GEOLOGICAL SURVEY OF CANADA

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Hudson 2002-011 cruise report
Flemish Cap Margin Transect

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Canada

FLAME 2002

Flemish Cap Margin transect
Hudson 2002-011

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Summary:

The Flemish Cap Margin Transect (FLAME) was a success with all the scientific objectives met in spite of sailing late and returning early. This experiment was the final one run under the auspices of Mariprobe, a three year co-operative program between Dalhousie and the Geological Survey of Canada Atlantic to study the manner in which nonvolcanic margins rift.

The technical objectives of the scientific expedition Hudson 2002-011 to acquire wide angle reflection/refraction data (WAR) and heat flow data to understand the margin of Flemish Cap were achieved. A 400 km long WAR profile with 21 Ocean Bottom Seismometers (OBS) deployments was the first experiment completed on the two week long expedition (Figure 1 Line 1). The acoustic source was an array of twelve airguns that have a combined volume of 6346 cu in. New shot phones provided control of the airgun signature. All the OBS were successfully launched and recovered.

The principal scientific objective of the WAR profile was to accurately define and compare the velocity structure of the sedimentary strata, crustal layers, and upper mantle from the fragment of continental crust of Flemish Cap to normal oceanic crust further offshore. The velocity data will be used to convert the coincident multichannel seismic reflection profile to depth. The seismic data will be interpreted in the context of similar data recently collected on the conjugate European margin off of the Goban Spur.

In addition, a series of heat flow measurements were completed at the oceanward end of the WAR profile to provide constraints on the age of the oceanic crust (Figure 1 point B). The thermal structure of the region will be compared with existing measurements on the conjugate margin and to the north in the Labrador Sea.

A high resolution WAR study with 21 OBS deployements over a 1 km range was run. The shooting sequence employed a series of shot lines 4 km long and 100 m apart with a shot spacing of 50 m (Figure 1 point D). All the OBS were recovered on this line as well. The close distribution of OBS will be used to improve images of a sedimentary horizon that was not well defined by conventional multichannel seismic profiles at the White Rose Oil Field.

Technical summary and recommendations:

This was the first time in 25 years of sea going experience that GSC has placed hydraulic gear (winches, power packs etc.) on a ship and there were no leaks of hydraulic fluid. In fact, there were no failures of this equipment at all.

The GSC (A) compressors are inadequate for this array, as configured. The requirement for a new compressor should remain high on the capital “wish list”. As the air guns and sleeve guns are one of the principle tools for GCS (A), we should not loose sight that the compressors are all 20 to 40 years old and *must* be replaced.

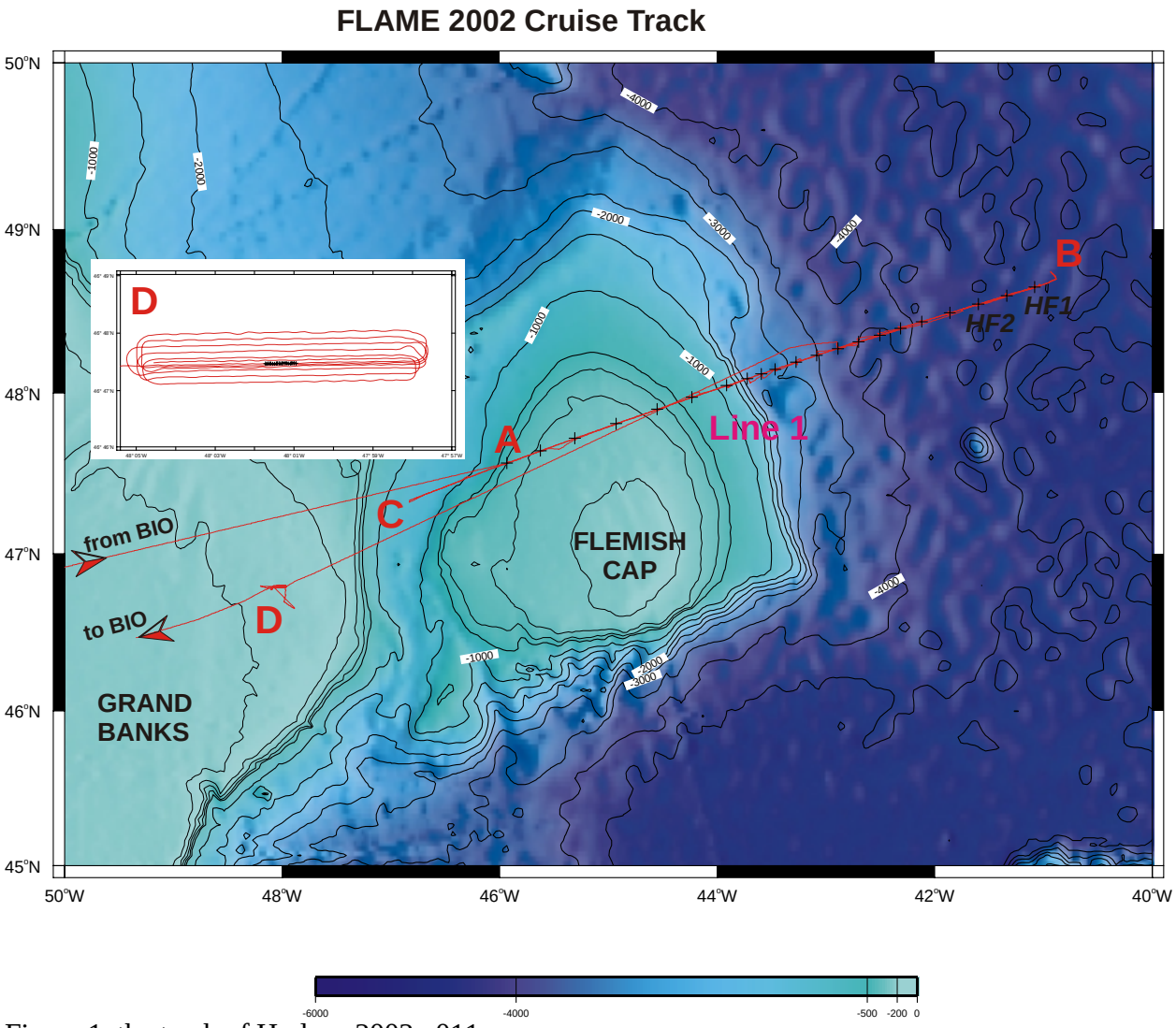


Figure 1. the track of Hudson 2002 –011.

Cruise Diary: (Ruth Jackson)

May 4, 2002 Day 124 Saturday

The scientific staff met with the Captain and Officers of the CCGS Hudson in the lounge immediately prior to sailing. We were given a summary of safety features and measures, followed by a familiarization tour of the ship. We completed the official paper work that included signing the ship's log and handed in our medical forms. The shipped sailed at 16:00 hr local time (19:00 GMT) under blue skies. The storm outside the harbor was subsiding and the swells were causing only a

slight roll. We are making 16 knots. It will be 48 hours to the launching of the first OBS on May 6th at suppertime. The work continues getting the hoses for the airgun array assembled, compressors tested, and spooling drums fitted out. All the floats for the OBS are assembled in the forward lab and the instruments and pressure cases are in the racks in the GP lab. The computers with the Regulus navigation system are being prepared. It is a relief to be sailing, all the complications with certification of the anchor windlass after refit, scheduling of Bedford Institute of Oceanography Open House interfering with the repairs to the windlass, and getting the scientific gear aboard are now over. The original sailing date had been May 3 (Day 123).

The science party had a review of nonvolcanic margins lead by Keith Louden the Chief scientist. The discussion then focused on the likely position of the ocean continent boundary and the different possibilities for the positioning of the 21 OBS. Andrew Bullock summarized his preliminary work on the new data collected in the conjugate Goban Spur margin.

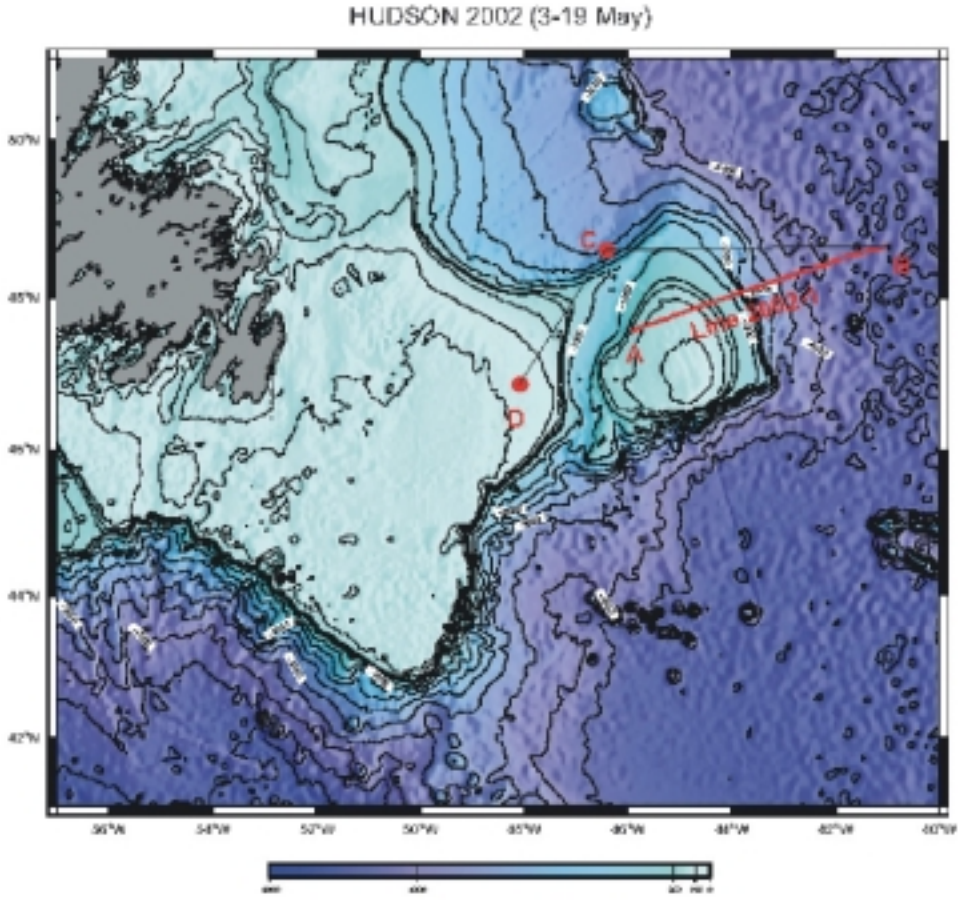


Figure 2. the proposed cruise track.

May 5, 2002 Day 125 Sunday

We awoke Sunday morning off the northern tip of Cape Breton. We were nearing the Laurentian Channel and there were whales, perhaps Minke, in the vicinity. We are averaging 16 knots and should be at the launch site for the first OBS at about 1600 local tomorrow. The sound source team of Borden Chapman, Ken Asprey, and Larry Johnston were cheerfully going about their business and were pleased that the diesel engine on one of the two compressors that had been over hauled was working so well. The team working with the receivers of Bob Iulliucci, Walter Judge, Chris Leblanc, and Andrew Bullock were doing the final preparations for the deployment of 21 OBS. The Regulus navigation stations were set up at various locations on the ship. Sonja got instructions on the digital camera in preparation of taking everyone's picture that will then be displayed to facilitate better communications. Keith and I decided that the record keeping would be based on meters not converted from fathoms to meters. A plastic scale had to be constructed as the sounder is usually scaled in fathoms. The complications do not end here. Many of the charts displayed by the navigation system are in fathoms but the automatic digitizing is in meters. I hope this will not be too confusing for the watch keepers. This raises the question as to when the ship will be able to automatically digitize a bathymetric signal of more than shelf depth.

After lunch emergency suits for evacuation into the cold North Atlantic waters were fitted to those who had not yet had them on and further safety training was done for staff sailing for the first time. This was followed by an introduction for the watch keepers and other interested parties in the navigation system Regulus by Paul Girouard. Then the ship's technician Robert MacGregor described the 12.5 Khz echo sounder.

During the day the electric compressor was run and the high pressure lines as far as the air bottle storage were tested. The two inboard beams were made ready for deployment and work was progressing steadily on the outboard beams. On the outboard beams the electrical lines are in place but must be connected and the high-pressure hoses have been assembled.

Figure 3. Bob and Walter preparing OBS for deployment on the starboard waist.

May 6, 2002 Day 126 Monday

Clear and calm, and we are steaming along at 16 knots. The high pressure weather system will likely bring us good operating conditions for another 24 hours; hopefully, we will have the airgun array in the water before the weather deteriorates. We were on the Grand Banks this morning passing the Hibernia Oil Platform on the starboard side.

The staff preparing the OBS were up late last night. The OBS should all be ready for launching by noon today. The crew working on the OBS deployment hoped to have the gear in good shape by the end of the day. Last year the deck crew experienced difficulties launching the array. Discussions with the boatswain on this crew should eliminate some of the problems. In particular, the boatswain plans to put the beams in the water followed, not proceeded by the floats.

A number of ongoing activities are taking place. The rented firing system was taken out of its packing and set up on a bench in the GP lab. The rental of $6000 was weighed in the context of the purchase price of close to $40,000. The 6-7 experiments required to buy this system are unlikely to take place before it is outdated and needs replacement.

Sonja is taking photographs of the staff and crew now that the digital camera is fully charged. Additional documentation of people and equipment will be made available by the logistic Officer Dave Archibald who is also active with his camera and Keith who has recently purchased a digital camera.

At 17:00 local (20:00 GMT) the first OBS was successfully launched on schedule. In the lab the new watch keepers were getting used to the various tasks they had to perform. For the next launching there was a new watch keeper and they were given a lot of support for their tasks. The time marks on the echo sounder are not synchronized so the ship's technician was called to correct the problem.

It was also noticed that the ship's log was reading about 15% lower than the distance over the ground. This is not believed to be due to currents but the need to recalibrate the log after the ship's refit. During the time when the gear is being towed the watch keepers will have to be particularly vigilant. They will have to monitor the floats on array instead of the computer screen to ensure the gear is not being towed too fast through the water.

Meanwhile Borden, Larry, and Ken are continuing to get the airgun array ready. Although the sea state is low and it's sunny, it is cold working on the stern. By suppertime the electrical and hydraulic cables were completed on two of the 4 beams. They continued working after supper to ensure that when the OBS are in the water that they will be ready and no ship time will be lost.

Figure 4. Launching of the OBS.

May 7, 2002 Day 127 Tuesday

Calm, clear, winds to 7 knots. The launching of the OBS went well over the night by breakfast time 17 of the 21 had been put in the water. Walter and Bob looked tired. Keith was up during the night helping the watch keeper with the echo sounder on the short steep slope. The watch keepers (Helen, Jack, Marie and Sonja) were diligent with their tasks.

The OBS's will start recording at 18:00 GMT. It will be difficult for the airgun team to have both the external hydraulic hoses and high pressure air lines connected and the wiring to the firing unit in the GP laboratory completed. The launching of the array takes an intensive hour or so and then they have 50 hours of shooting. They handle the long hours of work well, but we must try and ensure they can split up their watches so they all get sleep. If they are not ready Keith and the ship's crew are prepared for a heat flow station.

A notice to mariners was telexed to the Saint John's Coast Guard base to notify all parties of the firing of the airgun array during the next three days. On the top of Flemish Cap at a range of perhaps 15 miles, there were several fishing boats of probable Spanish origin.

The final OBS was dropped into the water 13:00 GMT and we steamed to the end of the line. Dolphins rode the bow wave for a short time. The OBS were not to start recording until 18:00 GMT. At 18:00 GMT the ship was about 8 nm miles from the beginning of the line and the array was going over the side. At this point the ship's electrician noticed that there was a short in the GP lab and wanted to turn off the power. After searching and turning off much of our equipment, it was discovered to be an external outlet on the port side of the ship.

During the deployment of the outboard starboard array the beam and the ships propeller were closer than ideal. The propeller was turned off. In future this should be a standard procedure.

The deployment of the airgun array went smoothly. It took about 70 minutes to have the array streaming behind the ship. Next, the compressors and airguns were started up by cycling on one airgun at a time. This meets one of the requirements of the Environmental Assessment.

The firing unit displayed the pulses from the guns as they fired. All were within a few milliseconds but the smallest the 160 cu in. The 300 cu in, one of our older guns, also had a more irregular signature than the others. The $20,000 invested in the shot phones has certainly made monitoring the signal easier.

The Dalhousie Odetics clock is being used to trigger the airguns and the watch keepers needed training in resetting it. This retuning was necessary because of problems with the electrical

compressor overheating and having to be shut down because the diesel compressor cannot fire the entire airgun array more often that once every two minutes. Eventually salt water was run through the electrical compressor to cool it down. This is not the best long term option but it has solved the immediate problem.

The pressure is not as high as optimum at 1400 psi. On the plus side the sea state remains quiet and if the airgun crew can rest in shifts tonight, tomorrow there will be the time to do adjustments. We are just about back on the schedule prepared weeks before sailing due to the 16 knot transit and calm sea.

Figure 5. Deployment of the air gun array took 70 minutes.

May 8, 2002 Day 128 Wednesday

Calm seas. The airguns fired all night. The smallest the 160 cu in was shut off because its signal was significantly delayed relative to the rest. All is going better than hoped especially weather wise. The ocean water used to cool the compressors was too warm so additional volume of cooling water was added. The pressure to the airguns is lower than desirable. We need to consider the possible cause and solutions.

After lunch adjustments were made to the compressors to bring the pressure up to 1520 psi. At about 17:00 GMT one of the stages in the diesel compressor was not operating properly. Borden

requested the ship to go in a slow turn for about an hour so he could repair the problem before it got out of hand.

In the evening as we approached the slope the firing rate was decreased to 90 s so that the pressure could be built up. The wider spacing of shots here was not deemed to be a problem for interpreting the structure.

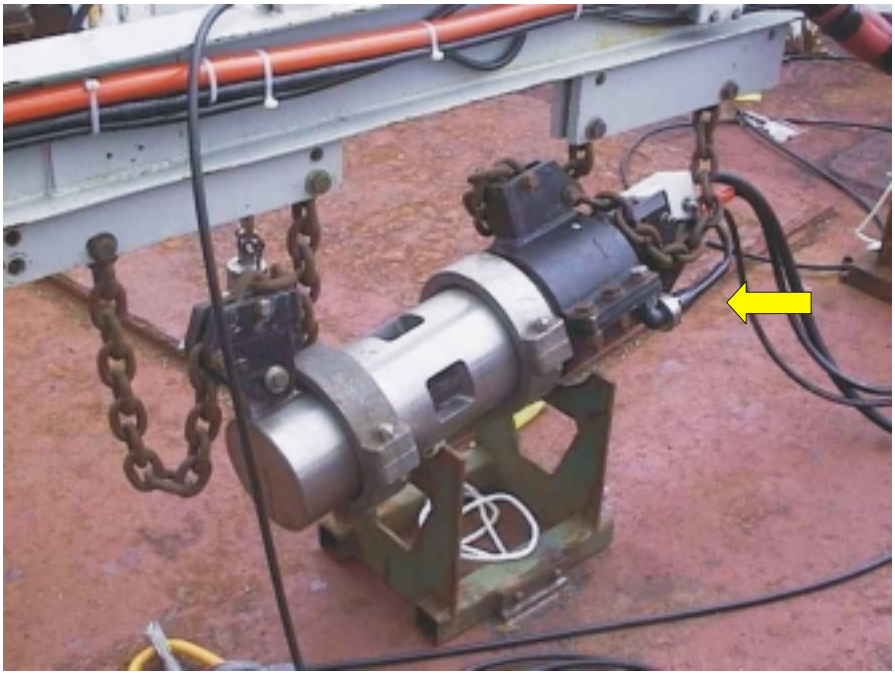


Figure 6. The airgun is shown with its newly acquired shot phone attached to the collar.

May 9, 2002 Day 129 Thursday

Foggy, calm seas. There was a problem with the electrical compressor last night. The pressure dropped rapidly so the airguns were shut down while the ship circled for an hour and a half so that repairs could be made. The speed controlled failed and the switches could not be prepared; so it is now running on direct drive. The reduction in the firing rate to 90 sec now means the pressure is 1850 psi. We are hearing numerous bottom bounces in the 300 m deep water on the top of Flemish Cap.

The fog lifted and the winds picked up slightly so that by noon white caps and choppy seas were occurring. Throughout the day the seas kept building. The winds reached 40 knots and the wave height is 6 - 10 ft. As we neared the position of OBS 1 on the landward edge of Flemish Cap at about dusk, the decision to leave the guns in the water or continue shooting was left for Borden and the Boatswain to make based on the safety issues. Scientifically, the main objectives of the profile will have been met at the position of OBS1. Additional data in Flemish Pass along the Lithoprobe

reflection profile might also be of value. At any rate, it is too rough to attempt to pick up the OBS so the ship will either be towing the gear throughout the night or turning bow into the winds near OBS 1. The barometer has been rising steadily for several hours and tomorrow the seas will probably be calmer.

Figure 7. Sonja on watch in the GP lab assisted by Alfred.

May 10, 2002 Day 130 Friday

Seas dropping. Just after midnight local the swivel on the wire cable, which is the main towing point for the inboard port array, was broken and the beam was being dragged thwart ships. The ship was brought to bare steerage and Borden and two seamen (Paul and Kelly) (actually one was a sea woman) got the situation under control. Using the hose reel the beam was brought closer to the ship and the wire cable was retrieved. A shackle chain was used to position the new swivel in a region where it was not being chaffed. With the new attachment to the cable, the wire was paid out with the tugger winch and the beam came back onto position. Firing of the airgun array was reinitiated

and the ship brought back up to speed and back on line.

Figure 8. The broken swivel that caused the starboard inboard beam to be towed thwart ship.

After breakfast at 6:00 local the Boatswain was called and the airgun array was shut down. The compressors had run 58 hours. It took one hour to bring the array onboard, just a bit quicker than going out. Several of the shot phones on the bigger guns were damaged, hoses were stretched and cables showed signs of wear. There will be a number of time consuming tasks before the array is ready for the high resolution study. It should be noted that not there were no leaks in the air hoses this trip. The new synflex hose has solved that problem. Overnight the ship crossed the edge of Flemish Cap, Flemish Pass, and unto the Nose of the Banks. This will all be useful data.

We were at the position of OBS 1 near 13:00 GMT. The burn time for the OBS release was nine minutes. The rope for retrieval did not fully deploy but the boatswain caught it with a boat hook on the first try. The Captain who had not seen the instruments before agreed the system for recovery was appropriate. His suggestion of keeping a list of who sited them first accompanied by a prize was initiated. The First Officer had the honor of getting the first prestigious award. Initially it was suggested that the prize should be chocolate bars but beer seems to be a more popular choice.

The burn times on the first 4 OBS had varied from 9 minutes to an hour and ten minutes. It is not obvious why they are taking so long. It is not likely to be due to the cold water. In northern Baffin Bay last year we regularly had burn times of 6 minutes. After considerable concern about the burn times the next few instruments burn statistics were consistent.

Paul was called to the GP lab early this morning and late in the evening to assist with the Regulus system. The system on the Bridge had been data logging for 10 days and the lack of available space was causing consistent failures and numerous reboots.

May 11, 2002 Day 131 Saturday

Light winds to 15-20 knots gusting to 40 knots last night, so there is a considerably swell. Last night a large copying machine tipped over that the boatswain had suggested be tied down before sailing and his instruction was ignored. The engineers are transferring fuel to remove a list but getting accurate measurements on an oscillating liquid is difficult.

By morning 11 OBS were safely onboard. The retrieval lines have not been uncoiling and the sea is rough so it sometimes takes 3 tries to pick them up. The beer for the person spotting the first OBS seems to be a good morale booster and the reward seems to be getting reasonably evenly distributed with only a slight bias for the Bridge.

The compressors are being prepared for the high resolution refraction profile. The volume of the airgun array is being decreased so that the firing rate can be increased. Only three beams will be towed. This will require switching several airguns around on the beams. The swell is large and working on the stern with the airguns requires caution.

OBS 13 did not respond to the signal from the transducer. After a short time the ship moved on to the next instrument. OBS 14 promptly came to the surface with its rope fully unfurled and was picked up readily on the first pass.

Figure 9. Between retrievals of the OBS, Walter with the white helmet models safety apparel.

May 12, 2002 Day 132 Sunday

Lighter winds, calmer seas. The low pressure has moved to the north. The spotting of OBS 21 when it came to the surface was made easier due to the curious flock of gulls that were floating around it. At the end of wide angle refraction line, 20 of the 21 OBS were recovered. We will go back to OBS 13 and try again. The OBS all recorded data and the hard drives have been removed and replaced. The shot tables were ready at the completion of shooting the line. The computers to be used for converting the raw data are having problems with their hardware so the process has been stalled.

Today a series of heat flow stations will be run along the seaward end of the refraction line. Final preparations of the probe began immediately after recovery of the OBS. During deployment three digital cameras were pointed at it so there should be lots of pictorial documentation. During the day four heat flow stations were tried. Two were successful; however, on the other two attempts the probe fell over. The 3.5 Kkz echo sounder was started and it was decided the sediments were too soft at this site near the position of OBS 21 so the probe was brought onboard and the ship moved to the OBS 19 site in search of a better sediment.

Repairs and rebuilding the array for the high resolution refraction survey are ongoing. The smaller volume airguns were rearranged on three beams. Borden examined the firing box and found that the channel that controlled the 160 cu in air gun was not operating; so that explains the problems we had with that airgun that resulted in it being shut off within the first few hours of shooting the line. Because we will not be firing all the airguns, it will be possible to use a different channel. In the future it would be wise to rent an extra bank of firing units to avoid this problem. The solenoid in the 300 cu in airgun that appeared to always be firing early was also removed and replaced.

Figure 10. Heat flow probe being lifted by the crane on the fore deck of CCGS Hudson

May 13, 2002 Day 133 Monday

Winds 15-20 knots overnight, choppy seas. Of the heat flow stations run over night, 3 out of 6 were successful. Then the winds gusted to 35 knots and started breaking over the bow as the ship steamed with three engines to the position of OBS 13. At a distance of 2 nm the ship tried to stop. It took some time and maneuvering to get the ship still enough in the water to have the transducer hanging down not streaming along the side of the ship. After at least 13 tries, OBS 13 released on May 13. This was a great relief. Not only to the science party but also to the crew because it would have cost a day to return to this site at the end of the cruise to attempt a recovery operation on the timed back up release.

All of the OBS recorded data. We now have a 15 hour steam to the White Rose site where a high resolution seismic survey will be run. The airgun team had to exchange cylinders and replace solenoids on several guns. The rain and rough conditions on the deck are undoubtedly making this operation more difficult.

The Captain found a warning to mariners that there are two current moorings at the site we planned the seismic survey. We verified the warning was valid by calling the Coast Guard Base in Newfoundland and got information on the telephone number of the contractor that installed the moorings. Keith called the contractor and Husky Oil. The mooring is 200 m from the OBS positions and we are unlikely to interfere.

May 14, 2002 Day 134 Tuesday

Light winds overnight 15-20 knots, in the morning air temperature 2C, water temperature .5C, snow squalls at times. The ship turned, so that the preparations for the launching of the 21 OBS on the starboard waist, was as comfortable as possible. The operation is more intensive than usual because all 21 OBS must be ready for launching in a tight array of 1 km distance with a 50 m spacing. The preparations are going quickly with the team preparing the OBS and the Boatswain's crew working cooperatively and efficiently. The OBS will be in the water before they are timed to turn on at 17:00 GMT. The airgun team has their equipment ready.

The launching of the OBS was delayed while negotiations with the engineers at Husky Oil in charge of the well site look carefully at the positions we have sent them and discuss the implications and priorities with the geologists who are supporting the high resolution survey. There is a worry that the airguns might affect the current meter. The offer is to turn the air guns off within 200 m of the submerged equipment. By about 17:00 GMT an email had arrived from Husky Oil that supported the running of the survey as planned. After getting back on line it took about an hour to launch the 21 OBS. The ship then had to steam beyond the end of the lines and the airgun array was launched now reduced to 6 guns firing every 24s for a shot spacing of 50 m at 4 knots. In short order to main pressure the 600 cu in airgun was shut off.

By early evening the pattern for running lines and turning was well established. The calm seas mean that it is easier for the ship to stay on the proposed survey lines. It took about 20 minutes for a turn. After dark we could see the flaring from the Hibernia Oil Field. It was cold at 1 C.

May 15, 2002 Day 135 Wednesday

Winds to 15 knots, calm seas. Smooth sailing overnight about 15 of the 21 lines completed by 11:00 GMT. Overnight the 200 cu in developed an air leak and had to be shut off. The brand new 160 cu in airgun has never fired (possibly related to the solenoid) and the 300 cu in has erratic triggering. The ship's speed is down to 3.5 knots and the firing rate is up to 30 sec to preserve air pressure.

One of the tanks, called the coffer dam, between the starboard aft trim tank and the engine room was discovered to be full of pressurized water. The aft tank is often full of water and it was pumped dry but it did not substantially relieve the pressure. The firing of the airguns was terminated at 13:30 GMT. The airgun array brought in. The Chief Engineer attempted to isolate or contain the water but this was not possible. The OBS will be retrieved and we will be heading to port. This is not too serious scientifically because about 95% of our objectives have been reached.

On retrieval of the array it was discovered that the hoses to the 200 cu in airgun had chaffed on a bolt in the mounting block. For another survey the length of electrical cable to the geophones will be customized so that the extra cable that is bundled on the beam is not creating unnecessary stretches.

The retrieval of the OBS was hampered by long times on the seabed after receiving the release signal. One OBS took four hours and many were taking over 2 hours reaching the surface. It was noted that the OBS with the longest release time also held the record on line 1 and was the instrument that was left behind on the Scotian margin project and retrieved by a fisherman. A detailed examination of that instrument release system may provide clues to the problem.

As day wore into night the winds came up to 35 knots and the release of instruments and shutting off of ones that were not yet on the surface became a complex operation. There were long periods when everyone was waiting and then there would be two instruments on the surface and a flurry of activity.

May 16, 2002 Day 136 Thursday

Steaming for home, the expected time of arrival is early Saturday morning. The last instrument was on board at 0600 GMT. Two OBS came to the surface close together. The nearer one was without a light and in the rough seas may have been difficult to locate. It was brought aboard. We had 42 launches and 42 recoveries for a perfect 100%. The recovery team for the OBS slept for the morning while the airgun team were preparing the gear for removal from the ship during the long weekend. There is a lot of packing activity in the GP level.

We will be in port a day early due to the leak in the coffer dam but we have completed the cruise as planned.

The night sky from the bridge was unusual, the new moon was circled by 5 planets. The swells were braking over the bow and spraying the windows on the bridge. The staff and crew were winding down from the trip with a few beer.

May 17, 2002 Day 137 Friday

Steaming home. Last night we crossed the Grand Banks, Laurentain Channel to reach Artimon Bank at breakfast time. Scaterie on the tip of Cape Breton is just to the north. The winds have dropped from 30 to 15 knots and the big swell has disappeared.
The final packing is being done and people are queuing up at the washing machines as they prepare to leave the ship.

The major successes of the cruise include:

1) GSCA/Dalhousie now have a reliable tuned airgun source of 6346 cu in
2) 100% recovery of the 21 OBS that were launched twice
3) A WAR profile coincident with the existing multichannel reflection profile across Flemish Cap
4) Test of a technique to improve imaging of a sedimentary structure not well defined by traditional methods

CCGS Hudson Crew On Board

Position (Rank)	Surname	Given Name
Commanding Officer	Hemeon	Michael
Chief Officer	Munn	David
Second	Munroe	James
Third Officer	Naugle	Bill
Chief Engineer	Brick	Peter
Senior Engineer	Boutlier	Wade
First Engineer	Rink	Harold
Second Engineer	Hawes	Gary
Third Engineer	Wilson	William
Electrical Officer	Bialowas	Jerzy
Logistics Officer	Archibauld	David
Nurse	Quinn	Joan
Bosun	Maclean	David
Leading Seaman	Newcombe	Murray
Leading Seaman	Maly	Stan J
Seaman	Dobbin	Bill
Seaman	Clayton	Chad
Seaman	Mcguigan	Kevin
Seaman	Johnstone	Kelly
Seaman	Pomroy	Paul
Seaman	Stevens	Garry
Leading Seaman	O'Quinn	Edward
Ship Technician	MacGregor	Robert
Oiler	McPherson	Phil
Oiler	Chase	Allan
Chief Cook	Birch	Paul
Storekeeper	Hann	Thomas
Second Cook	Jennings	Barry
Laundryman	Thomas	James C
Second Steward	Whittaker	Fred
Steward	MacDonald	Barry
Steward	Haines	Alfred
Sr. Scientist	Louden	Keith
2nd Sr. Scientist	Jackson	Ruth
Staff	Archambault	Marie-Claude
Staff	Chapman	Bordon
Staff	Girouard	Paul
Staff	Iuliucci	Bob
Staff	Goold	Sonja
Staff	Lau	Helen
Staff	Bullock	Andrew
Staff	Leblanc	Christopher
Staff	Johnston	Larry
Staff	Judge	Walter
Staff	Yue	Wu (Jack)
Staff	Asprey	Ken

Scientific equipment specific to cruise:
21 Digital Ocean Bottom seismometers
12 airguns on 4 beams totalling 6346 cu in
2 compressors
heat flow probe

The components in the airgun array:
1400 ft 3/4 inch high pressure air lines
1400 ft of electrical firing lines
weight 1650 x 4 =6600 lbs beams
length 26' beams
20 lifting harnesses and slings
array volume 6346 cu in
100' of ½ inch grade 80 chain

Line 1 way points (OBS drop positions):

SOL	48.666667	-41.0
OBS21	48.651108	-41.077926
OBS20	48.599313	-41.338989
OBS19	48.547246	-41.599002
OBS18	48.494106	-41.858103
OBS17	48.440125	-42.117215
OBS16	48.400593	-42.310574
OBS15	48.358452	-42.504967
OBS14	48.317379	-42.697974
OBS13	48.275875	-42.892014
OBS12	48.234102	-43.084306
OBS11	48.190901	-43.275713
OBS10	48.148952	-43.467669
OBS9	48.119559	-43.596722
OBS8	48.090656	-43.723855
OBS7	48.046534	-43.914784
OBS6	47.975298	-44.23227
OBS5	47.901395	-44.5481
OBS4	47.812282	-44.928326
OBS3	47.720806	-45.306373
OBS2	47.644395	-45.618221
OBS1	47.566603	-45.934092
EOL	47.530442	-46.08772

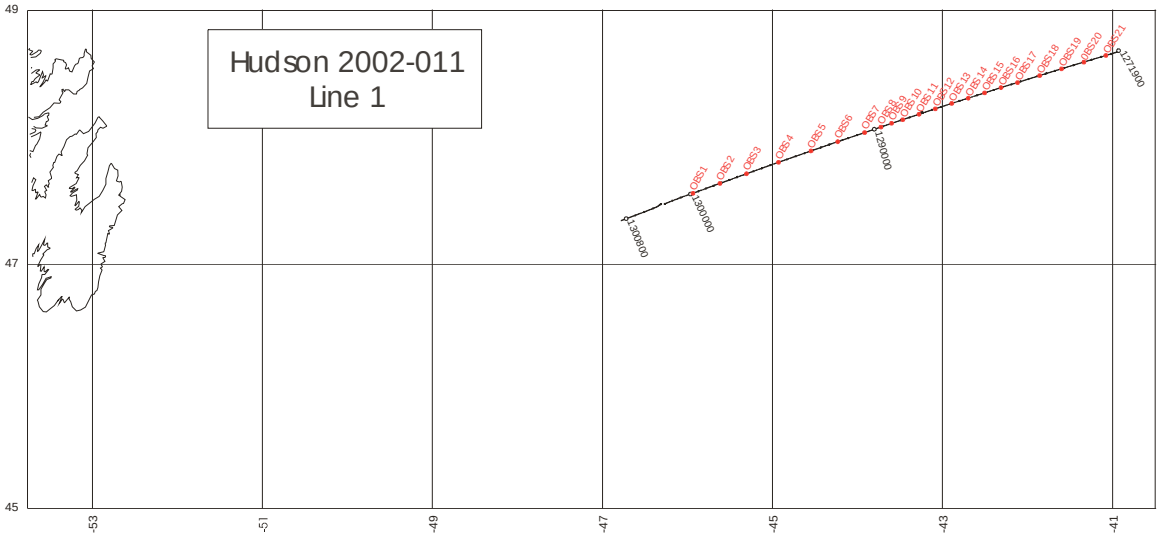


Figure 11. Location of OBS along line 1.

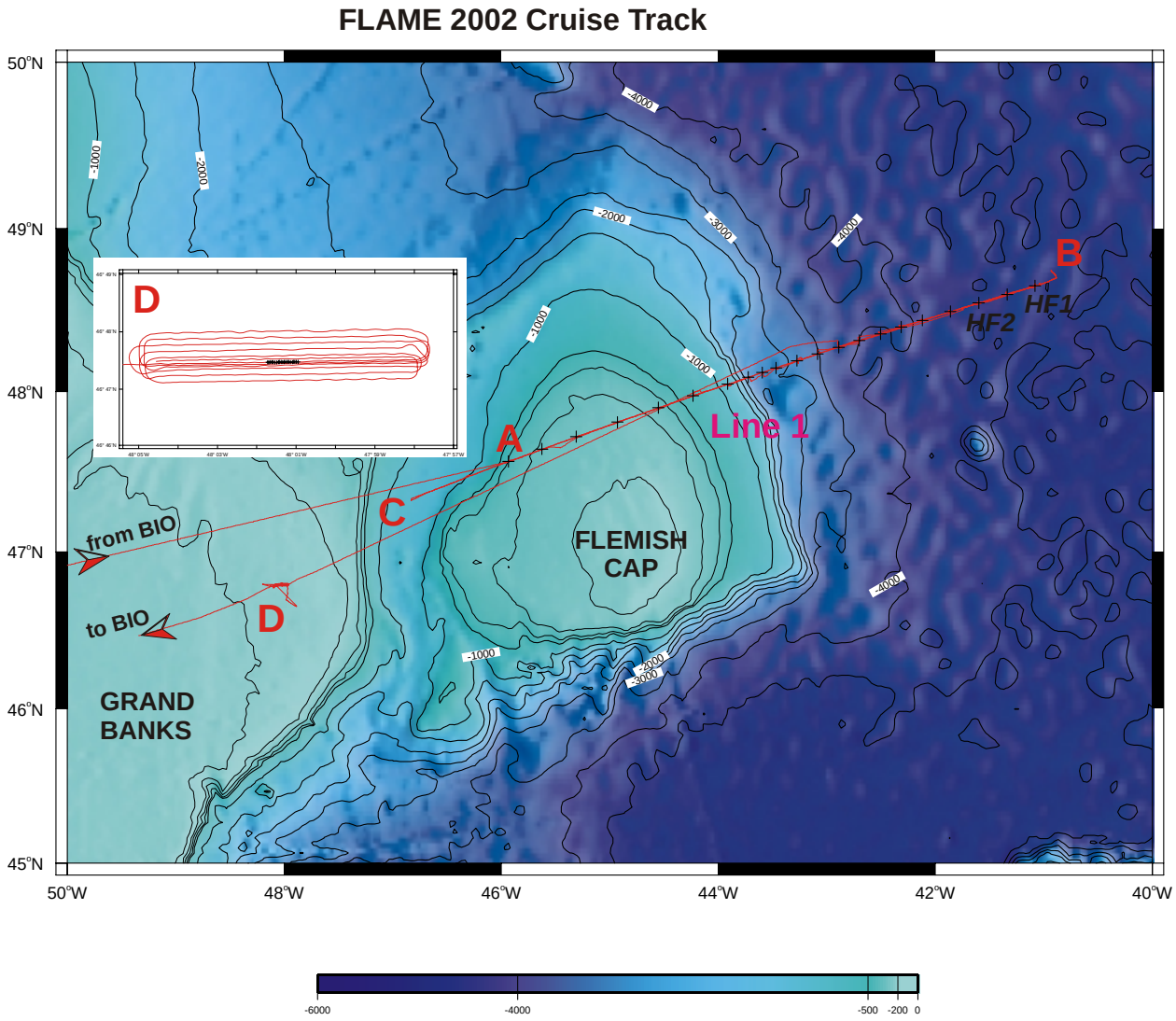


Figure 12. The actual cruise track accomplished on the expedition.

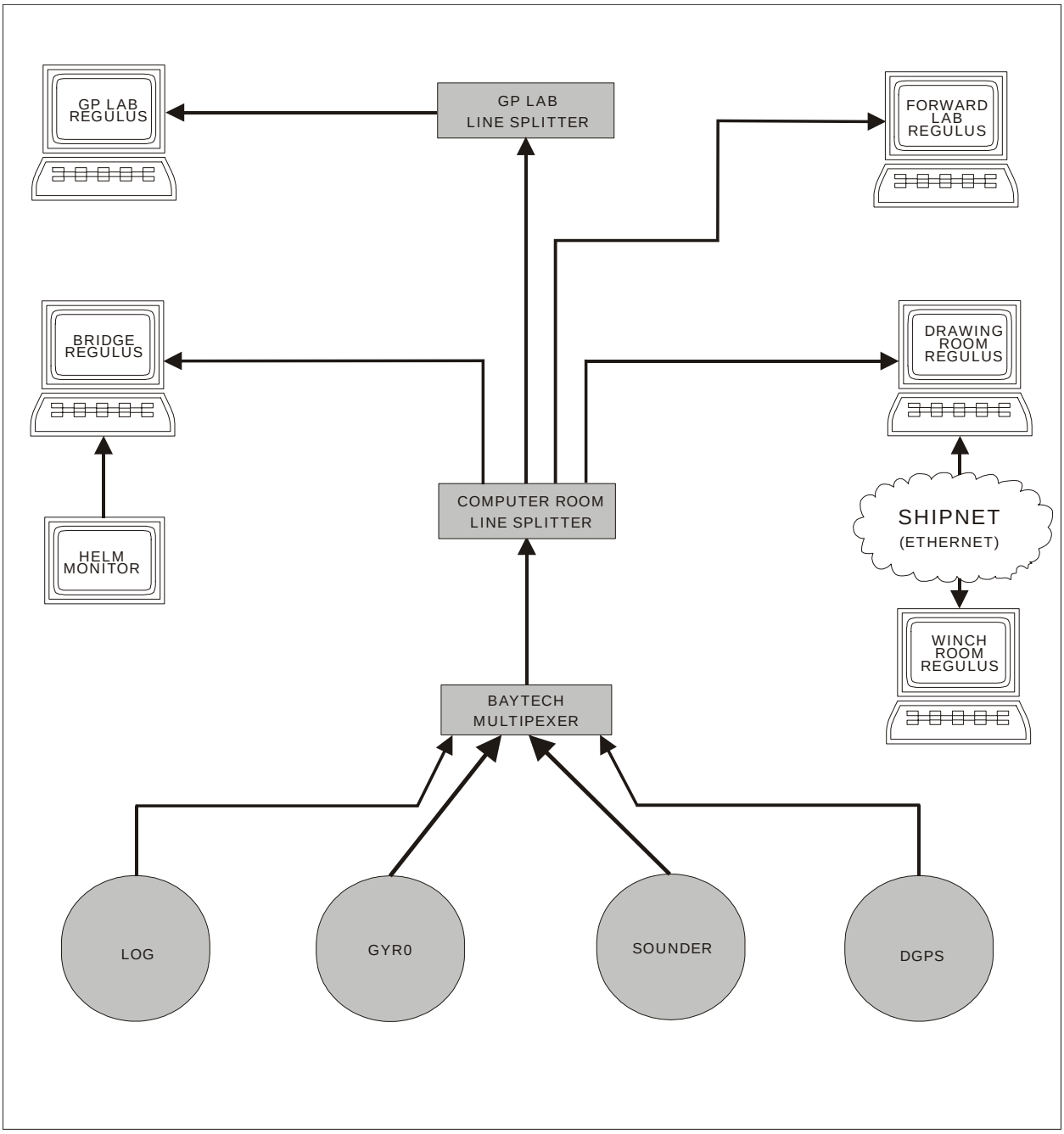
White Rose OBS Drops		
OBS101	46.79115	-48.0287
OBS102	46.79109	-48.0282
OBS103	46.79118	-48.0276
OBS104	46.79118	-48.0269
OBS105	46.7912	-48.0264
OBS106	46.79109	-48.0256
OBS107	46.7911	-48.0249
OBS108	46.79119	-48.0242
OBS109	46.79122	-48.0237
OBS110	46.79122	-48.0231
OBS111	46.79118	-48.0223
OBS112	46.79124	-48.0217
OBS113	46.79126	-48.0211
OBS114	46.79127	-48.0204
OBS115	46.79126	-48.0198
OBS116	46.79117	-48.0191
OBS117	46.79118	-48.0183
OBS118	46.79126	-48.0177
OBS119	46.79128	-48.0171
OBS120	46.79128	-48.0165
OBS121	46.79125	-48.0158

NAVIGATION

Differential GPS navigation was provided by the ship's MX-400 series navigation systems. 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 distributed throughout the ship over the ship's serial data distribution network. Relative positioning was based on the following dimensions: ship's length, 90.5m; GPS antenna 47m forward of stern and 4.5m starboard of centre line.

The scientific navigation was observed and logged on four REGULUS systems, running the latest version on the program, Build 22266. These were set up in the Drawing Room, Forward Lab, Winch Room and GP Lab. The GP Lab REGULUS system was used as the primary data logger. The navigation data was logged from the ship's serial data distribution system by the Drawing Room REGULUS system, which in turn, redistributed the data over the ethernet network to the Winch Room REGULUS system. The logfiles were 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 was cleaned and merged using the standard GSCA programs ETOA, INTA, APLOT and the PE editor. Raw E-format, raw A-format, with extracted bathymetry from the $SDDBK NMEA sentence where appropriate, and cleaned and edited 10 second A-format files were saved on a daily basis and transferred to the shipboard NT server. All raw and processed navigation files were later transferred to CD for GSCA archiving. In addition, raw A-format files with extracted ship's course from the $GPVTG NMEA sentence were produced for all lines for immediate use by the scientific staff.



Hudson 2001-028
Navigation Data Distribution

Figure 13. Hudson navigation data distribution flow chart.

Watch Keepers Guide for OBS deployment:

Approaching station:

Turn on the sounder, make sure power knob is in ON position and the transmit switch is ON. Check water depth, compare with the estimated depth from wall chart that summaries OBS deployment and with the REGULUS digital chart. Note that the REGULUS chart is in fathoms, multiply by 2 (roughly) to get meters. (For more accuracy try1.8288)

OBS Deployment and afterward:

1) On the REGULUS navigation computer type "e" as OBS hits the water to mark the event location. Note time and write on log sheet.

2) On sounder, use the "event mark " switch to mark the station. Write the station number, time and water depth on the chart. Use the cardboard scale to measure the depth, note that the measurement "Wrap" and depending on the SWEEP time, greater depth may be shallower. Check carefully, adjust SWEEP time if necessary, compare with the REGULUS value and the wall chart.

3) Turn power knob on sounder to STANDBY position and the transmit switch to OFF to track pinger from OBS as it descends

4) Return to REGULUS computer, change default event number to "station number" label. To do this, go to "Nav Elements" menu, select "Nav Manager", select marker to edit and press EDIT. Enter new name, press APPLY, press OK.

5) To display newest marker values, go to "New Elements" menu, select "Point of Interest", select marker you want, press ACTIVATE, press OK.

6) Reset depth recorder to power ON and transmit ON as ship moves to the next station.

IF you have questions, ASK for help.

Watch Keepers Guide for airgun watch

See samples and explanation in the General Cruise log book. Note fields that need to be filled in are highlighted.

Every fifteen minutes:
1) Hit the event key E key on the Regulus computer to mark the location. Write down course over ground (COG), speed over the ground (SOG), heading (Head) and speed (Log) also UT in the General cruise log. Use the right-hand mouse button on the event location to set as point of interest, and copy location (latitude and longitude) from screen (lowermost box) to the log book.
2) Go to the bathymetric recorder, mark event using the event mark button. Label with UT Day and time. Then measure water depth in fathoms, convert to meters (410fathoms=750m, or use chart on the wall), and enter into the log book, also mark depth on the chart record.
3) Check compressor pressure on grey air bottles outside the lab door, record in log book. Notify compressor watch if range is outside this range (1200-1700 psi).
4) Add any other necessary information and comment into the log book.

Other items of importance:
1) Check regularly on the Regulus navigation screen that Data logging is ON and file size is increasing. Report immediately to Paul Girouard if system is not logging.

2) Note whenever an OBS is passed as indicated by DTG WP (distance to go to the next way point) and enter into the log book.

3) Monitor the "Speed log" and make sure it is less than 5 knots. If speed exceeds 5 knots, notify bridge and ask them to reduce the speed. Enter time, comment, and speed change into the log book.

4) Include note on weather sea state every few hours.

5) Label hour marks on bathymetry record with day and time. Write depths in hard cover log for the 5 minute intervals .

6) Monitor firing signal on firing box computer screen. Report any problems to compressor watch.

IF you have questions, ASK for help

Watch keepers schedule:

Marie Archambault	0000-0600	Cabin 36 phone 208
Sonja Goold	0600-1200	Cabin 36 phone 208
Helen Lau	1200-1800	Cabin 37 phone 207
Wu Yue	1800-2400	Cabin 45 phone 212

Paul Girouard	navigation	Cabin 41 phone 210
Robert MacGregor	echo sounder	Cabin 121 phone 244

From centre point of the array
to the stern of the ship is 88ft

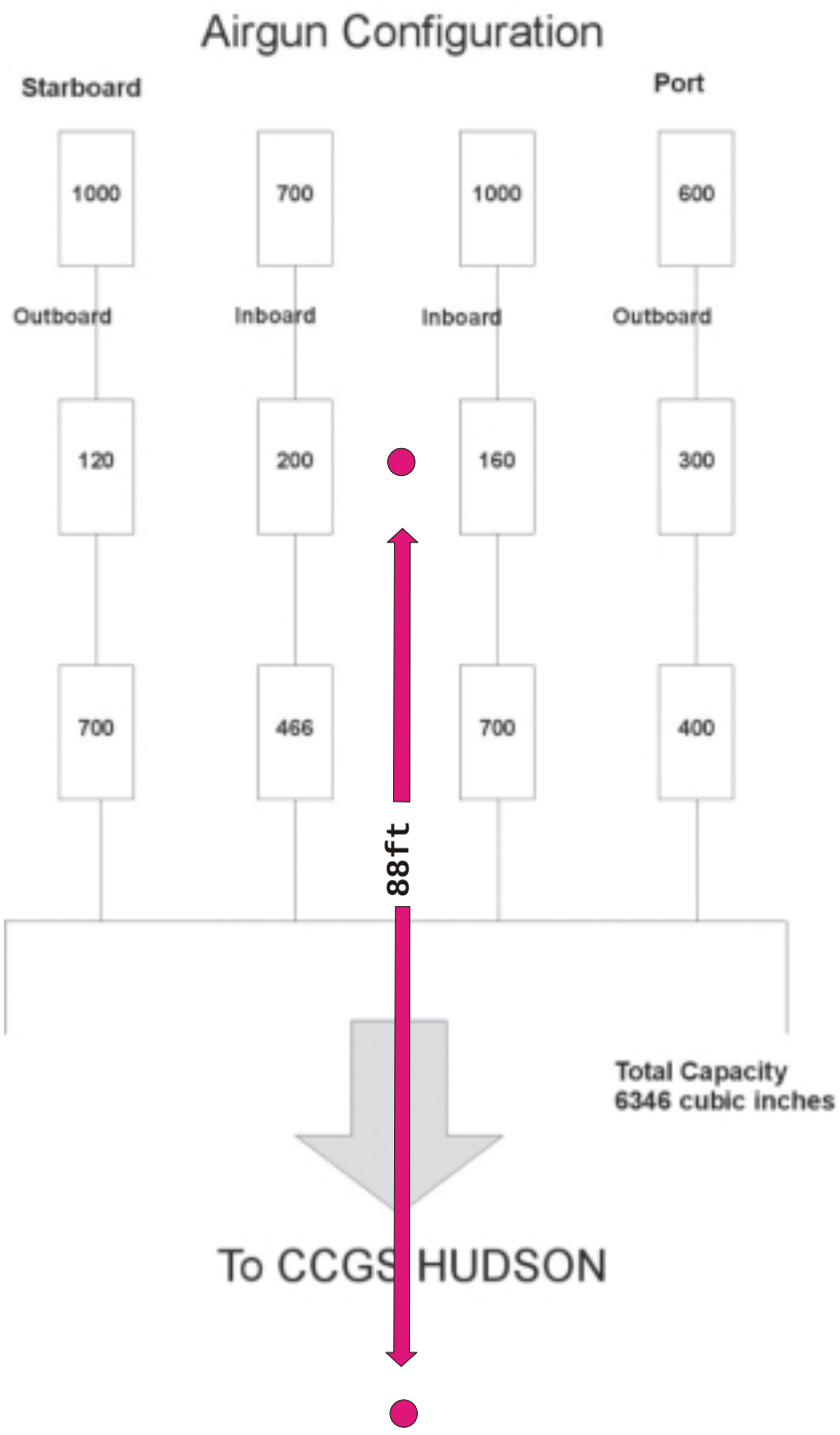
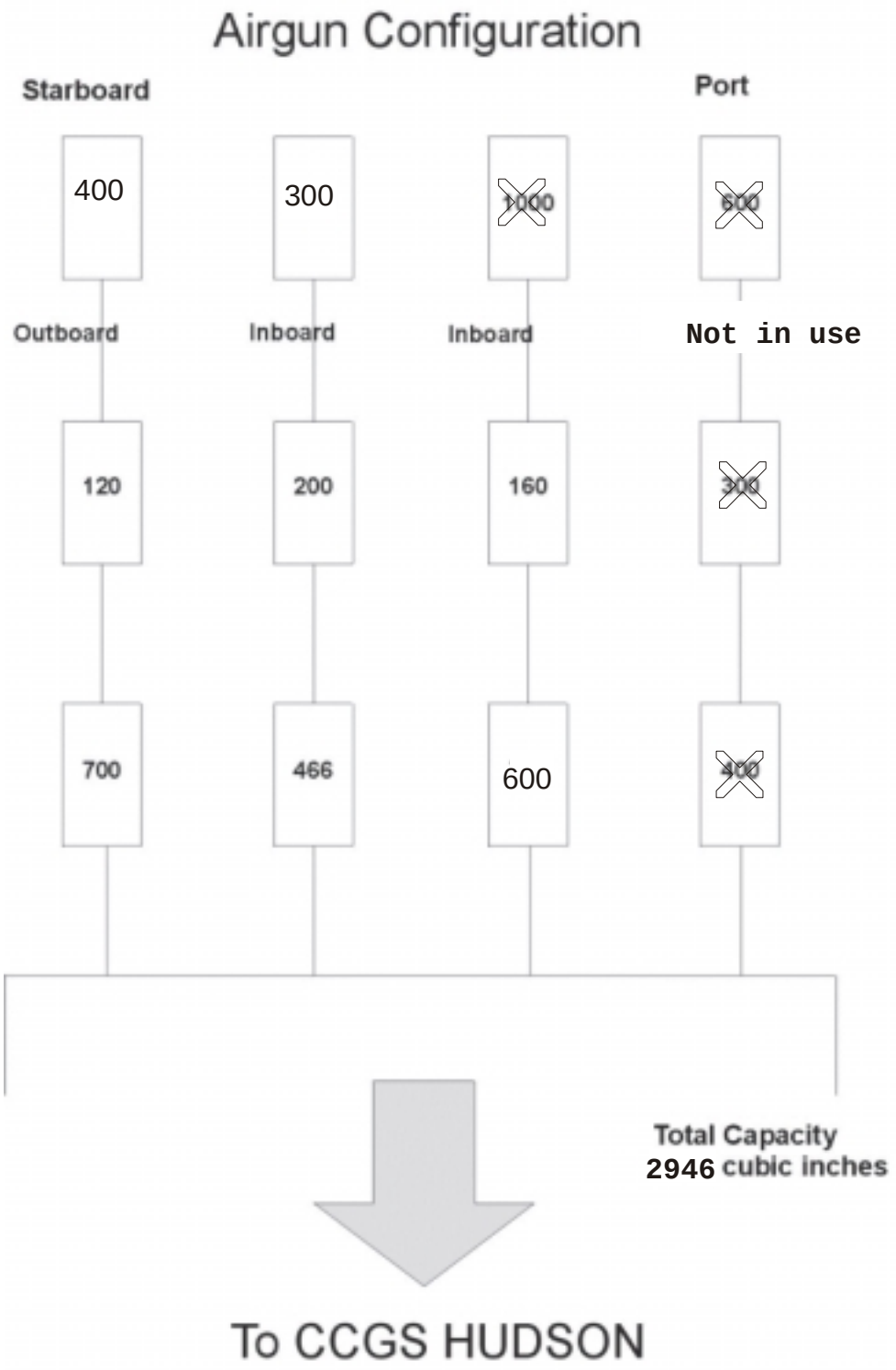


Figure 14. Full airgun array showing the configuration with respect to the CCGS Hudson



15. The configuration of the high resolution airgun array

Notes for the next cruise:

Always advise the Bridge to turn off the starboard propeller when deploying the outboard array

Buy a colour printer.

Why does the oceanographic ship not have a sounder that automatically digitizes water depth?

Cruise Report Hudson 2002-011
(Technical)

CCGS Hudson- Dalhousie University DOBS Refraction Program May 2002

Submitted by
Borden Chapman
Ken Asprey
Larry Johnston

May 2002

Cruise Overview:

The CCGS Hudson was the platform for a refraction program conducted from May 4, 2002 and ending May17, 2002. This was a joint project between Dalhousie University, Department of Oceanography, under the direction of Dr. Keith Louden and the Geological Survey of Canada, under the direction of Dr. Ruth Jackson.

The cruise objective was to run two refraction lines, one over the top of the Flemish Cap, and the second refraction line in the Hibernia/White Rose area. Technically, the two lines were a standard DOBS deployment, air gun array shooting program as conducted in past years.

Technical Overview:

During the cruise GSC (A) provided our pool of 10 DOBS instruments and the necessary towed air gun array equipment and Dalhousie provided their 11 DOBS.

Setup and operation of the equipment during the program was split between two technical groups. Dalhousie University provided students and technical personnel to prepare, deploy and recover the DOBS as well as a contract air gun mechanic, Mr. Larry Johnston. Mr. Johnston also helped in the preparation of the array prior to departure from BIO. GSC (A) supplied the operators for the air gun array and scientific support through Dr. Ruth Jackson.

The air gun array consisted of twelve Bolt Associates Inc. air guns in a configuration of four groups of three guns, chamber sizes ranging from 120 cubic inch through 1000 cubic inch. Each group of three guns was mounted on a steel support structure approximately 8.5 meters in length. The array was deployed from the stern of “CCGS Hudson” and towed through the water at speeds not exceeding 4.5 knots.

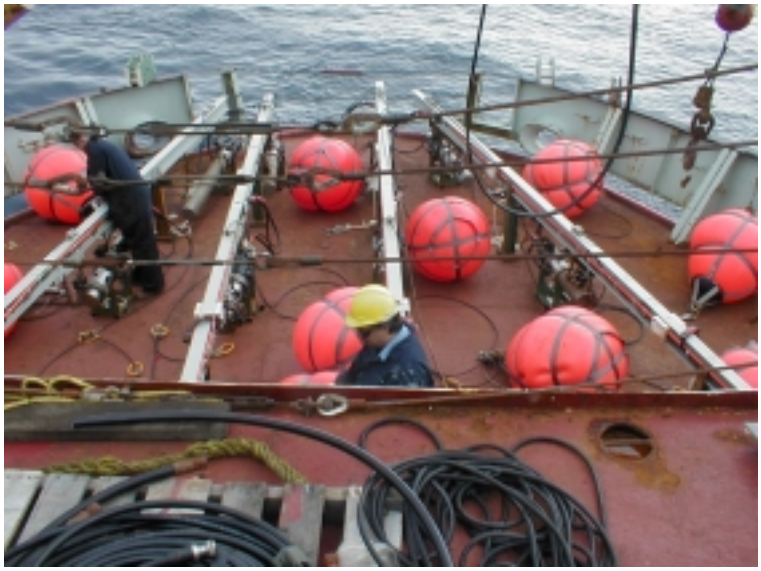


Figure 16. Air gun array in preparation for deployment.

Air gun array detail:

The air gun array was designed to provide a focused acoustic pulse to collect reflection seismic data. For the refraction program just completed some of the parameters which are important for the "tuning" of the array become less consequential. Actual array beam spacing is not as important for the collection of the refraction data as it would be for that of a reflection program. This allowed some latitude in the towing arrangement and deployment of the gun array. It should be noted that the distance of the array from the stern of the ship was kept at 25 meters, and the array beams were towed at a depth of 7 meters. This was consistent with other past cruises using a similar configuration.

The air source for the experiment was provided by two model W2 Price air compressors. These two compressors, one diesel driven unit, the second, a 150 HP electrically driven unit, provided a total of 360 SCFM air at pressures between 1500 and 1750 PSI. The air pressure was dependent on the gun cycle rate, and during the Flemish Cap line firing was at a 1.00 minute fire reparation rate. As the total air requirement to fill the 12 guns is approximately 366 SCFM, these two compressors were not able to provide enough air at the desired pressure of 1750 SCFM. Therefore, during the first phase of the work over the Flemish Cap operational pressures were in the area of 1500 PSI, well within the 1100 to 2000 PSI specified range of the air guns. It was noted, however, that there seemed to be more gun instability (+/- 2mSec) for some guns at the lower pressure. During the second experiment the number of guns and fire rates were adjusted to provide a fire rate of 23 seconds at a maximum pressure of 1750- 1800 PSI.

Air was delivered to the four air gun "beams" via Synflex hose bundles. This year differed from past in that three separate hoses were used to supply each gun on each of the four beams. This allowed for better control of air delivery. In the event a specific gun failed, as was the case of the 200 cubic inch gun during the second phase of the program,

the air to that specific gun could be shut down. (The gun failed, as later learned, due to a leaky air supply hose on the beam which had been cut through by chaffing.) The current configuration for the system used three “bundle winches” to deploy and recover the arrays. The fourth air line bundle was deployed and recovered by hand.

Small “tugger winches” were used to actually lift, deploy and recover the beams. The bundle winches were used to recover the air lines so no pulling strain was put on the bundles at any time during the deployment, pulling (surveying) or recovery of the beams. The tugger winches had approximately 50 meters of 3/8 inch stainless steel wire on the drum. Two independent electro-hydraulic tugger winches and two similar tugger winches located at the front base of the bundle winches provided the recovery method for the array beams.

Figure 17. Bundle winch holding the air hoses in preparation for deployment. The smaller winch in front (tugger winch) of the tugger winch holds the wire cables.

The firing of the air guns was controlled by a 12 channel firing system rented from Real Time Systems from Texas. This is a PC/ DOS based program that allows for auto synchronization of the guns. During the program one channel failed and it was initially believed a gun had developed problems, but it was discovered that the fourth channel of the second unit module was not supplying trigger pulses.

Shipboard operations:

The program allowed approximately two busy days of preparation work on the array after departure form Dartmouth base. Most of the time was spent in the final array assembly process. Because of the additional third air line, the configuration of the air distribution on the beams was different from past years. This meant that different methods of mounting air lines and electrical cables were developed “on the fly”. The addition of the blast hydrophones created space problems on the beam. The lead cables for all the blast phones were made 10 meters long. This was fine for the aft guns on each beam, but created space problems for the excess cable on the mid-ship and inboard guns. The excess cable was tied to the synflex air lines and tucked away as best as possible. However, after the array was recovered on completion of the first line, (approx 56 hours of shooting) the synflex had stretched badly and the excess cable was hanging below the beam and in one case was actually tangled with the air gun itself.

The deployment of the array was done in sequence, starting with the starboard outboard beam, then port outboard beam, starboard inboard beam, and finally the port inboard beam. This proved to be best sequence and the deployment took approximately 70 minutes. Recovery was in reverse sequence and took approximately the same time. The second work area (White Rose) used only three array beams, a total of 8 guns. The deployment used only three beams, and the port outboard beam was stowed on the hangar deck to allow more room on the quarter deck. One error in this three beam configuration which should not occur again was the placement of the 8th gun at mid ships rather than outboard on the array beam. With two guns mounted to the end of the beam closest to the ship, the beam was not level during the deployment and recovery operation and made for difficulty in handling the beam over the side. This can be corrected positioning a two gun array at either end of the beam.

Compressor operations:

During the past winter, both Price air compressors underwent extensive refits. The electric compressor was run up for approximately one hour prior to the cruise while the diesel compressor was not started until it was on the vessel. Fortunately the units worked fairly well. Problems developed in the diesel with some blow off from the third stage relief valve. This was caused from leakage of air from the fourth stage inlet valve. Although the assembly manual does not show this part, there is a small copper gasket located between the valve and head. This was omitted during assembly and there was no spare on the vessel. Ship’s engineers fabricated a copper gasket from a small piece of pipe and this worked well for the remainder of the cruise. A similar leak developed with the electric compressor, but this proved to be a fourth stage inlet valve disk. A replacement valve was installed and operation was restored to norm.

Figure 18. W2 Price air compressor.

The electric compressor developed an “overheat condition” early in the program. To solve the problem, the compressor was re-plumbed to circulate sea water though the inter-coolers. This is not a satisfactory mode of cooling, but proved necessary to keep the compressor cool throughout the program. It is assumed that an “air to coolant” leak has developed in one of the four intercoolers. This causes repeated air locks in the sea water to coolant heat exchanger, and thus an overheat situation. Some work will have to be carried out this summer to determine where the leak is, and also may lead to the possible replacement of a heat exchanger.

During the first refraction line the electric compressor was being run from the GEC electronic speed controller. Because of the demand for air, the controller was running at maximum capacity. At about 1AM the controller took out all three 200 AMP line fuses from the 440 line. It was determined a failure had occurred in one phase of the SCR banks and the associated driver circuit. To expedite the repair the old auto transformer starter was reinstalled and the pulley on the 150- HP electric motor was changed to accommodate the additional speed vs. frequency curve. During this 2 hour operation the firing rate was reduced to 2 minutes and the diesel maintained operational air pressure.

A problem with the oil pressure on the $3^{rd}/4^{th}$ stage sump of the diesel will have to be addressed. Pressure was running at about 15 to 20 pounds. This will have to be looked at and repaired before the compressor is used in the field again. Perhaps Nova Automotive should address this concern, as this was part of the work they carried out in the spring.

Conclusions:

The preparation for this program remains very labor intensive. It is estimated that approximately 8 man months went into the setup for the technical operations of this program. From a cost side it is estimated that the GSC contributed in excess of $75,000 towards the program's success. Although the scientific part of the program will probably be judged a success, it has proved to be a very expensive program to conduct. In the future, additional preparation could be completed long before the actual departure date if the funding and purchasing could be streamlined.

In fairness, having not had any opportunity to test the compressors prior to departure put the program in great jeopardy. The delay in completion of the refits, just prior to departure, will likely not happen again. Hopefully, with the equipment returning in better condition this year, it will greatly reduce the tool up costs for similar programs in the future.

There are several things to note here:

(1) This was the first year in the author's 25 years of sea going experience that GSC has placed hydraulic gear (winches, power packs etc.) on a ship where it has not caused problems with leaks of hydraulic fluid. There were no failures of this equipment at all. The money that was spent was spent well. It should not be assumed we won't have to spend any funds again this year for repairs, but it does reflect on the benefits of routine maintenance, which the gear has never had.

(2) The compressor equipment that GSC (A) has is inadequate for this array, as configured. The requirement for a new compressor should remain high on the capital "wish list". As the air guns and sleeve guns are one of the principle tools for GCS (A), we should not loose sight that the compressors are all 20 to 40 years old and *must* be replaced.

(3) A suitable budget for ongoing maintenance of these large capital items should be considered and put into place. This would hopefully prevent any major cost expenditures as we experienced this season.

(4) The man hours expended on such a cruise far exceeds any other program that GSC(A) undertakes. The author feels that if GSC (A) intends to continue this type of scientific endeavor within house, or in conjunction with universities or other scientific agencies, it is essential that additional mechanical personnel should be hired to help in the development of better methods of assembly and conducting better scheduled maintenance on this very expensive equipment.

On a final note: The author wishes to thank the following persons, for without their exceptional efforts the cruise would not have been a technical success. Mr. Todd Peters,

welder BIO; Mr. Neil MacKinnon, machinist BIO; Mr. Greg Middleton, Co-op student GSC (A); Dave MacLean, and ships deck crew, CCGS Hudson; Chief Engineer Peter Brick and the engineering staff CCGS Hudson; Mr. Larry Johnston, Dalhousie University contractor.