iceberg scour, finding predominantly large pits and a few small scours. Surveyed with sidescan a March 2002 scour and pit created by a tracked iceberg.

5. Filled in gaps in seismic coverage and cores in southern Orphan Basin, in the areas recently leased for hydrocarbon exploration, obtaining some 850 line-km of airgun seismic and Huntec. Obtained 12 piston cores all the way from the upper slope to the deep basin floor seaward of the major debris flows mapped by Hiscott and Aksu. Seismic coverage has tied the previous MUN surveys to our 2001 seismic north of Flemish Pass and put a regional Huntec line through core MD95-2026 and several TDI Brooks core sites. Major channels in Orphan Basin appear to be bypass zones for turbidity currents, with only debris flows sedimenting, which has hampered using basinal sediment to assess frequency of failure.
6. One additional piston core was collected in main area of WBUC for assessment of Th fluxes and paleoceanography by UQAM. Core top dinoflagellate samples were collected from all trigger-weight cores during the cruise.

Example of seismic profile with new GI gun and Teledyne eel, Laurentian Channel



NARRATIVE

The narrative is lightly edited from daily plans. Positions are those planned rather than those actually accomplished. Refer to cruise CD with navigation and tables of data for precise information.

Sunday 15th June
Ship eventually sailed at 1130 ADT and was delayed by traffic exiting the harbour. Poor weather, strong NE winds, made slow progress towards Banquereau.

Monday 16th June JD 267
Strong E winds continued much of the day, died down by early evening. Insufficient time to test new seismic system, so at 1900 ADT deployed Huntec (sparker), 40 cu in sleeve gun, and Benthos eel and ran the following lines at 5.0 to 5.5 knots through the water.

SOL 1	44° 27' N	-57° 53' N
EOL 1	44° 10.1238' N	-57° 47.2542' W

make a slow turn onto line 2

SOL 2	44° 11.8242' N	-57° 50.4504' W
SOL 3	44° 21.3642' N	-57° 44.0892' W
SOL 4	44° 20.5866' N	-57° 36.051' W
EOL 4	44° 13.1166' N	-57° 31.9236' W

ships power failure during line 4, circled to regain data coverage

Tuesday 17th June JD 268
weather: light winds.
make a slow turn onto line 5

SOL 5	44° 16.4916' N	-57° 29.097' W
EOL 5	44° 22.9746 N'	-57° 32.4738' W

make a slow turn towards line 6

SOL 6	44° 24.1914' N	-57° 28.5816' W

bring in gear at SOL 6 at 0615 ADT

Piston core 1	0736^{30} seismic time	750 m approx, seismic shows stratified but surface may be missing on ridge crest
44° 17.7929' N	57° 29.7920' W	

recovered about 7 m of red mud

Piston core 2	0757^{00} seismic time	Last upslope occurrence of some sub-bottom reflectors in Huntec
44° 19.8300' N	57° 30.8405' W	

TWC recovered a few cm of sandy grey mud; PC ~2 m stiff grey mud

Core 2 on deck by 1100 ADT. Then stream new GI guns and at 1230 deploy Teledyne eel.

Run the following lines at 5 kts through the water:

SOL 6	44° 27.2178' N	-57° 30.1362' W
TPA 6	44° 9.5562' N	-57° 21.1026' W
EOL 6	44° 5.0958' N	-57° 17.841' W
SOL 7	44° 4.8522' N	-57° 20.8848' W
SOL 8	44° 23.6718' N	-57° 35.2014' W

Wednesday 18th June JD 269
moderate SW winds

SOL 9	44° 28.4022' N	-57° 18.0006' W
TPA 9	44° 18.5886' N	-57° 10.6854' W
SOL 10	44° 14.5308' N	-57° 04.3812' W
EOL 10	44° 20.0556' N	-56° 45.0324' W

cut line 10 a little short, ran short line 11 to NNW

Bring in gear at 0620 ADT, piston core at same site.

Piston core 3	0942 seismic time	Apparent undisturbed stratified sediment sequence
44° 25.2650' N	56° 51.0452' W	

then steam to core site 4

Piston core 4	0807 seismic time	Stratified sediment on ridge crest, probably top missing
44° 19.2325' N	-56° 47.9446' W	

When core 4 completed, steam to point C

C	44° 50.46' N	-56° 02.91' W

At C, deploy SI gun, Teledyne eel and Huntec
moderate SW winds, considerable sea.

SOL 12	44° 50.5494' N	-56° 2.028'
SOL 13	44° 50.8128' N	-55° 59.3496'
Tp-a	44° 47.4012' N	-55° 59.0838'
Tp-b	44° 44.928' N	-55° 58.3032'
Tp-c	44° 41.3472' N	-55° 59.4588'
Tp-d	44° 40.257' N	-55° 59.3508'

gun started leaking, bring in to repair and circle
shortly thereafter, wind dropped, fog began

SOL 14	44° 36.3552' N	-55° 59.4636'
Tp-a	44° 38.2734' N	-55° 39.2526'
EOL 14	44° 39.342' N	-55° 21.2898'

Thursday 19th June JD 270
Light winds, fog much of day, clearing in evening.

SOL 15	44° 41.0091' N	55° 22.8909' W
SOL 16	44° 35.5501' N	55° 30.5331' W
SOL 17	44° 34.1992' N	55° 14.2683' W

bring in gear near beginning of line 17 and steam at full speed to drop OBS. at point D
D 44° 34.302' N -54° 51.768' W

then steamed at full speed to SOL 18 and deployed seismic gear (GI gun and Teledyne eel, NO Huntec)
run the following lines at 5 knots through the water

SOL 18	44° 41.2794' N	-54° 51.612' W
SOL 19	44° 27.348' N	-54° 51.9456' W
SOL 20	44° 29.7594' N	-54° 56.7918' W
EOL 20	44° 39.4122' N	-54° 45.318' W

Successfully recovered OBS. Note that during the experiment, the shot box was twice rebooted, meaning that the shot interval was not completely constant.

When OBS recovered, steam to 1 mile past SOL 21 and turn to deploy Huntec, GI gun and Teledyne eel.
Run the following lines at 4.5 - 5.0 knots through the water

SOL 21	44° 48.0930' N	-55° 01.263' W
SOL 22	44° 48.6186' N	-54° 57.5400' W
SOL 23	44° 42.1782' N	-54° 25.9758' W
SOL 24	44° 51.6480' N	-54° 17.5176' W

some problems with swordfishers on outer shelf, brought in gear twice overnight.

Friday 20th June JD 171
Moderate southerly winds, increasing during the day, light rain.

SOL 25	44° 57.5520' N	-54° 21.9114' W
SOL 26	44° 53.5614' N	-54° 33.6102' W
Tp-a-26	44° 56.6952' N	-54° 35.8266' W
Tp-b-26	45° 00.5088' N	-54° 36.5730' W
EOL 26	45° 04.1472' N	-54° 35.5788' W

Brought in gear at 0620 ADT.

Piston core 5 0828 seismic time Stratified material at limit of seismically incoherent material.
44° 57.0510' N 54° 35.9046' W
TWC had washed out fine gravel. Top of PC sandy, then several metres of stiff mud.

Piston core 6   0842 seismic time   Small terrace in seismically incoherent material.
44° 58.2350' N   54° 36.1364' W
recovered 1 m sorted sand, cutter badly damaged by hitting one or more cobbles.

Piston core 7   0751 seismic time   Thick transparent section over well stratified mud.
44° 54.1260' N   54° 33.9890' W
Piston core 8   0146/247/2002 seismic time   Iceberg scoured outer shelf
44° 59.58' N   -54° 57.156' W

IKU grab 9   0138/247/2002 seismic time   Cliff at which till appears to outcrop.
44° 59.01' N   -54° 57.81' W
Recovered stiff grey and minor purplish clay that appeared in one place to be outcropping. Overlain by bioturbated somewhat greenish sand and a more poorly sorted gravelly sand with some cobbles. No unequivocal clasts in the clay, so it may be proglacial mud rather than till (should look at forams). Made torque watch and constant volume measurements.

When IKU completed, closed down all equipment and steamed for St John's at 1800 ADT.

Saturday June 21st JD 172
light winds, sun.
Arrived St John's 0930 ADT and anchored in harbour. Took injured cadet to hospital.

after departing St John's at 1700 ADT, steamed to SOL 27 and deployed the following gear:
Huntec boomer, sidescan, 10 cu in airgun, Teledyne eel.
Run the following lines at 4.5 to 5 knots through the water, cut corners at end of lines

SOL 27	47° 32' N	52° 12' W
SOL 28	46° 48' N	52° 12' W

Sunday June 22nd JD 173
light to moderate winds

SOL 29	46° 48' N	51° 58' W
SOL 30	47° 08' N	51° 58' W
SOL 31	47° 04' N	51° 45' W
SOL 32	46° 56.3988' N	51° 45.0192' W
SOL 33	46° 56.4042' N	51° 30.0534' W
SOL 34	47° 14.3064' N	51° 30.0066' W
SOL 35	47° 14.3046' N	51° 24.0198' W
SOL 36	46° 59.5092' N	51° 23.8722' W

Monday June 23rd JD 174
light winds

SOL 37	47° 00.0168' N	52° 26.5068' N
SOL 38	47° 29.1726' N	52° 15.2004' N
SOL 39	47° 19.0020' N	52° 01.9980' N
SOL 40	47° 16.2000' N	51° 41.9994' N
SOL 41	47° 13.2000' N	51° 39.0024' N
EOL 41	47° 09.4974' N	50° 56.5020' N

Tuesday June 24th JD 175
Cold, light winds

brought in gear at end of line 41 just after midnight.

Then steamed at full speed to SOL 42.

Ran lines 42-44 at 7 knots: lab will use the hull-mounted 3.5 kHz sounder to find a core site

SOL 42	48° 05.2452' N	-51° 30.033' W
SOL 43	48° 11.1786' N	-51° 29.7444' W
SOL 44	48° 10.5042' N	-51° 33.4578' W
EOL 44	48° 07.2606' N	-51° 26.8614' W

Core 10: 50 ft piston core, water depth approximately 245 m
48° 08.8847' N 51° 29.8581' W
Successful long piston core in green and black mud, some minor gas expansion cracks low in core.
Acoustic section looks very similar to that in Downing Basin.

Core 11: Stacor at same site: good recovery

when coring completed, steamed at full speed to SOL 45
ran 3.5 kHz on line 45 at 7 knots to locate next core site

SOL 45	48° 06.9810' N	-51° 05.2746' W
EOL 45	48° 06.9960'N	-51° 03.4836' W

on line 45, picked core site from sounder
Core 12 Stacor 1433^{45}
48° 06.9815' N 51° 04.3252' W
good recovery

then steamed at full speed to SOL 46
ran the following line at 7 knots in order to pick core site from 3.5 kHz profile

SOL 46	48° 13.7844' N	-50° 50.0304' W
EOL 46	48° 15.6258' N	-50° 46.0818' W

selected core site 13 on line 46 Stacor 1639 on 3.5 kHz
48° 14.6008' N 50° 48.2726' W

barrel bent 0.5 m up, no recovery.

continued survey on line 47

SOL 47	48° 15.6258' N	-50° 46.0818' W
EOL 47	48° 14.3106' N	-50° 44.751' W

found what looked like a better spot, with less surface reflectivity and erosion

Stacor 14	48° 15.3121' N	50° 45.7895' W

no recovery, presumably even here a sandy erosional surface

then steam at full speed to SOL 48.
Deployed Huntec sparker, GI gun and Teledyne eel at SOL 48 at 2000 ADT
Ran lines 48 - 51 at 4.5-5.0 knots through the water

SOL 48	48° 52.8972' N	-50° 15.3912' W

Wednesday June 25th JD 176
cold, foggy, light to moderate SW winds

SOL 49	48° 58.4352' N	-49° 59.3202' W
Tp-a-49	48° 52.4628' N	-49° 55.8816' W
SOL 50	48° 40.0752' N	-49° 33.9216' W
SOL 51	48° 29.8566' N	-49° 48.3054' W
EOL 51	48° 37.365' N	-49° 56.6316' W

broke off line 51 at 0615 ADT after crossing 89-006 Huntec line

Piston core 15	40 ft	seismic time 0500	stratified high
48° 42.6505' N	49° 38.4651' W		

Liner telescoped, some damage to core.

Piston core 16	40 ft	seismic time 0304	near surface unconformity over stratified
48° 50.4482' N	49° 52.3061' W		

Piston core 17	50 ft	seismic time 0401	stratified high
48° 46 6113' N	49° 45.4815' W		

Core hit cobble; all sediment remoulded and disturbed.

Piston core 18	30 ft	seismic time 0600	downslope part of “debris flow”
48° 38.6440' N	49° 35.9301' W		

3 m stiff brown mud, some liner damage, no TWC.

Once core 18 is retrieved, steam to SOL 52 and deploy Huntec, GI gun and Teledyne eel. Run the following lines at 4.5 to 5 knots through the water. These lines pass through several TDI Brooks core sites.

SOL 52	48° 40.7352' N	-49° 35.0676' W
Tp-a-52	48° 27.5778' N	-49° 12.7362' W
Tp-b-52	48° 17.3292' N	-48° 42.7308' W
Tp-c-52	48° 17.2116' N	-48° 30.6204' W

Thursday June 26th JD 177
cold, light SW winds

SOL 53	48° 8.7288' N	-47° 54.2250' W
EOL 53	48° 0.9114' N	-47° 53.9430' W

broke off line 53 a little early because of boring iceberg scoured bottom, and brought in gear at 0730 ADT

Core 19 40 ft piston core seismic time 0916[30], smooth stratified high
48° 09.4858' N 47° 57.4407' W
Some liner damage.

Core 20 40 ft piston core seismic time 0805, smooth stratified valley floor
48° 11.8650' N 48° 07.6993' W
Core stopped by a pebble gravel layer. Damage to cutter and liner.

Core 21 30 ft piston core seismic time 0927, shallow debris flow. Intersected again at 1857, just below 35 ms headscarp.
48° 09.1191' N 47° 55.8691' W
Recovered mud clast conglomerate, with overlying fine sorted gravel, and then 1 m greenish mud. Some liner damage.

When core 21 completed, steamed to 1 mile S of SOL 54 and deployed Huntec, GI gun, and Teledyne eel. Run the following seismic lines at 4.5 to 5 knots.

SOL 54	48° 07.3890' N	-47° 56.8488' W
Tp-a-54	48° 14.1330' N	-47° 52.9662' W

Friday June 27th JD 178
light winds, fog, lifting in the afternoon

SOL 55	48° 27.6162' N	-47° 41.4210' W
EOL 55	48° 55.2828' N	-47° 55.9668' W
SOL 56	48° 55.2354' N	-47° 54.2580' W
SOL 57	48° 38.9214' N	-47° 26.5824' W
SOL 58	48° 44.376' N	-47° 21.198' W
EOL 58	48° 54.030' N	-47° 31.158' W

Bring gear in at 0620 ADT just after SOL 58.

Price compressor leaking antifreeze all night. Trigger jitter on Huntec all night.

Piston core 22 40 ft seismic time 0642[30] Inner levee of turbidite channel
48° 43.5181' N 47° 34.3515' W
Coarse sand bed over stiff mud, probably a debris flow deposit.

Core 23 30 ft seismic time 0629 Turbidite channel floor, just above talweg
48° 44.4820' N 47° 36.0018' W
Rather tan coloured sediment (?Holocene, ?Heinrich) over stiff mud, some sand.

Core 24 50 ft seismic time 0651 On levee crest
48° 42.9207' N 47° 33.3283' W
11.4 m of muds with some silts, no overconsolidated material recognised, presumably a long turbidite section. Suggests that the "inner levees" are built of debris flow deposits and that otherwise the channel is erosional.

when core 24 secured, steam to 1.5 miles from SOL 59 and deploy Huntec, GI gun and Teledyne eel.

Run the following line at 5 kts through the water

SOL 59	48° 43.7976' N	47° 21.9282' W
EOL 59	50° 03.3978' N	46° 31.6524' W

Price compressor overheated when first turned on, for no apparent reason. Huntec trigger jitter still a problem. Ran Huntec without heave compensation and digitised the 12 kHz for seafloor control.

Saturday June 28th JD 179

foggy, 25 knot winds in morning
brought in seismic gear at 0700 ADT

Core 25 50 ft seismic time 0949[30] Terrace on flank of Orphan Knoll, 37 m above turbidite plain
50 00.4514' N 46° 33.5427' W 2963 m
Recovered 10.89 m plus a full TWC

Core 26 ?50 ft seismic time 1001 Terrace on flank of Orphan Knoll, 168 m above turbidite plain
50° 01.3867' N 46° 32.9598' W
Recovered 11.38 m plus a full trigger weight core.

Core attempted 40 ft seismic time 0856
49° 55.8570' N 46° 36.5230' W
Trigger arm slipped prior to removing safety pin; caused Grove crane to slew and tore out worm

gear. Coring abandoned. Engineers worked until 2 pm ADT Sunday to repair Grove.

At 1700 ADT, deployed GI gun, Teledyne eel and Huntec sparker. Sparker still causing problems, run without pressure compensation.

SOL 60	49° 58.5570' N	46° 37.3578' W

Sunday June 29th JD 180
Fog, clearing in afternoon, light winds

SOL 61	49° 43.0950' N	45° 49.9542' W
SOL 62	49° 48.9582' N	45° 03.8598' W

A. Boyce fiddled with digitiser settings: not corrected until gear brought in for coring.

EOL 62	49° 37.9260' N	45° 02.2788' W

at EOL 62, turn and run line 63
EOL 63 49° 36.138' N 45° 29.994' W
then turn and steer course of 020° for Line 64
then run line 65 parallel to 62, but 3 nm to east

At 1400, Grove crane repaired. Steam to core site 27

Core 27 40 ft piston core Terrace above Orphan fan. Seismic time 0947
49° 45.5898' N 45° 03.3593' W
Long core, some sand noted near top

When core 27 completed, run to 1.5 miles before SOL 66 and deploy Huntec, GI gun and Teledyne streamer. Run lines at 4.8 to 5.2 knots through the water.

SOL 66	49° 41.0262' N	45° 04.2354' W
SOL 67	50° 06.4704' N	44° 06.3894' W

Monday June 30th JD 181
foggy, light winds

SOL 68	50° 12.8862' N	44° 12.8196' W
EOL 68	49° 59.8200' N	44° 42.7692' W

Broke off line 68 at 0600 ADT and steamed back to core site 28

Core 28 50 ft piston core Flat lower fan Seismic time 0800
50° 06.0196' N 44 28.3936' W
13-m long section in turbidite silts and mud.

When core 28 completed, steam at 10 knots towards point F
F 49° 59.658' N 47° 07.104' W
near F, turned onto course of 140°
Picked core site 29 along line from sounder record, intended to be on sandy mid-fan.

Core 29 40 ft piston core Irregular "mid-fan" Seismic time 1544
49° 54.4504' N 44° 52.7336' W
10-m core of turbidite sands and muds over thick muddy debris-flow deposit. Cutter damaged by cobble.

when core 29 completed, steam south for 5 miles, then to SOL 69
SOL 69 49° 48.94' N 45° 22.872' W
Deployed Huntec, GI gun and Teledyne eel at 1745 ADT

SOL 69 49° 48.8868' N 45° 22.8066' W

Tuesday July 1st JD 182
cold, foggy, light winds

SOL 70	48° 52.0224' N	46° 24.1350' W
EOL 70	48° 26.4912' N	46° 09.2202' W

EOL 70 ties into 2001-043 survey of Flemish Pass and Sackville Spur.

Recovered gear at noon. Then steamed to outer shelf sidescan survey.

Deployed sidescan and Huntec boomer at 2000 ADT and ran lines 71-77 at 500 m spacing, with sidescan on 300 m range.
SOL 71 47° 23.6982' N 47° 42.9237' W

Wednesday July 2nd JD 183
foggy, light winds

bring gear in at noon.
EOL77 47° 18.5997' N 47° 59.1120' W

Deploy Huntec and sidescan 1.5 mile before SOL 78 at 1600 ADT; then run following lines at 4.5 knots

SOL 78	46° 37.2714' N	48° 49.7316' W
EOL 78	46° 35.331' N	48° 51.4764' W
SOL 79	46° 35.2974' N	48° 50.6532' W
EOL 79	46° 35.877' N	48° 51.6132' W
SOL 80	46° 36.1512' N	48° 51.4002' W
EOL 80	46° 35.5746' N	48° 50.346' W
SOL 81	46° 36.021' N	48° 50.025' W
EOL 81	46° 35.5074' N	48° 52.0926' W

the line 82 parallel to line 78, 250 m to west

recover gear at 2000 ADT and steam to point H

H 45° 40.152' N 56° 27.222' W

Thursday July 3rd JD 184
foggy in morning, clear cold and sunny in afternoon
Steaming all day
Arrive at point H at 2040 ADT. Deploy Huntec, GI gun and Teledyne eel. Run the following lines at 4.5 - 5 knots.

SOL 83	45° 40.173' N	56° 27.2202' W
SOL 84	45° 32.64' N	56° 24.6126' W

Friday July 4th JD 185
cloudy, moderate SW winds

SOL 85	45° 12.2256' N	57° 12.3966' W
EOL 85	45° 42.96' N	57° 42.948' W

brought in gear at 0620 ADT shortly after SOL 85.

Core 30 50 ft piston core Seismic time 0909^{40}
45° 12.7939' N 57° 12.9653' W
Very stiff pullout, penetrated to till.

Then restart line 85, with Huntec, GI gun and Teledyne streamer and ran the following lines.

Tp-a-85	45° 42.9678' N	57° 42.9468' W
SOL 86	46° 9.2898' N	57° 58.3422' W
SOL 87	46° 6.7008' N	57° 40.3074' W

Saturday July 5th JD 186
foggy, light SW winds

SOL 88	45° 55.6962' N	58° 04.893' W
SOL 89	46° 12.2304' N	58° 24.2160' W
EOL 89	45° 53.2908' N	58° 57.2364' W

break line 89 and longitude 58° 48' W and bring in gear at 1025 ADT
Then steam to BIO.

SUMMARY OF SEISMIC AND SIDESCAN LINES

Lines 1-5. Slope off eastern Banquereau. Poor 40 cu in sleeve gun data, very discontinuous Huntec data. Shows transition from hard bottom (?till) to stratified bottom passing downslope. Lines 2 and 5 both have good shelf to slope transits.

167/2325 has clear sandy bedforms at 140 mbsl.

168/0000 is top of scarp at 250 mbsl in a hard amorphous unit that appears to have failed along a softer horizon; the analogous scarp (40 m high) occurs at 168/0300. The softer horizon near 168/0230 is deeply iceberg scoured at about 600 mbsl. Should attempt an IKU or piston core on the 0005 scarp sometime.

Lines 6-9. Slope and outer shelf off eastern Banquereau. Poor Huntec data on lines 6 and 7, patchy airgun data, showing shelf to slope transition. Line 8 is strike line on outer shelf. Line 9 shows excellent shelf to slope transition in both Huntec and airgun. On lines 6 and 7, the transition from incoherent to stratified occurs at about 1500 mbsl; on line 9 it is more complex and progradational, but also in deep water. In the Huntec data on line 9, multiple stacked tills extend to 675 mbsl, where there is a prominent scarp.

On line 8 on the shelf, gas at 0200 and sediment waves at 0245-0250 (105 mbsl)

On lines 6-7, excellent stratigraphy at 1900-1920, including a horizon resembling interpreted MIS 12 horizon east of Dawson Canyon.

At top of line 7 (0000) apparent till appears prograded over more transparent shelf units at the shelf edge, whereas at the equivalent position in line 9, till appears to underlie these shelf units.

Lines 10, 11. Upper western Laurentian Fan. Line 10 is a strike line across upper western Laurentian fan, with deep channels and remnants between channels. Line 11 is a dip line up an irregular interchannel ridge, with excellent stratigraphy that might correlate with 1900-1920 on lines 6-7.

Lines 12-17 St Pierre slope. Line 12 provides upper slope strike line tying 1999 and 2001 surveys. Line 13 a long dip line down ridge west of St Pierre Valley: lose Huntec continuity in zone of ?salt diapirism, but at southern end shallow airgun record can be correlated across St Pierre Valley. Line 14 is an excellent strike line across St Pierre Slope at about 2200 mbsl. Lines 15-17 are in the southeastern part of St Pierre Slope and the edge of Grand Banks Valley, showing a lot of active salt tectonism.

Lines 18-26 Deep water off Haddock Channel. Lines 18-20 were run as part of the OBS experiment and cover the area surveyed in detail in 2002. Line 18 replicates a TGS Nopec line and Line 20 replicates a 2002 sleeve gun line.

Lines 27-41 Grand Banks east of St John's. This sidescan, Huntec boomer and 10 cu in airgun survey mapped shallow bedrock and a thin veneer of overlying sediment in the area of the Grand Banks east of St Johns. In general, bedrock appeared to be very close to the seafloor, with only localized patches of thicker sediment, particularly in the east.

Lines 42-47 Northern Grand Banks 3.5 kHz only. Profiles used for locating core sites. Note that the 12 kHz also gave useful information on surface reflectivity.

Lines 48-51 Margin of Orphan Basin at 49° N. Line 48, 50 are dip lines across the shelf break. Suggest that till is present to several hundred metres water depth, overlain in line 50 by iceberg turbated muddy sediment. Long strike line 49 shows complex history of failure and unconformities, similar to that elsewhere on the Grand Banks margin.

At 0025, a peculiar flat area on the upper slope.

Lines 52-53 Western margin of Orphan Basin at 49° N. Line 52 was a long strike line at about 1000 mbsl. At east end of line, a major unconformity, overlain by Quaternary sediment. At west end of line, Quaternary overlies sediment waves with rare channels. Line 53 a short dip line, very steep. Not much useful information.

Lines 54-58 Southern Orphan Basin.

Line 59 Strike line across lower Orphan Basin. Passes through MD95-2026 and up onto the flank of Orphan Knoll. Crosses several incised channels.

Lines 60-65 Orphan Basin outlet. Lines 60-61 are E-W lines through the outlet. Mostly well stratified, but at eastern end of line 61 passes abruptly into a facies similar to the lower fan of Laurentian fan (hummocky, channelled, reflective). Lines 62 - 65 are principally N-S lines passing from this sandy fan facies southward onto the northern margin of Flemish Cap.

Lines 66-68 Orphan Fan. Line 66 went from margin of Flemish Cap with contourite drifts and very complex sub-surface geology across low levee with sediment waves. Line 67 and the beginning of 68 were on basin plain, but the southwestern part of 68 went back into low levee facies.

Lines 69-70 Southeastern Orphan Basin. Lines 69 and 70 were oblique lines from southern Orphan Knoll across eastern Orphan Basin and up the continental slope at the eastern end of Sackville Spur. They provide a tie to 2001-043 lines in Flemish Pass.

Lines 71-77 Outer Grand Bank. 300-m range sidescan and Huntec boomer lines in a 7-track mosaic of iceberg pits and rare small scours on very hard bottom, presumably till.

Lines 78-82 Rankin well site. 300-m range sidescan and Huntec boomer lines over a March 2002 iceberg grounding, showing a very shallow scour, then a W-shaped scour, terminating in a pit.

Lines 83-89 Laurentian Channel.. Complex relationship between tills and stratified sediment in Huntec in southern part of Channel, including clear lift-off moraines, and possibly till over stratified sediment. This till then pinches out northward (185/2010), where it is replaced by an unconformity in the Emerald Silt, and then re-appears. Iceberg scour at various levels. Basement shows much faulting in places, and a few possible near-surface offsets are seen over basement faults (185/1810, 1838, 1847 and 1140/186). Amazing Huntec images of bedrock at 185/2300-2355.

SUMMARY OF STATIONS

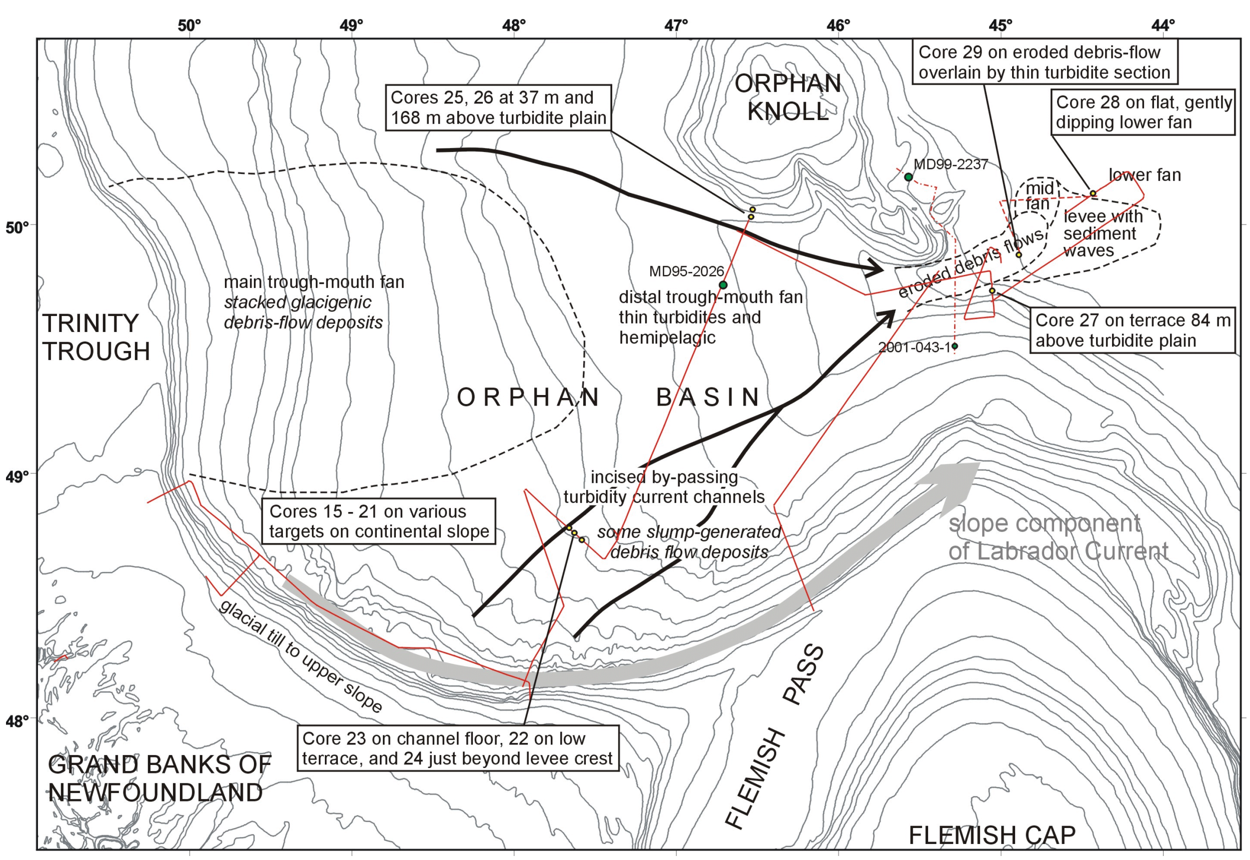
No	*mbsl*	*length*	*twc length*	
Eastern Banquereau and western Laurentian Slope				
1	509	721	68	Thick red mud, *probably eroded ridge crest*.
2	466	221	14	Stiff grey mud, probably older than youngest till; sandy eroded surface in TWC.
3	1481	1052	112	Green mud over red mud, *apparent late Quaternary complete sequence*
4	1645	823	56	Red mud. *Stratified sediment on ridge crest, probably top missing*
Slope off Haddock Channel				
5	660	369	0	Gravelly sand over stiff mud. *Core from stratified material at limit of seismically incoherent material.*
6	490	111	0	Gravelly sand. *Small terrace in seismically incoherent material*, cutter damaged by cobble suggesting till was not sampled.
7	1360	1169	105	Green mud over grey mud. *Thick transparent section over well stratified mud, probably thick Holocene.*
8	314	132	0	*Iceberg scoured outer shelf*
9		IKU		Stiff grey and purple clay, overlain by bioturbated greenish sand, and common pebbles and cobbles. *Cliff at which till appears to outcrop in seismic.*
Basins on northern Grand Bank				
10	241	1113	0	Long section in blackish mud
11	241	509		Stacor at same site as PC-10
12	274	413		Stacor, good recovery greenish to black mud
13	267			Stacor, no recovery, inferred sandy eroded seabed..
14	236			Stacor, no recovery, inferred sandy eroded seabed.
Orphan Basin				
15	818	841	140	Thick brown mud overlain by slightly greener mud. *Stratified ridge.*
16	693	797	0	Mud. *Near surface unconformity over stratified*
17	750	376	120	Core hit cobble; all sediment remoulded and disturbed. *Stratified ridge.*
18	768	406	0	Stiff brown mud. *Downslope part of "debris flow"*
19	1244	795	141	Mud. *Stratified ridge.*
20	1470	311	126	Mud over well sorted pebble gravel. *Small gully floor*.
21	1190	575	110	1 m greenish mud, over sorted fine gravel, over polymictic mud clast conglomerate. *"Debris flow" just below failure scarp.*
22	2359	831	1	Coarse sand bed over stiff mud (debris flow deposit?). *High terrace inside turbidite channel.*
23	2391	695	28	Tan ?Holocene sediment over stiff mud with some sand. *Turbidite channel floor, above talweg.*

24	2300	1167	123	Muds and silt. *Outside of levee crest*.
25	2959	1089	153	Thick muddy section. *Terrace on flank of Orphan Knoll 37 m above turbidite plain.*
26	2800	1138	133	Thick muddy section. *Terrace on flank of Orphan Knoll 168 m above turbidite plain.*
27	3698	1106	162	Thick muddy section. some sand at top. *Terrace on flank of Flemish Cap 84 m above turbidite plain.*
28	4023	1315	15	Long section in grey muds and silts. *Turbidite lower fan.*
29	3900	1003	150	Mud with fine sand, over thick stiff mud, presumably debris flow. *Channeled debris flow surface on mid-fan.*

Laurentian Channel

30	443	708	152	Green mud over red mud over compact red till. (Extra till sample from outside of cutter in bag). *Area of shallow till and little iceberg scour.*

Map of location of deep-water cores in Orphan basin in relationship to the turbidite system



EQUIPMENT

Navigation and data processing

P. Girouard

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.

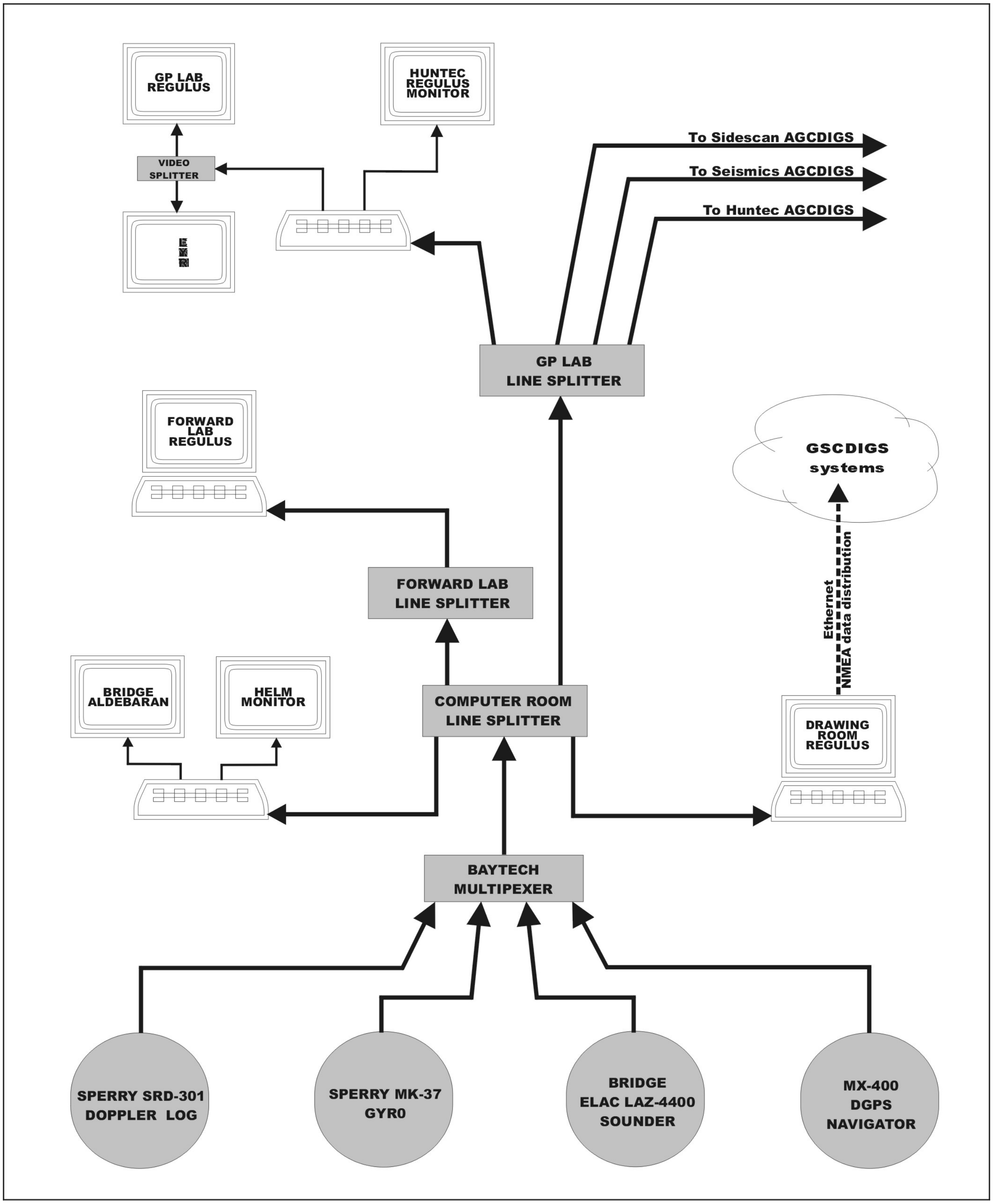
The scientific navigation was viewed and logged on four Regulus systems running the latest versions of the program, Build 24659 and, after June 21, Build 24784. These systems were set up in the Drawing Office, Computer Room, GP Lab and Forward. The GP Lab Regulus system was used as the primary data logger. 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. All NMEA sentences received by the Regulus systems were re-broadcast over the ship's ethernet network by the Drawing Office Regulus system to the new GSCDigs data loggers.

A second monitor was attached to the dual port graphics adapter on The GP Lab Regulus system. This allowed for the concurrent display and editing of the electronic scientific log on the Regulus system without interfering with the display of the navigation data. A video splitter was used to duplicate the navigation data on a third display for the benefit of the Huntec operator.

Two major problems were encountered with the Regulus operation. One was the result of duplicate NMEA data strings being distributed on the ship's RS-232 data network. Under normal circumstances, the $VWVHW and $HEHDT strings would respectively provide the ship's speed through the water and heading. In addition to those two strings, the $IIVHW and $HCHDT strings are also distributed containing null values for the speed through the water and heading respectively. Regulus interpreted these null values as "0" and, therefore, the speed through the water and heading were being displayed as "0"for most of the time. A Regulus software update was received during the stopover in St. John's which corrected this problem by ignoring null values.

A second problem caused the displayed value of the speed over ground to be replaced by the value of the speed through the water whenever the "VHW" string was selected for display and logging. This, in combination with the above problem, made it impossible to select the "VHW" string for display and logging as it corrupted both the speed over ground and speed through the water. It was originally thought that both problems were directly related but the update received in St. John's did not rectify this problem. It was possible to display both the the speed over ground and speed through the water following the application of the update as the correct speed over ground did flash on the screen every 5 seconds. This problem has been reported to Ican and should be corrected in the next software update. The speed through the water that is returned from the ship's log seems to be 1 to 1.5 knots lower than it should read. This assessment is solely based on visual observation but, if correct, has implications on the strain on the equipment being towed through the water.

A third, recurring, problem was that a false position of approximately 22°N is often returned when a position based on time is retrieved from the Regulus voyage file. This problem has been reported on several occasions but has yet to be resolved. The problem is inconsistent, which may explain the difficulty in identifying and correcting it. It has once more been reported to Ican.



Hudson 2003-033
Navigation Setup and Data Distribution

Acoustic Systems

W. A. Boyce, K. Asprey, D.C. Campbell, D.C. Mosher and B. Chapman

Besides standard high resolution seismic survey tools, CCGS Hudson cruise 2003-033 included a testing phase for seismic equipment newly acquired and as yet not field tested. This equipment included a refitted Teledyne 200 hydrophone streamer, a streamer DigiBird, a SSI GI gun, a Krohn-Hite filter bank, and a newly developed GSC-DIGS digital acquisition system. Details of these pieces of equipment and their operational settings, as well as all other geophysical equipment used during the mission, are provided below.

The following seismic systems were used during this mission:

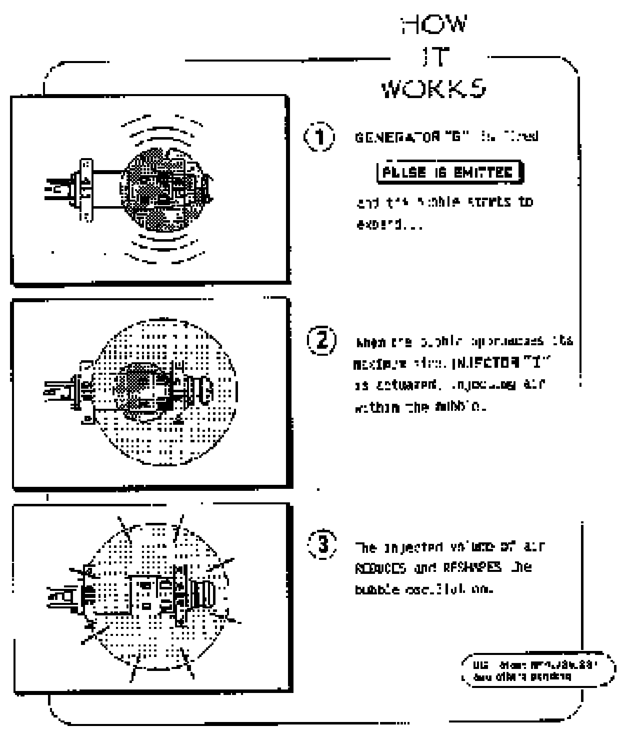
1. Single channel airgun systems consisting of a combination of airgun source and single channel hydrophone streamer.
2. Huntec Deep Tow Boomer /Sparker System (1000 J) using internal hydrophone and external deep-towed streamer.
3. An ORE 3.5Khz hull mounted sonar array profiler.
4. A Simrad 992 STABS deep tow Sidescan sonar.
5. Raytheon 12 kHz Echo Sounder.

1. Single Channel Airgun Systems

Seismic Sources:

The primary seismic source used was the new SSI Generator- Injector (GI) Airgun on a large Norweign buoy on all deep survey lines, fired at 6 second rate / 50 msec. injector delay at 1500 psi from a Price compressor / Detroit diesel combo. It takes 5.6 seconds to fill the GI gun properly so a 6 second shot rate was used. This remarkable gun features two chambers, which may be fired independently of one another. With an appropriate delay, a single GI Gun can produce a pulse to bubble ratio much higher than a single chamber gun, or even a six gun array. The gun can be configured for 90, 150, or 210 cubic inches.
(for more information see *Pascouet, A., 1991, Something new under the water: The bubbleless air gun: The Leading Edge, 10, no. 11, 79-81)*

Explanation of how GI Gun operates.



During side scan survey lines, an HGS 10 cu.in. sleeve gun on a Norweign buoy was the sound source, running at 3 to 4 second firing rate at 1800 psi. pressure from a Rix K88 air compressor.

On June 16th, the first evening of operations, the weather made deployment somewhat difficult and it was felt wise to forego implementation of the new equipment. A single HGS 40 cu. In. sleeve gun was deployed in combination with the 100 ft. plus 25 ft. Benthos streamer.

Hydrophone Streamers:

The Teledyne model 28420 streamer was acquired recently on permanent loan from Dalhouse University. It was a warehoused streamer that was in poor state of repair and inoperable. It was shipped to Swain Geophysical in Houston Texas to be refurbished. Repairs include replacement of the jacket, oil, wires and hydrophone elements…in essence a new streamer with the original Dalhousie design. Hydrophone cartridges are Teledyne B-1 acceleration canceling cartridges. The active section is 148.33 ft long, consisting of 2 interlaced sets of 3 groups, comprising a total of 6 groups. There are 16 individual hydrophones within a group, each element separated by 3.14 ft. The companion interlaced group is equivalent in dimensions and is separated from the first group by 0.75 ft. For all operations the streamer was operated by summing all active groups into a single channel. There is a 27 ft lead in dead section and a 16 ft dead section at the tail.

This hydrophone streamer was outfitted with a DigiCourse DigiBird Model 9000-5010, mounted at the lead dead section, and a lead weight at the tail end. The "bird" allows for actively setting and maintaining hydrophone streamer tow depth. It can be controlled and monitored from the shipboard lab with the DigiScan system and it is self correcting (dynamic) to maintain depth of flight. In order to remain compatible with the tow depth of the sound source array, the bird was set to fly at 9 ft (3 m). The streamer was towed between 50 and 150 m astern of the fantail.

As mentioned, during the first evening, 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 was used. 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.

Acquisition and Processing Details:

Filters- Settings: BP 30-900 Hz for digitizing, BP 85-500 Hz to EPC

Digital Acquisition-

Parameters:
GSCDIGGS (GDAIMS v. 1.25)
GI Gun / Sleeve Gun
sample rate 200-250 microsec (0.2 ms), number of samples ~8000
Deep water delays managed on the fly through software window and recorded in the segy header.
Data written to harddrive and backed up on DVD-R media.

AGCDIGGS (v. 2.33)

GI Gun / Sleeve Gun
Sample rate 500 microsec (0.5 ms), number of samples 4096
Deep water delays managed on thr fly through the MITS system and not recorded.
Data written to Exabyte tape.

Analogue Acquisition- EPC9800 thermal hardcopy, Sony 4.7Gb DAT Cassette 4 mm tape

Shipboard Processing- All GIGun and 40 cu. in. airgun data collected were put through the following processing steps:

1. Shotpoint values were added to the segy files.
2. Segy files covering individual lines were concatenated.
3. Static shifts (deep water delays) were applied and the data window increased to accommodate the expanded record length.
4. To reduce file size, the data window was then minimized to remove water column (padded to minimum delay).
5. Segy files were created for each line, named by line number and streamer (i.e., line17_teledyne.sgy).
6. Ascii navigation files were generated of Shotpoint Latitude Longitude for easy loading into interpretation software.
7. The sgy files and navigation were burned to DVD-R.

An atlas of 8.5" x 11" plots of each GIGun and 40 cu.in. airgun line was prepared in Adobe pdf format and saved on the cruise CD.

2. Huntec Deep Towed System
(see also GeoForce Client Report)

The Huntec Deep Tow Seismics System [DTS] with the 1000 joule sparker sound source, or boomer source in shallow water, was deployed during all surveys to produce ultra-high resolution seismic reflection profiles. The fish was deployed to tow depths of up to 100 m and data were received on the internal LC10 hydrophone [heave compensated], and external GF24/24 element linear towed streamer. Information on the performance of this system can be found in the Geoforce Consultants contractor's Mission Report. The internal hydrophone and external streamer data were stored to exabyte tape at 64 microseconds sampling, gain of 8, delay triggered with AGC Digitizer channel #1 = internal hydrophone data, and channel #2 = externally towed 25 foot Geoforce linear 10 element streamer data. The data were also were acquired digitally using the GSCDIGGS system (same channel allocation), sampled at 50 microsec. (0.05 ms), and 8192 samples. The 25 foot towed streamer data was recorded on an EPC9802 channel graphic recorder at a 1/4 second scan. On shallow survey lines, the EPC9802 hardcopy was switched to 1/8 second scan , two channel to display the internal hydrophone and external streamer data.

3. ORE 3.5 kHz Hull Profiler

The 3.5kHz ORE transceivers this year were tuned up to 4 kHz since it was noticed that the centre frequency of most of the hull array transducers on the CCGS Hudson was 4 kHz not 3.5 kHz. This seemed to provide slightly better results and much sharper null tuning of the transceiver's receiver circuit than 3.5 kHz. resulting in less noise at higher gain settings.
The 4 kHz , 16 tranducer Hull array profiler was recorded to an EPC9800 during sampling. The profiler was set to 0.2 and 0.5 millisecond pulse length and 2.0 kHz bandwidth settings, with 1/4 sec. scan rates delayed by the MITS trigger unit. Due to interference with the Huntec data, the 4 kHz profiler was not operated during tow gear survey lines with Huntec deployed.

4. Sidescan Sonar

The Simrad Model 992 dual frequency Side Scan Sonar was deployed while rigged to an Open Seas "STABS" (**S**ubmercible **T**owed **A**pparatus **B**uoyancy **S**ystem) and depressed by a 120 kg. depressor, all attached to an 800 meter coaxial towcable on a remotely controlled Markey winch. Sonograms of 600m. range (1200 m. swath) were generated off St.John's,Nfld., with 120 kHz data recorded to exabyte and DAT tapes, and Alden9315 CTP printer with 1:1 speed correction and ship position on the hardcopy. A 3 minute layback of towed vehicle from ship position was common at 5-6 knot survey speeds.

On the eastern Grand Banks, 300 m. range (600 m. swath) was used with 120 kHz data recorded to exabyte, DVD-R and DAT tapes. Hardcopy was generated on an Alden9315 hardcopy printer. 330 kHz data were also recorded to tape/disc but this data has a 200m. range limit.

Simrad Sidescan data were stored to exabyte tape at 100 microseconds (300 m. range) and 300 microseconds (600m. range) sampling rates, with a gain of 1, and Channel setup for AGC-Digitizer and GSC-Digitizer is as follows:

Channel 1 = 120kHz left side data;	Mean TVG: 120kHz; A=30, B=50, C=10-12,
Channel 2 = 120kHz right side data;	L=125;
Channel 3 = 330kHz left side data;	Mean TVG: 330kHz; A=32, B=60, C=22-24,
Channel 4 = 330kHz right side data .	L=125;

The TVG values had to be changed during the 2002 Iceberg grounding site survey on the middle Grand Banks as the towfish had to be towed below a 30-40 m. thermocline.
New Values are: TVG: 120kHz; A=30, B=32, C=12; 330kHz; A=34, B=50, C=10.

All data were simultaneously recorded to the three GSC-Digitizers and backed up to DVD's with great success.

5. 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.

During a two evening period when motion compensation was not avaialble for the Huntec DTS system, the signal from the 12kHz echo sounder was digitized using the GSCDIGGS system with the hope of reconstructing the seafloor for the Huntec Data.

Timing

The lab triggers for the 3.5 kHz hull profiler, Huntec DTS, seismics guns and recorders were handled by the GSCA-MITS trigger unit. This kept systems from interfering with each other and allowed depth delaying to one millisecond accuracy. This unit also fired the GI Gun Injector chamber 50 milliseconds after the Generator chamber. The newly purchased "Long Shot" adaptive trigger unit's computer was non-functional from the factory and not used.

Performance

All systems worked well and any failures were backed up by redundant units. The new Krohn-Hite quad Bandpass filters was used with good results and ease of programming. However the input 20 db. gain module before filtering seem to add some ringing to the data, so this was set to "0"db. gain.

The Sony PC208A DAT tape recorder had problems with tape head noise and signs of wear, and may need to be sent back to the factory for new tape heads. A Cleaner tape had to be used after every two tapes, which shows that the heads are worn past manufacturers recommendations.
The Huntec DTS in the sparker mode is susceptible to high voltage electrical pickup especially with the streamer so close to the 6000 volt sparking electrodes in the water. This may have caused preamp noise problems and pressure sensor problems which are explained in the Geoforce Mission Report.

Half a line was missed on the Ragnar Mosaic as the Sidescan umbilical cable, just recently made up, had a bad internal connection that was unexpected. New Rochester Kevlar cable needs to be purchased as recycling old Klein tow cables to save money has its reliability drawbacks.
The drifting, internal Simrad clock marking the Alden9315 hardcopy was kept accurate by the watchkeepers.

It was determined on the Sidescan Ragnar mosaic lines that the ship's log speed through water on the Regulus screen was one knot short. So the entire survey, rather than the 4.8 to 5.1 water speed specified, was really being run at 5.8 to 6.2 knots water speed, with 7.5 knot turns, which may have contributed partially to the problems with the Huntec DTS. It was noticed during a flat sea condition that the Teledyne 200 meter streamer's tail rope was towing on the surface. The faster than known survey speed contributed here also. The FRC boat was even sent back to investigate; in the water for other reasons. A 2 kg lead weight was added to the end of the dead section of the streamer on the tail rope which seemed to make the streamer behave much better according to the DigiBird screen, with a more constant depth keeping.

The new GSC-Digitizers work well for proto-types. Certain presets have to be determined for various uses as some settings of sample rate and samples were not accepted by the software. To get a two second window for seismics, oversampling had to be performed at twice the necessary rate. The ZDA string readout needs to be moved to the Delay screen which is the running screen so watchkeepers can be sure the Navigation data is arriving. The delicate A/D board plug and input wiring at the back of each unit are susceptible to severe damage, as there was not time to make it more robust. A box needs to be added to the back of the computer chassis to contain and protect all this with BNC connectors for hook-up. The flat screen displays were greatly welcomed, taking up much less space. VGA Display cards with flat screen power connectors built in need to be purchased to save on power wiring which is becoming a problem.

To generate five minute marks for the GSCA TSS 312B Annotators, the ships clock used for the sounder UGR recorders throughout the vessel was used. This was a problem as this is a very old clock with questionable reliability, although its clock does not drift. Putting it on the GP Lab

UPS power system helped but a GSCA owned 10 minute pulse generator running off the ZDA nav string needs to be made up. Also, as mentioned many times in previous years, the obsolete, aging TSS312B Annotators need replacing as they are absolutely needed if hardcopy recording continues and reliable time marking is required. Out of four units, only two survive from cannibalized parts. An attempt was made years ago to replace these with a PC but failed. Single channel Annotators exist off the shelf, but four channel units modified for GSCA survey methods are required. Adding three or four laptop PC's to the three or four EPC9800 recorders, most wanted by scientists, is cumbersome and the internal DOS clocks are not accurate.

Mechanical equipment

The seismic program this year used the GSC-A Rix Compressor, model K88, with Haliburton Geophysical Services 10 cubic inch or 40 cubic inch sleeve gun as the sound source, or the Price Gun Master W1 powered by a 671 Detroit Diesel combination with the Harmonic Model 210A Dual chamber GI Air Gun sound source.

The Price compressor worked well. No compressor down time was experienced and had no problem maintaining 1700-1800 psi while firing the GI gun at a rate of 5 or 6 seconds.

Two GSC(A) air compressors were installed on the vessel prior to departure from BIO base. The smaller of the two compressors, a Rix Model K88, was used to supply high pressure air at 1850 PSI to either the 40 cubic inch or the 10 cubic inch sleeve guns. The Rix compressor is an electrically driven compressor capable of producing approximately 80- 85 SCFI of compressed air, at pressures up to 2500 PSI. The compressor is housed in a 10 by 8 foot modified shipping container. The compressor is powered by an eighty horsepower electric motor. Power for the motor is provided from the ship's main generators. Cooling water for the compressor intercoolers comes from a pump in the engine room of the vessel. During normal seismic operations, the compressor is left unattended and checked every 15 to 20 minutes by the seismic watch keepers. Because of its low air volume capacity, using this compressor restricts the "fire rate" of the 40 cubic inch sleeve gun to 4 -5 second shot intervals.

The second compressor is a Price Air compressor model W1. This compressor delivers air at 185 SCFM @ 2500 PSI. The air compressor is driven by a Detroit model 671 diesel engine. The unit is a stand alone system having its own fuel tank, burning the diesel fuel supplied by the vessel. Like the Rix, it uses the cooling water from the vessel's secondary salt water pump in the engine room. The compressor was used for 190 hours during the cruise to supply high pressure air to the GI gun. During this time, cooling water to the unit was lost on two occasions. It would appear that only minor damage occurred to the diesel engine, and this will be repaired prior to the unit being put back into service.

Price compressor with diesel drive on flight deck

Because of the complexity of the Price compressor, an operator must be constantly available to monitor the functions of both the diesel engine and the compressor. All machine statistics were recorded at 15 minute intervals and entered into a log by the watch keepers.

The new GI gun proved to be a considerable improvement from a mechanical point of view. It never failed and during daily inspection suffered little wear or damage throughout the trip. Deployment and recovery was very simple and in most cases was done by staff and only the "Sea Watch" which allow for ease during silent hours.

In general all equipment performed to expectations. We would like to thank the Chief, Senior and 1st Engineers for their mechanical support as well as supplying fuel. We would also like to thank the Bosun and Deck Crew for their professional services deploying and recovering the gear on a daily basis.

OBS wide-angle reflection experiment

D.C. Mosher

June 19th (Day 270)

Deployed at 10:57:26 at 44˚ 34.31'N and 54˚ 51.74' W
Settings: 300 Hz high cut, 532 µs sample rate.

2 airgun reflection lines – Line 18 and 19, shot across the streamer. Line 18 parallels TGS-NOPEC line 1330 and Line 19 parallels Huds2002-046 Line 106. The GI Gun provided the impulse sound source. It was operated in harmonic mode. For Line 18 it was fired every 5 seconds; for Line 19 it was fired at 10 sec intervals.

OBS ID	4 (GSC)
OBS software version	2.51
Sampling rate (Hz)	558
Water depth (fm)	1700??
Deployed (day / time)	170/10:57:26UTC
Deployment Position (Lat / Long)	44° 34.31'N / 54° 51.74' W
Recovered (day / time)	170/xxxx
Recovery Position (Lat / Long)	44˚ xx.xxx N / 54˚ xx.xxx W
Sleeve gun firing rate (ms)	5/10 sec
Clock set (day / time:sec)	170 / xxxx:xx
Time of pre-drop offset check (day / time:sec)	170/ xxxx:xx
Pre-drop CPU clock offset (1.8 ms offset from GPS time)	1.000934
Time of post drop offset check (day / time:sec)	236 / 1256:06
Post drop CPU clock offset (1.8 ms offset from GPS time)	1.001642
Number of Datafiles	xx

Coring

K.W.G. LeBlanc

Core equipment

The piston coring system used was the AGC Long Corer. This device obtains a core sample with an ID of 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 10ft. lengths, 4.25"ID, with 3/8" wall thickness, and exterior couplings secured by set screws. The liner used was a CAB plastic extruded into 10ft 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.

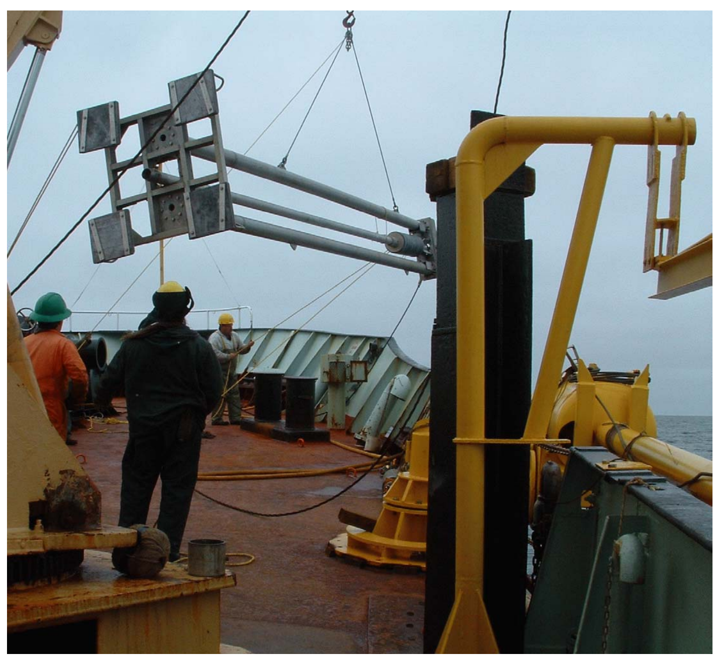
The AGC free fall gravity Stacor, with a stationary piston, consists of two 22ft aluminum support columns welded to a base plate covering an approximate area of 147cm x 150cm. A maximum penetration of 6.1m (20ft) of undisturbed sediment can be obtained upon impact utilizing a 1200 lb ballast. The core 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 20ft lengths. The AGC Stacor provides an undisturbed sediment core sample that can have up to 90% recovery using a stationary piston. The 2 cores obtained on this cruise will be used as reference cores for undisturbed sediment stratigraphy.

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

On-board sample processing and subsampling

A total of some 46 cores (2 Stacors, 19 TWC's and 25 PC's) or 217.03 m (188.71 m Piston cores; 19.10 m TWC cores and 9.22 m Stacor) of deep sea sediment were obtained from 30 sample stations. All cores were processed according to the standard GSC Atlantic core procedure manual (GSC Open File #1044).

All cores were identified alphabetically by section at the time of dismantling individual 10ft core barrels from the bottom to the top, commencing with the bottom-most core barrel and proceeding to the upper-most barrel containing sediment. Samples for physical properties (penetrometer and



The GSCA Stacor fixed-reference corer

constant volume), were taken from the top and bottom of each 1.5m section. For the constant volume determination, stainless steel cylinders of known volume were introduced at a constant rate and immediately removed in the GP lab onboard ship. At this time the sediment was extruded from the cylinder, placed within a 1 oz screw-top glass bottle and sealed to prevent further desiccation. The sample will be later weighed, dried at 105ºC 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 taped and sealed in wax to prevent further oxidation and drying, until splitting at the GSC Atlantic core repository within the coming months. A sub-sample for dinoflagellate analysis by GEOTOP, (UQAM) was taken from the top of each TWC.

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 #9), 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 handling 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 sample was sub-sampled as follows: a) 23 litres of surficial sediment was sieved for benthos and, b) several clean pieces of stiff mud were sub-sampled for geotechnical measurements.

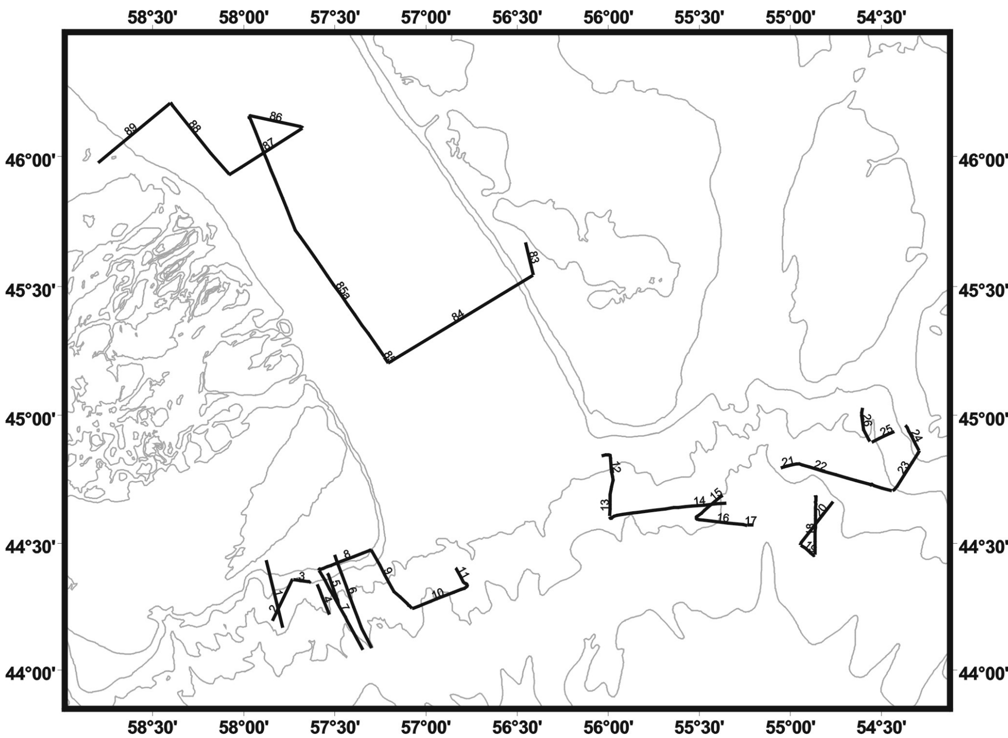
The ED at Sea database was used throughout this cruise in order to document and edit cruise expedition sample data. While the data has been documented on paper field sheets, corresponding data was also entered into the ED database onboard. Data has been backed up and will be verified before downloading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

Equipment problems

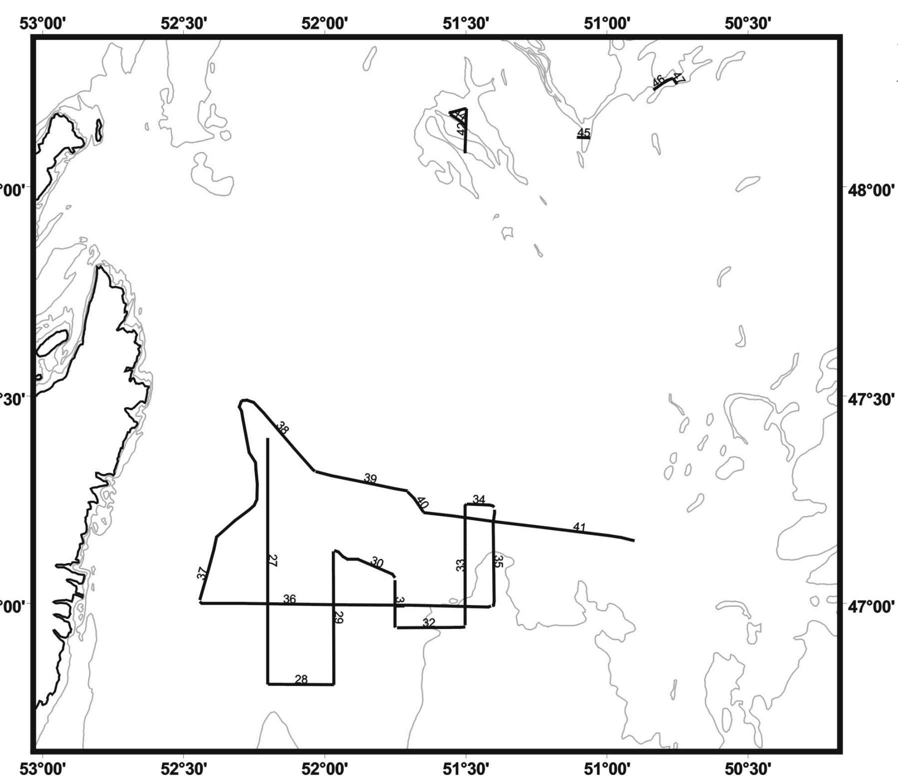
The following equipment problems are highlighted in approximate order of priority. All impact the effectiveness of doing deep-water work from Hudson.

1. The Pengo ¾" wire badly needs lubricating.
2. There is almost no paper left for the 12 kHz sounders. Putting them on another recorder is unsatisfactory unless it is a recorder on which the write sweep is visible, or unless a digital output is used with a waterfall display. (The sounder is used to select core stations and to make decisions on when to turn the ship on the basis of bathymetry).
3. There have been persistent trigger problems with the Huntec system.
4. Having to stand a continuous watch on the Price compressor is very unsatisfactory and very demanding of staff numbers.
5. The time annotator for the 3.5 kHz recorder is unreliable (see above).
6. Three problems with Regulus are identified in the Navigation report and have been reported to Ican.
7. The motor for the crane in the half-height needs repair.

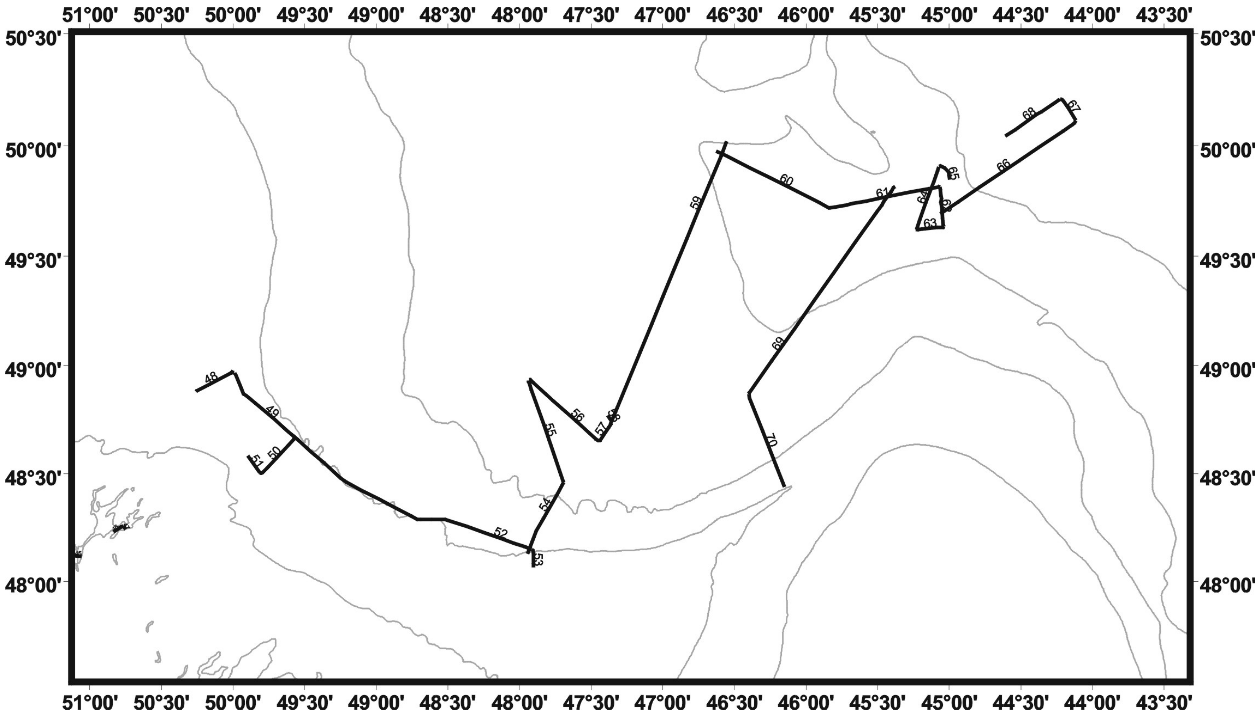
APPENDIX



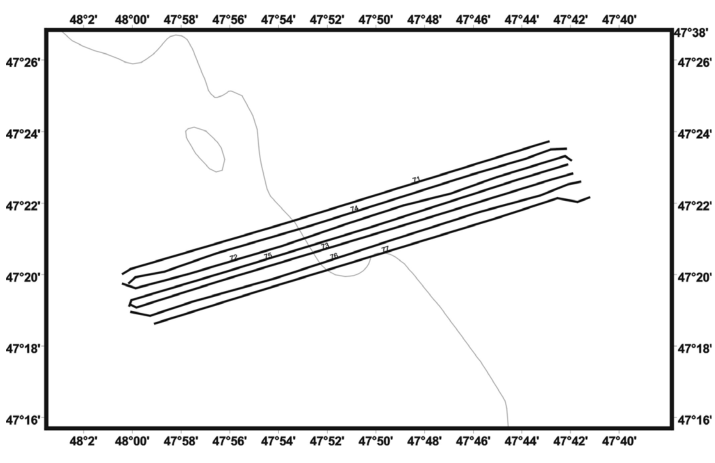
Seismic tracks, Laurentian Channel and adjacent continental slope

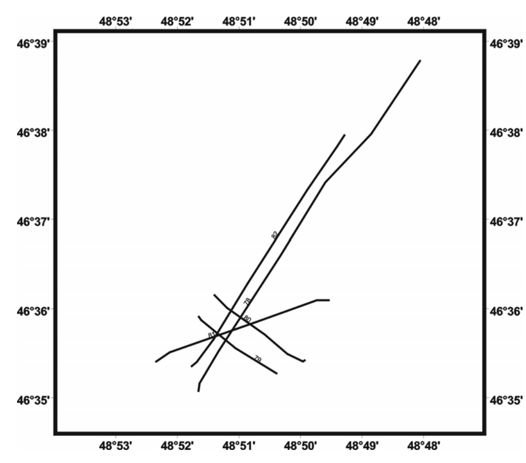


Seismic tracks, N E Grand Banks and Orphan Basin

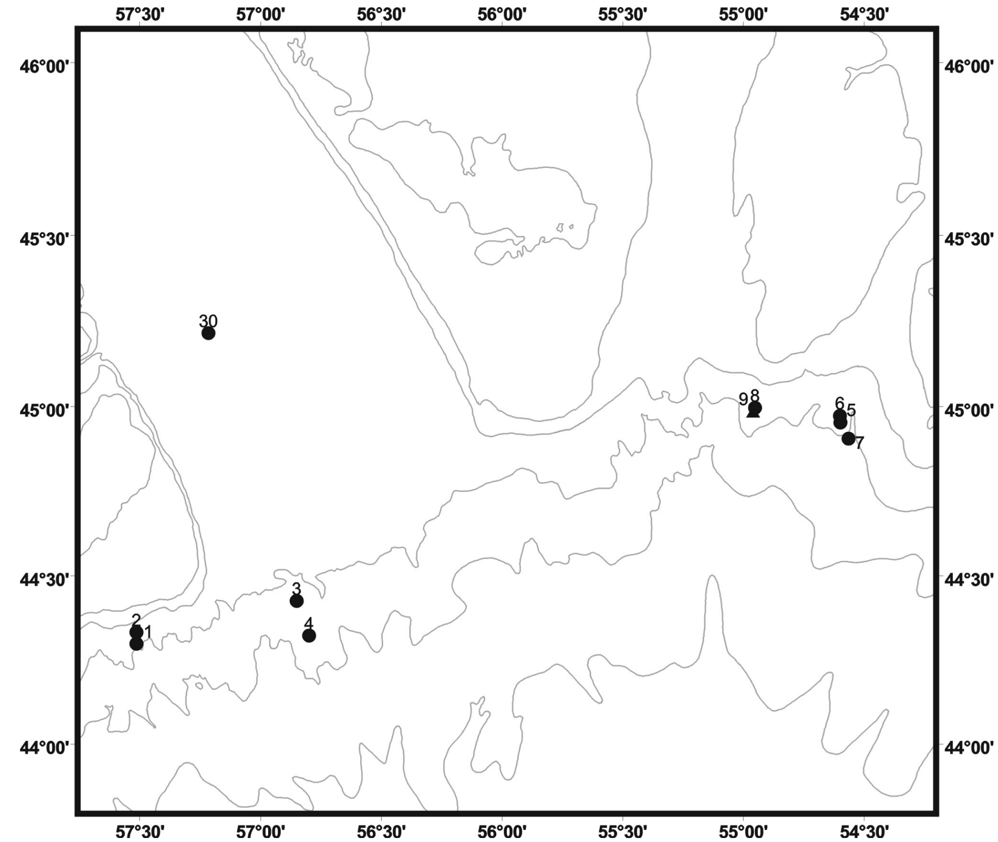


Seismic tracks in Orphan Basin





Detailed track plots of iceberg scour sidescan surveys



Maps showing location of cores

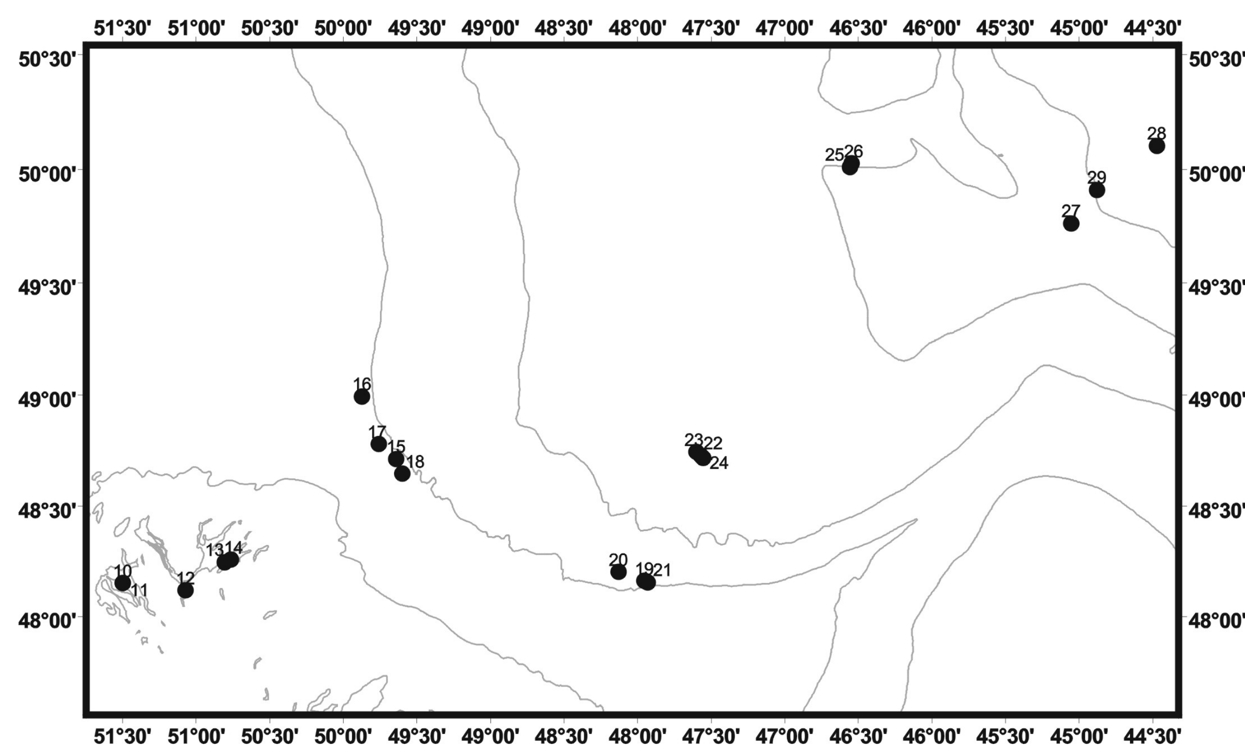


Table of Station information

STATION #	LATITUDE	LONGITUDE	WATER DEPTH (m)	PC LENGTH (cm)	TWC LENGTH (cm)	SEISMIC TIME	TYPE
001	44˚17.797667	057˚30.84250	509	709	52	2003-033, 1680736	AGC large
002	44˚19.82900	057˚30852333	466	212	0	2003-033, 1680757	AGC large
003	44˚25.431166	056˚51.00667	1481	1032	102	2003-033, 1690942	AGC large
004	44˚19.231500	056˚47.93667	1645	823	38	2003-033, 1690807	AGC large
005	44˚57.062000	054˚35.94983	660	369	0	2003-033, 1710828	AGC large
006	44˚58.262667	054˚36.12483	490	111	0	2003-033, 1710842	AGC large
007	44˚54.193667	054˚33.989667	1360	1169	105	2003-033, 1710751	AGC large
008	44˚59.617667	054˚57.150333	314	132	0	2002-046, 2470146	AGC large
010	44˚08.907333	051˚29.924167	241	1113	0	2003-033,1750805 & 89-006, 1260655	AGC large
011	48˚08.8813	051˚29.8837	241	508	n/a		Fixed reference
012	48˚06.9740	051˚04.3156	274	413	n/a	2003-033, 175143335	Fixed reference
013	48˚14.6142	050˚48.3062	267	0	n/a	2003-033, 1751639	Fixed reference
014	48˚15.3492	050˚45.8310	236	0	n/a		Fixed reference
015	48˚42.6090	049˚38.7464	818	841	130	2003-033, 1760500	AGC large
016	48˚50.4496	049˚52.4737	693	794	0	2003-033, 1760304	AGC large
017	48˚46.6041	049˚45.4859	750	347	105	2003-033, 1760401	AGC large
018	48˚38.6712	049˚35.9932	768	406	0	2003-033, 1760600	AGC large
019	48˚09.4817	047˚57.4331	1244	795	141	2003-033, 1770916	AGC large
020	48˚11.9227	048˚07.7856	1470	311	126	2003-033, 1770805	AGC large
021	48˚09.1325	047˚55.8517	1190	575	110	2003-033, 1770927	AGC large
022	48˚43.5190	047˚34.3211	2359	831	0	2003-033, 1780642	AGC large
023	48˚44.4808	047˚35.9725	2391	695	28	2003-033, 1780629	AGC large
024	48˚42.9221	047˚33.3312	2300	1167	123	2003-033, 1780651	AGC large
025	50˚00.4476	046˚33.5478	2959	1089	159	2003-033, 1780949	AGC large
026	50˚01.3672	046˚32.9140	2800	1131	152	2003-033, 1791001	AGC large
027	49˚45.5894	045˚03.3663	3698	1106	162	2003-033, 1800947	AGC large
028	50˚06.0172	044˚28.3816	4023	1315	15	2003-033, 1810800	AGC large
029	49˚54.4214	044˚52.7677	3900	994	150		AGC large
030	45˚12.7564	057˚12.9888	442.6	708	141	2003-033, 1850909	AGC large

25' BenthosRecords				78' Benthos Records			
Record #	Start Time	End Time	Line #	Record #	Start Time	End Time	Line #
1	168/0145 168/0520	168/0403 168/0918	2 to 5	1	168/0148 168/0520	168/0403 168/0918	2 to 5

Teledyne Records							
Record #	Start Time	End Time	Line #	Record #	Start Time	End Time	Line #
1	168/1713 168/2014 168/2048	168/1934 168/2035 168/0922	6 to 11	2	169/1834 169/2313	169/2120 170/0927	12 to 17
3	170/1218	170/1727	18 to 20	4	170/2145 171/0449 171/0635	171/0407 171/0530 171/0921	21 to 26
5	172/2226 173/2043	173/2019 175/0210	27 to 41	6	175/2325	176/0918	48 to 51
7	176/2109	177/1032	52, 53	8	177/1843	178/0929	54 to 58
9	178/2015	179/1003	59	10	179/2058 180/1517	180/1355 180/1645	60 to 65
11	180/2115	181/0902	66 to 68	12	181/2048	182/1452	69, 70
13	185/0009 185/1157	185/0924 186/1326	83 to 89				

Huntec Records							
Record #	Start Time	End Time	Line #	Record #	Start Time	End Time	Line #
1	167/2226 167/2304 167/2311 168/0519	167/2257 167/2307 168/0412 168/0920	1 to 5	2	168/1952	169/0922	7 to 11
3	169/1822 169/2313	169/2128 170/0928	12 to 17	4	170/2149 171/0452 171/0639	171/0403 171/0527 171/0921	21 to 26
5	172/2215	172/0917	27 & 28	6	173/0917	174/1500	29 to 38
7	174/1503	175/0206	38 to 41	8	175/2322	176/0915	48 to 51
9	176/2112 177/0948	177/0938 177/1030	52, 53	10	177/1841	178/0919	54 to 58
11	178/1925	179/1003	59	12	179/2103 180/0052	180/0026 180/0655	60, 61
13	180/2121	181/0901	66 to 68	14	181/2305	182/1449	69, 70
15	182/2252	183/1529	71 to 77	16	183/1958	183/2233	78 to 82
17	184/2358	185/0922	83 to 85	18	185/1157	186/0203	85a, 86
19	186/0205	186/1325	87 to 89				

3.5 KHZ Records

Record #	Start Time	End Time	Line #	Record #	Start Time	End Time	Line #
1	168/0928 168/0956 168/1337 169/0922	168/0949 168/1321 168/2241 169/0931	6, 7	2	169/0935	169/1502	n/a
3	170/1200 170/2001	170/1732 170/2145	18 to 21	4	171/1027	171/2047	n/a
5	175/0702	175/1925	42 to 47	6	176/0930	176/2046	n/a
7	177/1036	177/1822	n/a	8	178/0900	178/1334	n/a
9	178/1354 179/1147 180/0757 180/1000	178/1925 179/2055 180/0937 180/1710	61 to 65	10	180/1722 181/0054 181/0921	180/2122 181/0902 182/0047	66 to 69
11	185/0950	185/1128	n/a				

12 KHz Records

Record #	Start Time	End Time	Line #	Record #	Start Time	End Time	Line #
1	167/2212 168/0425	168/0404 169/0936	1 to 11	2	169/0940	170/0930	12 to 17
3	170/0939	170/1253	18	4	170/1325 170/1944	170/1733 171/0926	18 to 26
5	171/0929	171/2102	n/a	6	172/1939 175/0735	175/0240 175/0920	27 to 44
7	175/0923 175/1149 175/1236	175/1441 175/1218 175/1926	45 to 47	8	175/2244	176/0915	48 to 51
9	176/0918	177/1030	52, 53	10	177/1033 177/1250 177/1504	177/1230 177/1447 178/0930	54 to 58
11	178/0934	179/1003	59	12	179/1006 179/1241 179/1624	179/1127 179/1546 180/1705	60 to 65
13	180/1709 180/1855 181/1134 181/1712	180/1747 181/1012 181/1624 182/1506	66 to 70	14	182/2230	183/1531	71 to 77
15	183/1945	183/2242	78 to 82	16	184/2358	186/1325	83 to89

120KHz Simrad Records

Record #	Start Time	End Time	Line #	Record #	Start Time	End Time	Line #
1	172/2203	173/0743	27	2	173/0748	174/0126	28 to 35
3	174/0128	174/1705	36 to 38	4	174/1706	175/0210	39 to 41
5	182/2254	183/0539	71 yo 73	6	183/0540	183/1538	74 to 77
7	183/1956	183/2234	78 to 82				

Exabyte Tapes

Tape #	Start Time	End Time	Line #	Tape #	Start Time	End Time	Line #
Huntec				**Seismic**			
1	167/2239	168/0920	1 to 5	1	168/0111	168/0400	2, 3
2	168/1932	169/0923	7 to 11	2	168/0523	168/0920	4, 5
3	169/1821	170/0927	12 to17	3	168/2021	169/0923	7 to 11
4	170/2146	171/0920	21 to 26	4	170/1201	171/0907	18 to 26
5	172/2205	175/0206	27 to 41	5	172/2205	175/0206	27 to 41
6	175/2357	176/0915	48 to 51	6	175/2319	177/1032	48 to 53
7	176/2103	177/1029	52, 53	7	177/1841	178/0938	54 to 58
8	177/1840	178/0919	54 to 58	8	178/1930	179/1003	59
9	178/1926	179/1023	59	9	179/2024	180/1650	60 to 65
10	179/2120	179/0758	60, 61	10	180/2131	181/0903	66 to 68
11	180/2133	181/0901	66 to 68	11	181/2044	182/1452	69, 70
12	181/2101	182/1445	68, 70	12	185/0005	186/1354	83 to 89
13	182/2251	183/1529	71 to 77				
14	183/1957	183/2233	78 to 82	**Sidescan**			
15	185/0000	185/0922	83 to 85	1	172/2106	174/1707	27 to 38
16	185/1157	186/1325	85a to 89	2	174/1708	175/0206	39 to 41
				3	182/2330	183/0429	71 to 73
				4	183/0550	183/2240	74 to 82

DVD's							
DVD #	Start Day	End Day	Line #	DVD #	Start Day	End Day	Line #
Huntec				**Seismic**			
1	167	169	1 to 7	1	167	170	1 to 13
2	169	170	5 to 12	2	168	174	6 to 41
3	170	171	9 to 17	3	168	174	6 to 57
4	172	173	27 to 35	4	167	182	1 to 70
5	173	173	27 to 35	5	168	186	6 to 26
6	174	175	35 to 41				42 to 89
7	174	175	35 to 41	6	167	174	1 to 5
8	175	176	48 to 52				27 to 41
9	177	177	52 to 55				
10	178	178	55 to 60	**Sidescan**			
11	179	179	59, 60	1	172	175	27 to 41
12	180	181	60 to 69	2	182	183	71 to 82
13	182	182	70, 71	3	182	183	71 to 82
14	183	183	71 to 81				
15	183	183	71 to 82	**12 KHz**			
16	185	185	83 to 85a	1	179	180	59 to 64
17	185	185	83 to 85a				
18	186	186	86 to 89				

DAT Tapes							
Tape #	Start Time	End Time	Line #	Tape #	Start Time	End Time	Line #
1	168/0030	168/0140	1	2	168/0141	168/0758	2 to 5
3	168/0800	168/2120	5 to 7	4	168/2120	169/0007	7
5	169/0010	169/0253	8, 9	6	169/0253	169/0559	9
7	169/0600	169/0908	9 to 11	8	169/0908	169/2320	11 to 13
9	169/2322	170/0228	13, 14	10	170/0229	170/0520	14
11	170/0521	170/0828	15, 16	12	170/0828	170/1415	16 to 18
13	170/1415	170/1720	18 to 20	14	170/1721	171/0038	20 to 22
15	171/0039	171/0340	22, 23	16	171/0340	171/0535	23, 24
17	171/0639	171/0930	25, 26	18	172/2207	173/0121	27
19	173/0122	173/0418	27	20	173/0419	173/0716	27
21	173/0716	173/1021	27 to 29	22	173/1021	173/1328	29, 30
23	173/1328	173/1639	30, 31	24	173/1640	173/1946	31 to 33
25	173/1946	173/2254	33, 34	26	173/2255	174/0132	35
27	174/0133	174/0438	36	28	174/0440	174/0746	36
29	174/0746	174/1055	36, 37	30	174/1055	174/1400	37
31	174/1400	174/1706	37, 38	32	174/1707	174/2013	39, 40
33	174/2014	174/2318	40, 41	34	174/2318	175/0201	41
35	175/2320	176/0229	48, 49	36	176/0230	176/0537	49
37	176/0538	176/0835	50, 51	38	176/0835	176/1110	51
39	176/2117	177/0020	52	40	177/0021	177/0326	52
41	177/0327	177/0632	52	42	177/0632	177/0947	52, 53
43	177/0949	177/2102	53, 54	44	177/2102	178/0001	54, 55
45	178/0003	178/0320	55	46	178/0322	178/0644	56
47	178/0646	178/0930	56 to 58	48	178/1925	178/2229	59
49	178/2230	179/0140	59	50	179/0204	179/0510	59
51	179/0512	179/0819	59	52	179/0820	179/2234	59, 60
53	179/2235	180/0144	60	54	180/0146	180/0453	60, 61
55	180/0457	180/0812	61	56	180/0813	180/1121	61 to 63
57	180/1121	180/1431	64, 64	58	180/1431	180/2022	64, 65
59	180/2203	181/0110	66	60	181/0110	181/0417	66
61	181/0418	181/0724	66 to 68	62	181/0724	181/2218	68, 69
63	181/2218	182/0125	69	64	182/0125	182/0430	69
65	182/0432	182/0738	69	66	182/0738	182/1052	69, 70
67	182/1052	182/1402	70	68	182/1402	183/0050	70, 71
69	183/0053	183/0400	72, 73	70	183/0400	183/0707	73, 74
71	183/0708	183/1016	74, 75	72	183/1017	183/1315	75 to 77
73	183/1315	183/1545	77	74	183/2000	183/2240	78 to 82
75	185/0059	185/0300	83, 84	76	185/0300	185/0557	84
77	185/0558	185/0846	84	78	185/0847	185/1220	84 to 85a
79	185/1220	185/1515	85a	80	185/1515	185/1816	85a
81	185/1817	185/2117	85a	82	185/2117	185/2352	85a
83	185/2353	186/0300	86, 87	84	186/0300	186/0545	87
85	186/0546	186/0853	88	86	186/0900	186/1154	88, 89
87	186/1154	186/1325	89				

Line No.	Start Time	End Time	DAT	Seismics					Sidescan			Huntec			3.5 KHz	12 KHz	
			Tape #	Record # 25' Bent.	Record # 78' Bent.	Record # Teledyne	Tape #	DVD #	Record #	Tape #	DVD #	Record #	Tape #	DVD #	Record #	Record #	DVD #
1	167/2223	168/0057	1				1	1, 4,				1	1	1		1	
2	168/0141	168/0332	2	1	1		1	1, 4, 6				1	1	1		1	
3	168/0332	168/0424	2	1	1		1	1, 4, 6				1	1	1		1	
4	168/0526	168/0632	2	1	1		2	1, 4, 6				1	1	1		1	
5	168/0712	168/0828	2,3	1	1		2	1, 4, 6				1	1	1, 2		1	
6	168/1535	168/1918	3			1		1 to 5				2	2	1, 2	1	1	
7	168/2000	169/0005	3, 4			1	3	1 to 5				2	2	1, 2	1	1	
8	169/0005	169/0241	5			1	3	1 to 5				2	2	2		1	
9	169/0241	169/0603	5 to 7			1	3	1 to 5				2	2	2, 3		1	
10	169/0608	169/0826	7			1	3	1 to 5				2	2	2, 3		1	
11	169/0826	169/0923	7, 8			1	3	1 to 5				2	2	2, 3		1	
12	169/1823	169/2044	8			2		1 to 5				3	3	2, 3		2	
13	169/2044	169/2347	8, 9			2		1 to 5				3	3	3		2	
14	169/2347	170/0443	9, 10			2		1 to 5				3	3	3		2	
15	170/0521	170/0652	11			2		1 to 5				3	3	3		2	
16	170/0652	170/0909	11, 12			2		1 to 5				3	3	3		2	
17	170/0909	170/0927	12			2		1 to 5				3	3	3		2	
18	170/1150	170/1424	12, 13			3		1 to 5							3	3, 4	
19	170/1424	170/1514	13			3		1 to 5							3	4	

20	170/1518	170/1727	13, 14			3		1 to 5							3	4	
21	170/2141	170/2224	14			4	4	1 to 5				4	4		3	4	
22	170/2224	171/0234	14, 15			4	4	1 to 5				4	4			4	
23	171/0241	171/0431	15, 16			4	4	1 to 5				4	4			4	
24	171/0431	171/0634	16			4	4	1 to 5				4	4			4	
25	171/0634	171/0742	17			4	4	1 to 5				4	4			4	
26	171/0748	171/0921	17			4	4	2 to 5				4	4			4	
27	172/2203	173/0740	18 to 21			5	5	2 to 6	1	1	1	5	5	4, 5		6	
28	173/0742	173/0915	21			5	5	2 to 6	2	1	1	5	5	4, 5		6	
29	173/0922	173/1317	21, 22			5	5	2 to 4,6	2	1	1	6	5	4, 5		6	
30	173/1317	173/1530	22, 23			5	5	2 to 4,6	2	1	1	6	5	4, 5		6	

Line No.	Start Time	End Time	DAT Tape #	Seismics Record # 25' Bent.	Seismics Record # 78' Bent.	Seismics Record # Teledyne	Seismics Tape #	Seismics DVD #	Sidescan Record #	Sidescan Tape #	Sidescan DVD #	Huntec Record #	Huntec Tape #	Huntec DVD #	3.5 KHz Record #	12 KHz Record #	12 KHz DVD #
31	173/1533	173/1656	23, 24			5	5	2 to 4,6	2	1	1	6	5	4, 5		6	
32	173/1700	173/1852	24			5	5	2 to 4,6	2	1	1	6	5	4, 5		6	
33	173/1855	173/2210	24, 25			5	5	2 to 4,6	2	1	1	6	5	4, 5		6	
34	173/2218	173/2248	25			5	5	2 to 4,6	2	1	1	6	5	4, 5		6	
35	173/2252	174/0124	26			5	5	2 to 4,6	2	1	1	6	5	4 to 7		6	
36	174/0127	174/0808	27 to 29			5	5	2 to 4,6	3	1	1	6	5	6, 7		6	
37	174/0823	174/1422	29 to 31			5	5	2 to 4,6	3	1	1	6	5	6, 7		6	
38	174/1422	174/1702	31			5	5	2 to 4,6	3	1	1	6, 7	5	6, 7		6	
39	174/1705	174/1941	32			5	5	2 to 4,6	4	2	1	7	5	6, 7		6	
40	174/1957	174/2035	32, 33			5	5	2 to 4,6	4	2	1	7	5	6, 7		6	
41	174/2035	175/0206	33, 34			5	5	2 to 4,6	4	2	1	7	5	6 to 8		6	
42	175/0742	175/0826													5	6	
43	175/0826	175/0849													5	6	
44	175/0849	175/0909													5	6	

45	175/1424	175/1438													5	7		
46	175/1629	175/1647													5	7		
46a	175/1818	175/1827													5	7		
47	175/1827	175/1835													5	7		
48	175/2328	176/0140	35			6	6	3, 4, 5				8	6	8		8		
49	176/0140	176/0537	35, 36			6	6	3, 4, 5				8	6	8		8		
50	176/0537	176/0807	37			6	6	3, 4, 5				8	6	8		8		
51	176/0807	176/0915	37,38			6	6	3, 4, 5				8	6	8		8		
52	176/2113	177/0933	39 to 42			7	6	3, 4, 5				9	7	8, 9		9		
53	177/0939	177/1030	42, 43			7	6	3, 4, 5				9	7	9		9		
54	177/1842	177/2221	43, 44			8	7	3, 4, 5				10	8	9		10		
55	177/2221	178/0325	44, 45			8	7	3, 4, 5				10	8	9, 10		10		
56	178/0343	178/0740	46, 47			8	7	3, 4, 5				10	8	10		10		
57	178/0746	178/0850	47			8	7	3, 4, 5				10	8	10		10		
58	178/0850	178/0918	47			8	7	4, 5				10	8	10		10		
59	178/1932	179/0957	48 to 52			9	8	4, 5				11	9	10, 11		11	1	
60	179/2057	180/0334	52 to 54			10	9	4, 5				12	10	11, 12		12	1	

Line No.	Start Time	End Time	DAT Tape #	Seismics Record # 25' Bent.	Seismics Record # 78' Bent.	Seismics Record # Teledyne	Seismics Tape #	Seismics DVD #	Sidescan Record #	Sidescan Tape #	Sidescan DVD #	Huntec Record #	Huntec Tape #	Huntec DVD #	3.5 KHz Record #	12 KHz Record #	12 KHz DVD #
61	180/0334	180/0903	54 to 56			10	9	4, 5				12	10	12	9	12	1
62	180/0903	180/1106	56			10	9	4, 5						12	9	12	1
63	180/1106	180/1219	56, 57			10	9	4, 5						12	9	12	1
64	180/1219	180/1534	57, 58			10	9	4, 5						12	9	12	1
65	180/1619	180/1643	58			10	9	4, 5						12	9	12	
66	180/2117	181/0454	59 to 61			11	10	4, 5				13	11	12	10	13	
67	181/0500	181/0600	61			11	10	4, 5				13	11	12	10	13	
68	181/0600	181/0900	61, 62			11	10	4, 5				13	11	12	10	13	
69	181/2053	182/0952	62 to 66			12	11	4, 5				14	12	12	10	13	
70	182/1958	182/1449	66 to 68			12	11	4, 5				14	12	13		13	
71	182/2233	183/0045	68						5	3	2, 3	15	13	13 to 15		14	
72	183/0057	183/0308	69						5	3	2, 3	15	13	14, 15		14	
73	183/0322	183/0535	69, 70						5	3	2, 3	15	13	14, 15		14	
74	183/0550	183/0757	70, 71						6	4	2, 3	15	13	14, 15		14	
75	183/0810	183/1035	71, 72						6	4	2, 3	15	13	14, 15		14	
76	183/1049	183/1248	72						6	4	2, 3	15	13	14, 15		14	
77	183/1309	183/1529	72, 73						6	4	2, 3	15	13	14, 15		14	
78	183/2009	183/2033	74						7	4	2, 3	16	14	14, 15		15	
79	183/2049	183/2100	74						7	4	2, 3	16	14	14, 15		15	

80	183/2113	183/2124	74						7	4	2, 3	16	14	14, 15		15	
81	183/2140	183/2155	74						7	4	2, 3	16	14	14, 15		15	
82	183/2205	183/2233	74						7	4	2, 3	16	14	14, 15		15	
83	185/0014	185/0150	75			13	12	5				17	15	16,17		16	
84	185/0150	185/0900	75 to 78			13	12	5				17	15	16,17		16	
85	185/0903	185/0922	78			13	12	5				17	15	16, 17		16	
85a	185/1205	185/2350	78 to 82			13	12	5				18	16	16, 17		16	
86	185/2350	186/0200	83			13	12	5				18	16	18		16	
87	186/0200	186/0545	83, 84			13	12	5				19	16	18		16	
88	186/0549	186/0936	85, 86			13	12	5				19	16	18		16	
89	186/0942	186/1324	86, 87			13	12	5				19	16	18		16	