GEOLOGICAL SURVEY OF CANADA
OPEN FILE 4427

HUDSON 2001-028
SCOTIAN MARGIN TRANSECT

R. Jackson, S. Dehler, T. Funck, P. Girouard, K. Giles

2003

Natural Resources Canada | Ressources naturelles Canada

Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 4427

HUDSON 2001-028
SCOTIAN MARGIN TRANSECT

R. Jackson, S. Dehler, T. Funck, P. Girouard, K. Giles

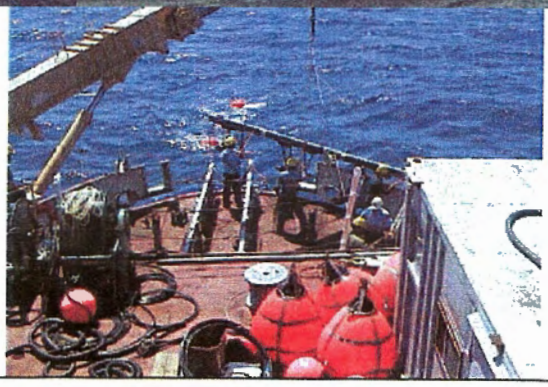
Available from
Geological Survey of Canada
Bedford Institute of Oceanography
1 Challenger Drive
Dartmouth, Nova Scotia B2Y 4A2

R. Jackson, S. Dehler, T. Funck, P. Girouard, K. Giles
2003: Hudson 2001-028, Scotian Margin Transect;
Geological Survey of Canada, Open File 4427, 47 p.

SMART 2001

Scotian Margin Transect

Hudson 2001-028



Geological Survey of
Canada Atlantic Division
Dartmouth, Nova Scotia

Dalhousie University
Department of Oceanography
Halifax, Nova Scotia

Scotian Margin Transect (SMART)

Table of contents

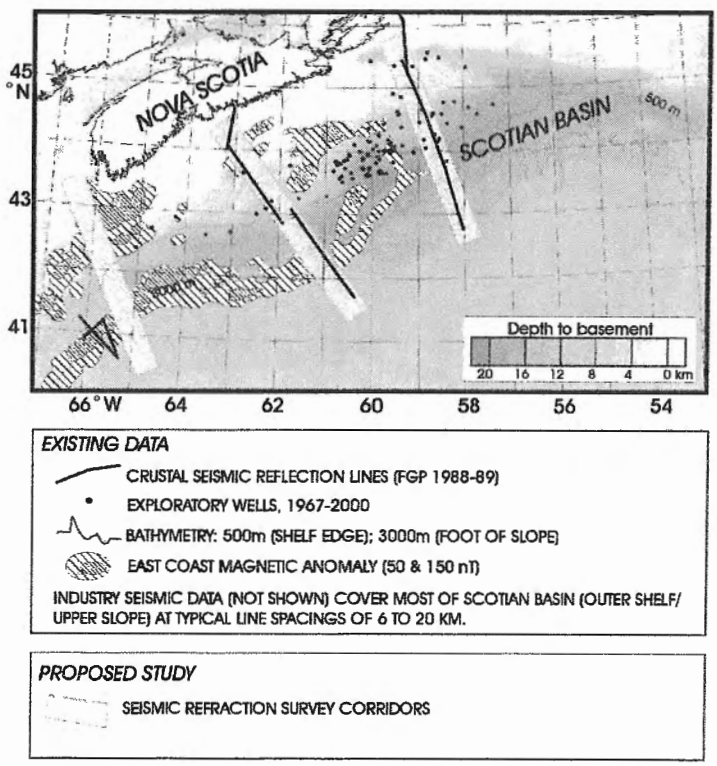
for cruise report for **Hudson 2001-028**

Project descriptionas planned

The scientific goal of the Scotian margin seismic experiment is to address questions concerning the structure and evolution of the continental margin and sedimentary basins off Nova Scotia. The continental margin formed during rifting and separation of Africa and Nova Scotia, and the present day structure holds the key to understanding the processes involved in continental rifting and basin formation. The exploitation of recognised hydrocarbon resources contained within the sedimentary basins off Nova Scotia will require greater understanding of the margin. In addition, the new information will aid decision-making concerning resource and risk management, exploration strategy, and government regulations.

The goal of the Scotian margin project will be achieved by using the seismic refraction method, in which acoustic waves generated below the sea surface travel through the water and underlying rock to receivers located on the sea floor. Interpretation of the data, which involves ray path and amplitude modelling, will provide velocity-depth information on the upper 40 km of the Earth's crust. Three profile lines, ranging from 300 to 500 km in length, are planned to sample the structure across the Nova Scotia margin (Figure 1). Profile one is located off the northern tip of Cape Breton Island, profile two lies offshore from Halifax and profile three starts at the southern tip of Nova Scotia. The program is scheduled for June 20th to July 11th, 2001. The acoustic source is an array of twelve airguns that have a combined volume of 6346 cu in. High-pressure air is vented through portals in each gun to produce an air bubble of about 1 cu m. This source generates a low frequency signal of 5 to 100 Hz. The airguns are towed about 30 m behind the 100 m diesel-electric vessel CCGS Hudson. The sound after it has been reflected and refracted through the layers in the earth is recorded on up to 21 instruments (digital ocean bottom seismometers) on the seafloor.

Figure 1 Proposed experiment to compare with the lines actually run.



Existing multichannel reflection profiles that imaged the sedimentary and basement features off Cape Breton and Halifax provide constraints on sediment thickness, basin shape and crustal thinning along lines 1 and 2. Shorter lines off southern Nova Scotia provide information on the structure of the slope in this region. The new refraction data will help to determine: (1) the location of the continent-ocean transition on each line; (2) the thickness of the continental crust and the degree of thinning associated with rifting; (3) the presence or absence of volcanic underplated or extrusive material; and (4) the thickness and velocity layering of sedimentary basin fill.

Scientific Staff:
Ken Asprey, GSC
Borden Chapman, GSC
Sonya Dehler, GSC
Thomas Funck, Danish Lithosphere Centre
Joanna Gerlings University of Copenhagen
Paul Girouard, GCS
Kristina Giles, GSC volunteer
Dave Heffler, GSC
Bob Iuliucci, Dalhousie
Chris LeBlanc, Dalhousie
Ruth Jackson,GSC
Larry Johnston, GSC contractor
Walter Judge, Dalhousie
Helen Lau, Dalhousie
Keith Louden, Dalhousie
Cory Nixon, GSC student
Martin Uyesugi, GSC contractor
Wu Yue, Dalhousie

Ship's Officers:
Commanding Officer Michel Champagne
Chief Officer Craig Miller
Second Officer Glen Adams
Third Officer David Boyd
Chief Engineer John Blagdon

Scientific equipment specific to cruise:
21 Digital Ocean Bottom seismometers
12 airguns on 4 beams totalling 6346 cu in
2 compressors
heat flow probe
AGCDIG-system for digitizing seismic signals

Cruise Diary: Hudson 2001-028

Wednesday June 20 Day 171

Hot and sunny. In fact, it was unpleasantly hot on the stern as the airgun array was being assembled Scheduled sailing time 14:00 hr local(l), 3 hr less than GMT (1700 hr). The OBS are all aboard, airguns are on beams on the after deck and the compressors are welded to the deck. This was a considerable feat. The ship arrived at the BIO dock on a Friday and the gear from the previous cruise was removed. Borden Chapman and Larry Johnston worked the weekend assembling equipment for the airgun array. The compressors were welded to the decks on Monday, and Tuesday was a crew change day. All this complicates and slows down preparations for the mission. In the laboratories and working areas there are a raft of PC running. Regulus, the navigation system, is up and running thanks to the efforts of Paul Girouard. The Second Mate had entered the way points for line 2 that runs out of Halifax Harbour for 460 km across the shelf, slope and into deep water. All hands were on board by 13:30. Keith Louden mentioned he was not certain if a system was onboard to digitally record the seismic reflection across line 2. After checking I discovered it was not aboard. Mike Gorveatt was leaving the ship and I requested his help. He said if the system could be found he would have it to the ship by 14:00. At 13:55 he and Kevin Robertson carried the electronics and a monitor aboard.

We sailed on time accompanied by kilted Nathan Hayward on the bagpipes and Matt Salisbury on the penny whistle. It was much appreciated. Finally we were leaving port after months of preparations. A small benefit to the timing of this cruise is the avoidance of the worst traffic congestion that has ever been experienced on the Mackay bridge due to resurfacing.

We mustered in the lounge and were given instructions for fire drill procedures. Then we had fire drill and watched the boat drill. This was followed by a familiarization tour. This took us to supper time. The fog had rolled in and the motion of the ship was apparent now. The water temperature at about 10:00 pm local time was 15 ^{0}C.

The first OBS went over the side after supper. It took much longer to prepare than expected. The OBS deployment crew was used to launching over the stern. The new airgun array occupies the entire afterdeck and this is not possible. It is difficult to prepare the instrument on the foredeck while steaming. The operation takes about 45 minutes rather than 15. To shorten the time on station over night the OBS crew were setting up the next instrument while watching the pinger on the previous deployment as its dropped to the seafloor.

The waves were about 1.5 m and the wind speed 20- 25 knots so the motion of the ship caused a few of the new staff to be mildly uncomfortable.

Marty Uyesugi was concerned about the resistors in the GSC model OBS ie the last modification. Dave Heffler reassured him no changes had been made since Dalhousie used them in their last experiment.

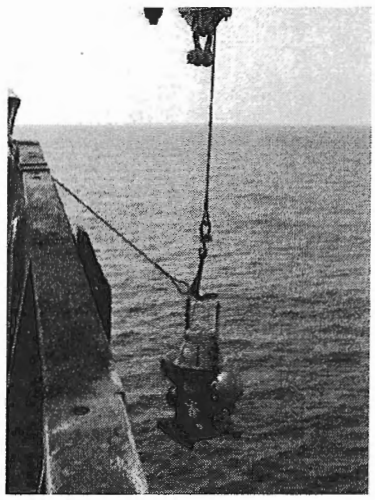
Thursday June 21 Day 172

The training of the watch keepers is underway. This is always a confusing time for the new staff. After a night of watches Sonya Dehler prepared a check list. Paul Girouard is training the watch keepers in the use of the Regulus navigation system and is setting up the network connections.

Although the launching of the OBS is taking slightly more time and we are about 3 hours behind schedule at 11:00 l, it is not critical at this point for two reasons. The end of the line will be reached prior to day light and we will not stream the air gun array until then. Secondly the airgun array will not be ready by tomorrow morning.

The watch keepers are being entertained by pilot whales at station 7 on the first line (line 2) and several common dolphins at station 8. I watched two of the dolphins swim below a large bird floating on the water and torment it into flapping across the sea surface. After station 8 the OBS are closer together and there are not many prepared -- it will be necessary to monitor the progress. The launching of OBS was a continuous activity from 7:00 l yesterday.

Figure 2 OBS launch



Meanwhile there are four people working diligently to prepare the multi-gun array for firing. They will work until 20:00 l. At that time they will give me an estimate of the number of hours required tomorrow for the array to be ready. I talked over the plan for tomorrow with Keith Louden, the second scientist, and then reported to the bridge.

Talked to Borden Chapman, Ken Asprey and Larry Johnston about the readiness of the air gun array and authorized overtime. It is still unlikely that the airgun system will be operational when the OBS launching is over. The problems with getting machinists to work prior to sailing, the two days spent welding when the ship was in port and the short time from port to start of line have contributed to this situation. The airgun group have succeeded in repairing six non-operational solenoids and had to deal with problems due to cost cutting on blocks that hold the firing lines to the beams. The cheaper nylon blocks cannot be machined to the same precision and the hoses slip through the blocks chaffing the wires and putting stress on the fittings.

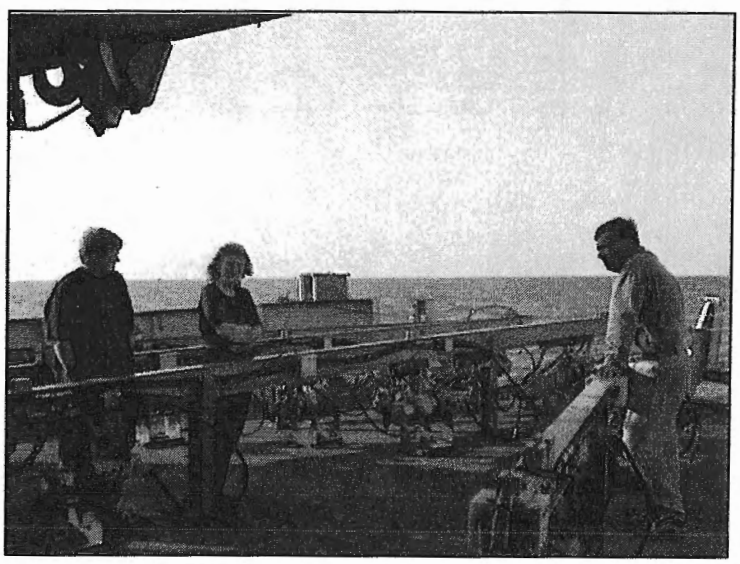
Friday June 22 Day 173

Calm seas and bright sun. The final OBS was launched at 10:30 l so the total time to steam and launch the OBSs took about 38 hours opposed to the 30.6 calculated. We then steamed 15 nm along the line and we are now waiting for the airgun array to be made operational. Dave Heffler lowered a hydrophone 1000 m into the water to test a component of the new system he is working on for the accurate location of cores.

The GPS clock and time break generator Keith bought for firing the airgun array was not working. Dave Heffler set about to design a new box to do this but before this was completed Keith's system was up and running. This was due to Dave's suggestion that the antennae was the problem and he gave Keith another to try. As we wait for the airgun system to be prepared, the students had a tour of the engine room and we had a science hour with Sonya Dehler presiding. The Captain attended and the discussions lasted about an hour with the students onboard describing their scientific interests to him. Kristina Giles continues to take digital photographs of the staff and ships crew for setting up a rogue's gallery on the bulkhead so we can all put names to faces. Before bedtime she put a montage of labelled photos up. There are still crew members to be added to the group picture, plus printing the photos in colour and preparing them for the cruise report but the bulk task is completed. She has also been documenting the airgun array set up and the launching of the OBS.

I must admit I am sorry to learn that needle guns are still used to chip paint while at sea. It brings conversations to a halt and if you're lucky forces you to move to a quieter location on the ship. The deck crew have supplied all the staff with ear plugs. These are small orange cylinders with a fetching matching string that often decorate the neckline of officers, staff and crew. After supper overtime was authorized for GSC staff working on the array.

Figure 3 Discussion about the need for and the number of overtime hours.



The situation can be summarized as: we are on the CCGS Hudson with a crew of 51 not being able to work for want of authorization for 3 hours overtime each for two people. After consultation with

Sonya I tried calling Dick Pickrill on the MSAT telephone with permission from the Master. He was not at home so I called Kevin Robertson. He was sympathetic and authorized overtime for this problem. The work on the airgun array continues. After completing the assembly of all high pressure and electrical cables on the four towing beams, the hoses to the 300 cu in gun in the mid position of one of the arrays was discovered to have a faulty high pressure line and the hoses had to be dismantled and rebuilt. This problem is exacerbated due to the cost cutting measures that prevented the buying of new lines and necessitated the reuse of the hoses

We had a pancake flat sea for the sun to set into in the next to the longest day of the year. This was followed by a starry night. The storm petrels disorientated by the light were landing on the ship and staggering about. The mate was going to send the sea watch to carry them into a dark area on the ship and toss them into the air so they could fly again. This is a far cry from the incident years ago when a Canadian goose flew aboard and one of the Mates grabbed it and rang its neck. It was eaten for supper.

Saturday June 23 Day 174

Clear and calm. We are still waiting for the airgun array preparations to be completed. Last night the firing lines and high pressure hoses were completed and tested. The floats for the array must be added and the firing system made ready.

Paul Girouard is distributing the position of the OBS to the scientific crew on network, preparing way point files for the bridge for the airgun shots and making plots for the cruise report. Keith, Thomas and I had a scientific discussion about the transition from oceanic to continental crust along the margin from Nova Scotia to Newfoundland trying to identify salient points to concentrate the interpretation phase of the project and short comings in the present experimental set up.

Thomas Funck had water velocity profiles from the Newfoundland Basin and their application to this area was thought reasonable as most of the variation took place in the top few 100 meters. This difference is insignificant in a ray path through 4800 m. Keith was considering modifying the CTD from the heat flow probe so it could be lowered independently to measure the entire water column while we are on station. Consultation with Walter Judge indicated that this was indeed possible and they ran a CTD to about 2000 m and got a good velocity depth curve.

The seismic profile to be run is 264 nm long. At 4.5 knots it will take 59 hours (~2.5 days), at 4 knots, 66 hours (2 days 18 hours).

All day long in the hot sun the seismic technical support slaved over the airgun array until 20 30 l. The four staff were being supported most of the day by Greg, one of the capable deck hands, later by several seaman and the Chief Engineer when electrical problems were detected with the starboard tugger winch. From the bridge monitor I could see the airgun array surrounded by up to nine workman all with their heads down concentrating on their job. They were probably within an hour of completing the job. The solenoids were installed and they were inserting nylon blocks for protection of the cabling into them. The sun was setting, they were tired and would have to be up

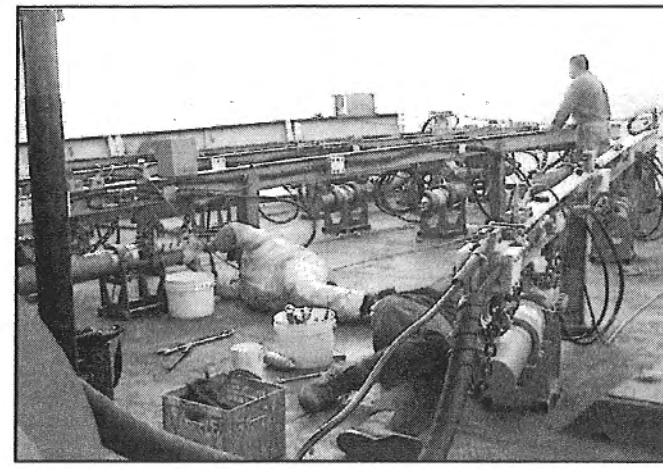
all night on compressor watch. In addition the deck hands were new and it would take several hours to deploy the array and the work site had the feeling of an accident about to occur. It was agreed by all not to deploy the array until the morning. After the ships crew retired Borden, Larry and Cory continued working until 22:00 hours to have the array ready for deployment in the morning.

The third Officer David Boyd called me to the bridge and gave me the information that the ship the Professor Polshkov was firing an airgun array in a box centred at 44°30'N 55°W. We may or may not hear their signal.

Meanwhile the rest of the staff and crew enjoyed a BBQ on the waist of the ship and watch the play of sun and light on the waters. The seabirds flew low around the ship hoping to share our repast.

Sunday June 24 Day 175
Sunny and calm in the gulf stream. The Captain and department heads are dressed in their number one uniforms for weekly inspection.

Figure 4 The components in the airgun array:
1400 ft 3/4 inch high pressure air lines
1400 ft of electrical firing lines
424 bolts
32 air hoses
weight of beams1650 x 4 =6600 lbs
length of beams 26'
20 lifting harnesses and slings
array volume 6346 cu in
100' of ½ inch grade 80 chain



The airgun team, hereafter the A team, prepared to deploy the airgun array. The compressors were run up. There were concerns about the high temperature of the sea water as a coolant. The ship's technician was called to start the echo sounder in the GP lab. It is running on the hull mounted transducer. If the Ram is needed due to rough weather causing deterioration of the signal, a minimum of an hour will be required due to the air quality tests before an individual can go into the confined chambered to lower it. Regulus was set up, so that the most important parameters were shown in a red font and the log books made ready. Sonya and Kristina were training log keepers and making suggestions on how to improve the watch keepers' notes.

At 0855 l the crane on the fantail was in operation and the starboard beam of the array was being lowered into the water. By 10:00 l it was obvious there was a problem. The Mate asked for the engine RPMs to be brought to 0. After considerable activity on the stern while the crew and the A team tried to manoeuver the starboard beam in place it became obvious the cable lengths were too

short. Towing lines and hoses had to be lengthened. This all takes time. The cable lengths were adjusted and the starboard beam lowered successfully into the water. The crew broke for a short lunch and by13551 the compressors were run up and shooting began. All airguns were firing. To Keith and I the array has a sharper or higher frequency sound than the older array as planned. The OBS data should show us if this is true.

Almost immediately after the first few shots the compressors were shut off and the deck crew called to clean up a small fuel spill on the deck. This was done and the fueling system for the compressors corrected and the compressors restarted. They ran for a few minutes and they were off again. The two sets of floats on the starboard rails had tangled. The array design indicated that the beams on the starboard side should be a mere 7 metres apart. This is obviously inadequate and a greater separation will be used. An hour later they were back in the water. Then back out because one of the floats on another beam was towing below the water due to a tangled harness. This was corrected. The compressors were restarted and at about 16:00 local the shooting was initiated several nm landward of the first OBS slightly shortening the proposed line. It is now imperative to collect data and the hour to be spent circling and the several hours to go back along the line are not available.

Keith was concerned with the shot breaks on the firing box. Dave Heffler spent about an hour insuring that they were all aligned. There is still a question if there is a 100 ms offset between the firing pulse and the GPS clock. This will be discussed in more detail tomorrow.

The outer starboard beam lost a float. We have never lost one before and we only have one spare. We will try ordering floats, bridles and shackles and have them delivered to us at Louisbourg before we start shooting the line off Cape Breton.

Monday June 25 Day 176

Airguns operated consistently all night. This meant half of the A-team had been up for 24 hours. Larry Johnston said that by the end of his watch all that occupied his mind was how great it was going to be to crawl into his bunk.

Mid morning due to compressor maintenance a request for change in firing rate was misinterpreted and did not happen. The air pressure dropped and firing was stopped until pressure could be built up. It became clear that the firing system was not well understood. During investigation of the clock firing ceased and the pressure built up forcing the compressor to be turned off again This entire episode caused a loss of thirty shots. The lesson learnt was the controls for the Odectics clock are not readily changed so it will be easier to shut the compressor off for short maintenance checks rather than resettting the clock.

The concern raised yesterday over the delay between the Dalhousie Odectics clock and the firing signal was addressed after Dave Heffler adjusted the signals on the rented firing box.

The A team continues monitoring the airguns and compressors. Meanwhile preparations for the next phase of the work is ongoing. Thomas is preparing shot tables for the OBS data, Marty is preparing the retrieval lines for the OBS.

Late in the afternoon the fog rolled in and the constant drone of the fog horn keeps us company. Piped through ship was the announcement that we were back in range of TV. This meant that email was available and I was able to read my messages from work and send one home. It was also possible to surf the web while steaming in the North Atlantic.

Talking to the boatswain Claude Warren he mentioned that it would be prudent to retrieve the air gun array during day light hours. This is another constraint for planning the survey. The ETA for this line is about 6:00 l on June 27. This works out well but a 1 knot change in speed due to currents and tides will be a 25 % change in the estimate of 34 hours. Keith and I discussed stopping prior to the end of line if we had travel paths long enough to sample Moho beneath the margin. Otherwise it will not be possible to run the short high resolution seismic line through OBS 5 because it stops recording data at 21:00 on day 178. This also gives the A-team more time to work on the valves on the electric compressor. Another option is to finish the line and drop an OBS later to run the short high resolution profile.

About 21:00 l it was noticed that the towing cable on the inboard starboard rail had broken. A defective swivel on the ship end, with a section broken clean away from the eye, had caused the problem. Borden requested the crew's assistance and Captain Champagne immediately called them out. They lifted the beam out of the water, replaced the shackle and we were underway again in an hour. The overtime report will be accompanied by the defective shackle given to me by Greg MacLellan.

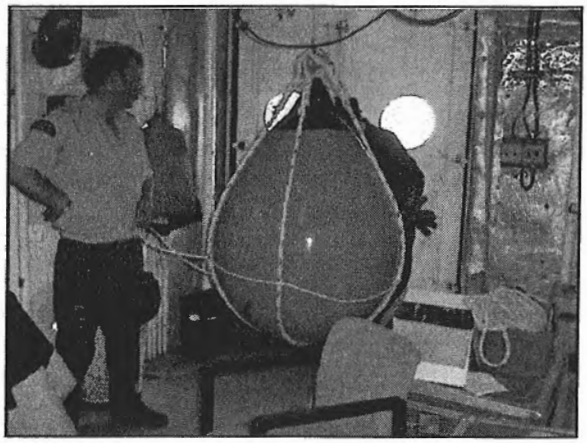
Tuesday June26 Day 177

Foggy with calm seas. The bleat of the fog horn continues.

We are in shallow water now and the vibrations from the airguns are strong. It is less noticeable on the stern than on the bridge. The compressors ran all night but the pressure continues to drop. The problem is related to either hoses or airguns on the outboard starboard beam. The guns were shut off and no improvement in air pressure was noticed. The outboard starboard beam is missing a float and is now towing at an angle probably stressing hoses. Based on increasing problems with this beam it will be lifted out of the water for repairs. This cannot be done until a basket is woven by the crew to put our last float on the array. The Boatswain Claude Warren and Seaman Bill Dobbin are using conventional nautical technique with knots, polypropylene rope, metal eyes and twine to construct one. Yesterday Borden called Mike Gorveatt to see if he could order additional floats, baskets and fittings to be ready prior to the start of shooting on the next line.

The ETA for the end of the line is now about 3:00 l on Wednesday for OBS 1 and just after 4:00 l for end of line.

Figure 5 the Boatswain Claude Warren supervising the construction of a net to secure to an airgun beam for flotation.



I do not think the geology will allow shortening the line by pulling the guns before dark tonight. This will mean sacrificing the short high resolution line Keith hope for across OBS 5. This instrument finishes recording at 21:00 l tomorrow, bringing in the airgun array, steaming and retrieving 4 OBS and setting up the high resolution system is unlikely to be completed in that short time period.

A notice to mariners indicates that the seismic vessel MV Arctic is shooting in the following area.
42^0 34 30 N 61^0 50 36W
43^0 16 30 N 60^0 32 12 W
42^0 50 00 N 60^0 32 24W
42^0 16 06 N 61^0 13 36 W
However it is not visible on the radar screen with a 24 nm range and is not answering VH radio or other attempts at radio communication. The third Officer David Boyd will try to contact them throughout his watch to answer a series of questions about if and where they were shooting.

By about 14:00 l the starboard outboard array was back in the water and all the airguns were firing and the ship was brought back to full speed 4.5 knots.

I called Mike Gorveatt and he will arrange for 5 floats, two nets and several harnesses to be delivered to the Coast Guard base at Louisbourg by Friday at noon.

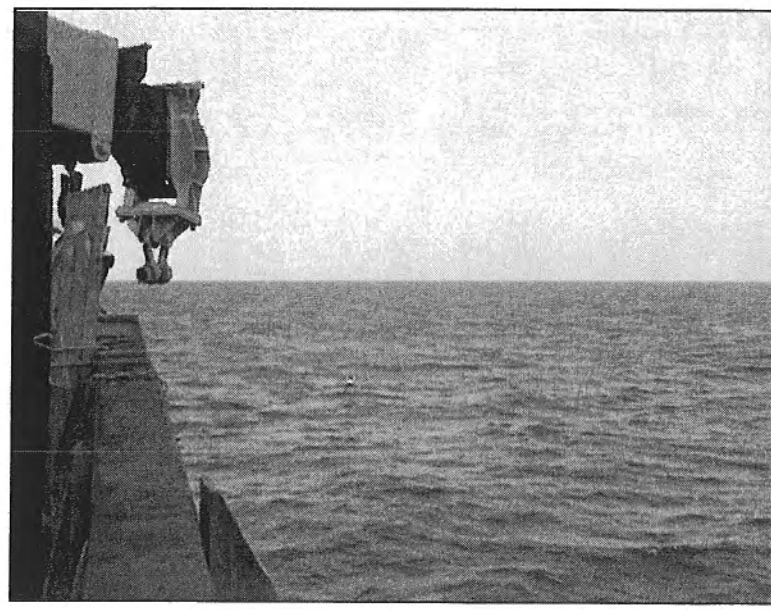
Sonya, Thomas and I discussed scenarios for the remaining 14 days. It will take everything to work without a hitch to get a significant third line. There was also much thought put into an acronym for the Nares Strait project.

Wednesday June 27 Day 178

The airguns were shut off at 04:00 l. Until 06:00 l the ship just crept forward so as not to move us further from the position of OBS 1. By 6:10 l the ship's crew were bringing in the airgun beams. The towing bridle tipped the first beam over on recovery but this was fixed before it was laid in the cradle. Beam 2 was easily placed on the deck. On beam 3 a piece of marlin caught the handle on a high pressure line and the noise sent people scattering all over the deck and blew Larry's cap off. Fortunately, there was no harm done. The last beam on outboard starboard is the most difficult to recover because of its position relative to the Hampton crane. This one came in smoothly. The entire operation took an hour and a half. The ship turned and we raced 4 engines on the line to the position of the first OBS.

The retrieval of the OBS went fine for the first four instruments. Refinements in picking the OBS out of the water could be done. The first four OBS had a metal hoop to be caught by a hook but no rope that trailed in the water. It often took two passes to capture them. On OBS retrieval 5 the instrument's pinger turned on but it did not float to the surface after an hour. A pod of pilot whales played beside the ship while we waited. Why do the OBS not return? We have been doing this kind of experiment for twenty years and for periods we have good recovery statistics and then poor statistics. We postulate, modify and compare and there seems to be no pattern to be discerned. Thomas has taken the raw OBS data from the first several OBS, merged it with the navigation data and converted it to SEGY format and the data looks good.

Figure 6 Small yellow object is an OBS floating at the surface prior to recovery.



At the position of OBS 6 we deployed a 40 cu in gun and fired it every ten seconds for 10 nm. This short high resolution line is an effort to detect gas hydrates and is

being run for Chris Leblanc at Dalhousie. After two hours of shooting the line was terminated and we retrieved the OBS.

We steamed back to OBS 5 that was still pinging. Several attempts were made to release it and to turn off its pinger to save its batteries, none were successful.

Thursday June 28 Day 179

Good visibility, a breeze accompanied by a swell. Overnight the OBS came to the surface as planned. We have 9 safely onboard. One instrument flooded , luckily we got it back and it may have recorded data. This instrument was giving problems when pressure tested so it is not deemed reliable enough to relaunch. We will now redistribute the OBS along line 1 planning on nineteen instruments.

Borden asked for the expected start of shooting for the next line. An estimate of 2 days and 18 hours was made bringing it to Monday morning. This will also suit the stewards and cooks who were planning on a BBQ for Saturday.

Friday June 29 Day 180

The skies are filled with small fluffy white clouds (cumulus) like John Constable painted, navy blue seas and white caps and a swell.

The pick up of the OBS went well over night with two left to retrieve. The planning for the next line has begun in detail. Calculated the number of hours for last pick up, plus transit time to the next line of 7 hours for a distance of 105 nm, gives an estimate of launch time of the first instrument on next line at 22:00 l tonight. The plan for who will launch the first group of instruments is critical because the Captain is offering to use 4 engines and we must be ready when the ship arrives at the first station. The way points for the next line are ready providing all instruments are recovered. Keith is preparing launch time and secondary release tables. These releases will be planned for pick up just prior to steaming to the dock for 14:00 l on July 11.

Discussions with Paul for the refraction processing system on the cruise on the CGGS Louis St Laurent have moved forward. Paul has called Art Jackson to ask him to configure a PC with Linux, Seismic Unix, Fortran, C++, GMT. They will then switch my new PC with this one and it will be put on board the Louis.

Detailed planning took place with the Captain on transferring the floats for the airgun array and other essential items from Louisbourg to the ship. The search and rescue launch may not be available due to repairs, the CCGD Sir Wilfred Laurier will be still loading buoys but we still have the option of going into Louisbourg ourselves and picking them up at midnight. It is such a pleasure to work with a Captain and crew that are working constantly on your behalf. This increases the scientific productivity of the expedition and reduces the stress of all the participants.

The last OBS on the first line recovered at about 13:30 l. The score is 20 out of 21 recovered (95% recovery rate) and one with a leak that will not be relaunched. The data appears to be good and is all backed up. Therefore the next line will be limited to 19 deployments. The airgun array and compressors are ready as well and the ship is flying off to the beginning of the line off of Cape Breton..

It took about 9 hours to steam between the oceanward ends of the line 2 and 1. Speed had to be reduced due to an engine overheating. The Mate Dave Boyd contacted the GecoSearcher and learned that two seismic vessels were operating near Sable Island owned by the same company. (Geco Searcher and Western Monarch). They were shooting from June 24-26 at a firing rate 12-13 s between 42 ^{0}20.0 N 64.3 ^{0}W. Email pc@searcher.vessel.geco-prakla.slb.com.

The launching of the Dalhousie OBS began this time from the starboard waist with the instruments prepared and ready to drop when the ship reached station. The GSC instruments will be dropped from the fore deck as they are prepared in the forward lab while Dal's are prepared in the GP lab.

Saturday June 30 Day 181

A rosy fingered dawn on wine dark sea. Five OBS were dropped in 6 hours. There are two schools of thought in the scientific party on the speed the ship should be using between the OBS drops one slower than the other. The ship has an inherent self correcting mechanism. If you do not specifically ask for a speed of 10 knots they resume their normal mode of operation and this is working to our advantage to get the line run as quickly as possible and to get to the shelter of land before the nor'wester blows up to 45 knots.

The ship got a call from the rescue coordinating centre. The sail boat Lady Iata en route to the Azores has a sick person onboard. There is some possibility the ship will be called to assist.

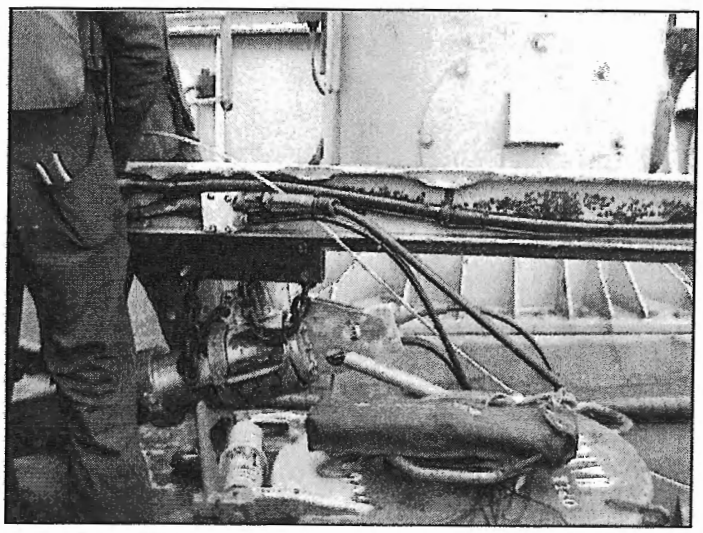
The ship had a barbeque with 35 knot winds and a significant sea swell. Only one wave rained down upon the diners. A North Atlantic picnic is not for the pampered. The last two OBS waiting for deployment served as plate rests. After supper these OBS were launched and we headed for Louisborg to pick up floats, fittings, ties, and pails of various lubricants. There were high seas, rain and fog just before midnight. Inside the harbour the fog lifted, the rain stopped and the sea was calm. The FRC (Fast Rescue Craft) zodiac was lowered over the side and the Chief Officer commanded it on its short voyage to the Coast Guard base. The equipment was brought safely on board. A few members of the crew were disappointed there were no news papers. I asked my personal shopper but he undoubtably had other priorities.

Sunday July 1 Day182

Foggy with swells. Borden, Larry and Ken were roused at 04:00 l so that the equipment that arrived during the night could be configured onto the airgun array for launch at 06:00 l when the crew had eaten their breakfast. The outboard starboard beam was being lowered into the water when by

combination of the ship's roll and human error the bridle supporting the beam hit the propellor and cut it. There after the beam collided with the propellor six times. The props were stopped and the salvage operation began. The array hanging vertically by one metal cable was carefully hauled back onto the ship. The Chief Engineer and the Captain surveyed the damage to the ship and equipment. A diver will have to examine the propellor in port. Miraculously although the beam was twisted and had six dings in it none of our cables (electrical or high pressure) were damaged. The process of making a new bridle was begun. This was followed by problems with winches spooling out but not in and solenoids not operating on a 200 cu in airgun. The A-team worked from 4:00 -12:45 l when the first shot fired. At this point a responding boom echoed beneath the ship. Closer inspection showed several guns on different arrays not sealing. The guns on the port side were sealed. The 1000 cu in airgun solenoid that is not firing probably sustained damage during its close encounter with the propellor. I spoke to Keith and we both agreed to start the line without the 1000 cu in gun. We have a higher pressure and it may compensate. Tempus fugit. Ten days left in the cruise.

Figure 7 shows dents in beam that occurred during launch when the propellor and beam collided. The high pressure airguns and electrical cables were undamaged



Borden and the A-team continue to monitor the airgun array. Just after supper the infamous outboard starboard array was shut down and the cables rerouted to prevent chaffing on the ironing boards. The array was turned on again. The pressure with the one gun shut off is about 1550 psi (1200 psi was all that was reached on the first line) and may compensate for the smaller number of cu inches 5446 compared to 6446.

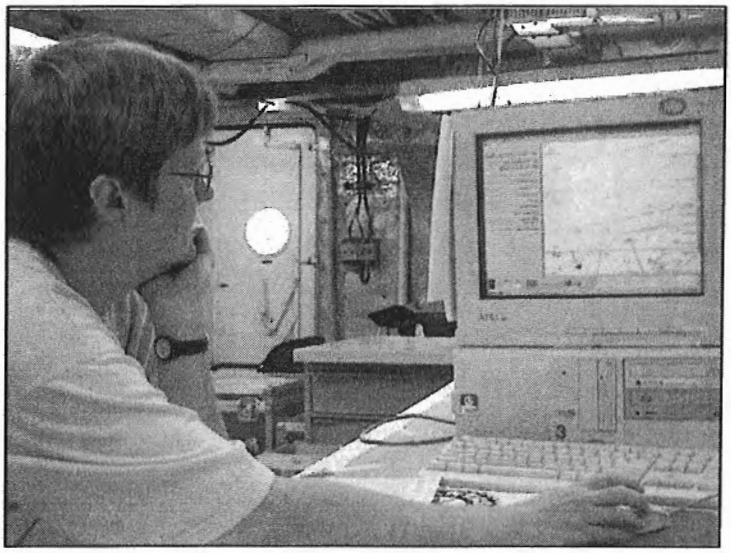
About 22:00 l two of the airguns on the inner port beam were leaking air and had to be turned off. Keith, Larry, Ken, the Captain and I discussed the alternatives. Since the deck crew had been up late last night and early in the morning, bringing in the beam was not a reasonable option especially in the dark. The volume of airguns left was deemed insufficient to continue so we determined our best option was to keep bare steerage of 1-3 knots until morning. At about 23:00 l Larry called to say that by blasting the problem air line with high pressure he must have cleared a blockage of dirt and

the guns were sealing now. With 11 operational guns the ship was brought back to 4.5 knots and there is no immediate reason to pull an array with all the accompanying problems and loss of time.

Monday July 2 183

Thick fog and a swell. During the early morning hours all 12 guns were firing and then for most of the day ten guns were operational. A 700 and 120 cu in airgun had to be shut down. The pressure is good at least 1500 psi. Discussions among Keith, Borden and Dave indicate that the shot break sensing is not working. Thus we cannot adjust the timing of the airguns to synchronize the exact time of release of the air. Keith suggested that at the end of line we could use his hydrophone off the stern of the ship and individually fire each gun at a 10 s firing rate to calibrate the differences. In the longer term we may have to mount hydrophones on each airgun. Borden mentioned that we have these hydrophones.

Figure 8 Sonya Dehler monitoring the navigation during the shooting of the airguns.



Thomas is checking clock drifts and plotting record sections of the SEGY data for the first line. He filtered and printed out the hydrophone and vertical for all the instruments but two. The data on the shelf has good ranges but is overprinted by drilling and/or industry seismic signals. Notch filters not available on the ship will help clean this data up. The OBS in deep water not affected by industry activity have excellent signal to noise ratios. There are indications that the currents are with us and our speed over the ground will bring us to the end of the line earlier than anticipated. If we reach the end of the line prior to midnight the Captain will authorize overtime to bring the guns in so we can start the picking up the instruments as quickly as possible.

Tuesday July 3 Day 184

Bright sun, barometer rising. The ship is making up to 5.3 knots over the ground. If the airgun array remains operational we will reach the end of line around 23:00 l. Thomas is working on making copies of the data. The raw data will be stored on .DAT tapes that Dalhousie will keep. Two copies of the SEGY files will be made. One for the person who will actually work on a particular line and the other for archiving with GSCA. One GSC instrument had a strong time signal on the hydrophone. Dave believes it was related to lose AMI boards in the instrument and this has been corrected already by Marty and himself.

On the inboard port array, there is significant leakage of air. Two more guns were shut off, bringing the array size down to about 2/3 the maximum. The plan was to slow down to bring the array in and repair it on deck and then relaunch it. This has been delayed because there are problems with the tugger winches' hydraulics. Borden had to spool the wire off the winch and attempt a repair. If this does not work a snatch block and capstan will be used to pull the beam inboard.

The hydraulic system on the tugger winch was repaired but the brake shoes had to be removed. The inboard port beam was brought in and then the airguns repaired while we continued firing and steaming at 4.5 knots. It was relaunched and we finished the line with 10 airguns firing. After supper the compressor was shut down due to over heating. It was restarted and no further problems were noticed. We were prepared to go to a longer shooting interval.

Sonya, Keith and I discussed revisions to the plan for line 3. Fewer OBS will be used and the line will be shortened so that we will finish on time.

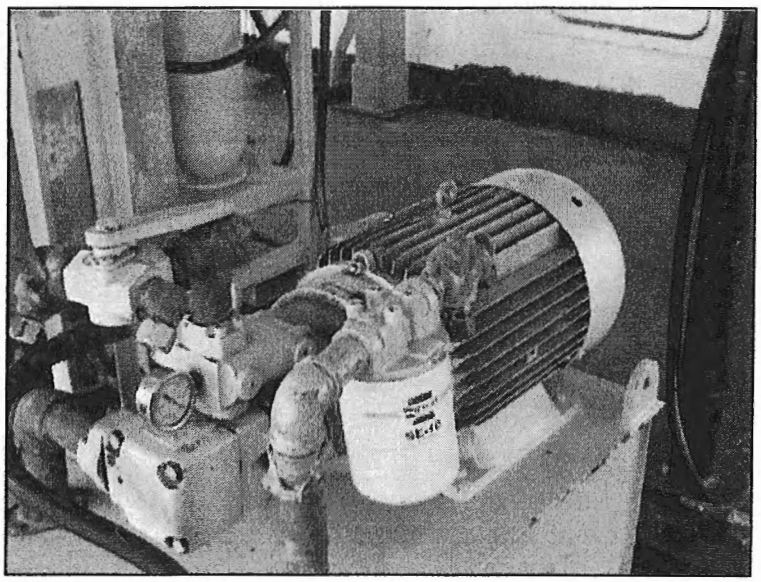
Beautiful sun set followed by a full moon illuminating the seas.

Wednesday July 4 185

Sun, high clouds, flat calm sea. The shooting finished at 3:00 l and a slow turn toward the first OBS was executed. At 6:00 l the crew began to retrieve the airgun array. The lack of brake on one of the winches from yesterdays repair make the operation more difficult. As the crew is working with the heavy beams swaying over the rail, the winch has to be slowly paid in to compensate for slippage. So far this trip the deployment and retrieval of the airgun array has taken place in calm seas.

On the retrieval of the inboard starboard beam it flipped over again. This was related to the amount of slack that was paid out and perhaps a human error. (This winch was operating properly.) The hydraulic filter on the other tugger winch was blown off its mounting and poured oil over the deck. Hands scampered in all directions to get the materials for containing the spill before it reached the ocean. The Chief Engineer was standing by at the time and he assisted in the diagnosis and solving of the problem. He pulled long strips of rubber from the hydraulic lines out of the winch. He will try to jury rig a filter for this winch or remove one from the Pengo. The hydraulics for this system were repaired. Later in the day the hydraulics on a winch on the helicopter deck also caused problems spraying oil and necessitating another clean up.

Figure 9 The white filter on the yellow tugger winch decoupled during retrieval of the airgun array necessitating a rapid response from the crew to cleanup the hydraulic oil.



The numerous problems we are having with the winches for retrieving the airgun array are related to their old age. Although money has been spent on the equipment to repair it, Ken suggested the analogy to money spent on an old car and it is still not reliable. There are too many problems and no reliability.

During the retrieval of the first OBS on this line there was considerable confusion on the bridge generated by two sets of directions from scientific staff. One set of the staff was sure the OBS was on the surface based on the echo sounder cross over of pinger record, the other on the lack of radio signal. It turns out the bridge was given the wrong radio frequency. This problem was exacerbated by the growing rivalry between Dalhousie and GSC that I do not seem to be able to contain. I explained the problem to the bridge in terms of technical aspects and that the pinger record is more reliable. The absence of a radio signal could be due to a number of reasons. As usual the Captain was understanding and remarked by the second retrieval we would probably have the problems dealt with.

The first OBS was released off the bottom during recovery of the airguns and we were a couple of miles from it so we steamed onto position in preparation for it reaching the surface.

Thursday July 5 Day 186

Sunny in the morning increasing fog as we steamed towards the Scotian margin. The pick up of the OBS went smoothly yesterday and last night. By breakfast 10 of the 19 instruments were safely onboard. The transit speed of the ship has been reduced to about 13-14 knots because we are using three engines now. However we will not need to slow down on the slope to collect missing bathymetric data. Sonya has checked and with the ram down we get adequate bathymetic records.

Sonya, Marty and Thomas are all practising the download and backing up of the GSC instruments. Thomas is preparing SEGY files for line 1 and Keith is making copies of the data.

During the night Greg MacLellan heard a shot like a shot gun firing. Bob Iuliucci discovered the lights on one OBS blew up. The OBS had been retrieved from at least 4000 m and a combination of sea water getting into the batteries and pressure caused the problem. Fortunately no one was near the light when this occurred. This problem has never been observed before. Care must be taken that it never happens again.

We are now looking for the paper copy of the bathymetric data for the first line. It was discovered put away in the other data box. All is well.

The recovery of the OBS went well during the day. Meanwhile Thomas was preparing the SEGY files and printing out a copy of the filtered data for the hydrophone and vertical geophone. The data on instruments 1-10 in deep water looked good. Instrument 4 will not have useful data due to a battery pack failure.

During the evening the logistics officer Danny Marsh played the video of the CCGS Louis S.-St Laurent and USCGS Polar Sea to the North Pole in 1994. There was great interest in it. I particularly enjoyed it because I knew many of the people and ships involved.

The pick up of the last few instruments was slowed by the fact that the ship was not using the bow thrusters. There are only a few fuses on board and after using the thrusters a fuse blows and the port propellor is disabled. We will pause off of Sambro to pick up fuses on the way to line 3.

Friday July 6 Day 187

Foggy along the shelf adjacent to the eastern shore and a big swell that causes the ship to pitch. The last OBS retrieval was early in the morning. Not bad, 19 out of 19 recovered. We will rendezvous with a Coast Guard vessel off of Sambro at about 15:00 l to pick up the needed fuses. We are steaming along at 15 knots towards our destination. Confirmed with the Captain that the transfer will take only a few minutes and there is not time for Dave to tests the new instrument he is working on. It will wait until OBS launch or recovery.

The Coast Guard boat with the fuses for the engine department arrived at 15:00 l and the transfer took several minutes at most and the boat disappeared into the fog. On the transit to the third line preparations were underway. Keith prepared the OBS launch time and position tables for the bridge. Paul put the navigation into the format the bridge wanted. Dave was modifying the GSC firing box to fire at two minute intervals for use in the future. The data was played back, backed up, put in labelled CDs cases and plotted.

Dave modified the GSC clock block so that it could generate two minute pulses as well as one minute ones.

Saturday July 7 Day 188
Pitched all night with the waves from a distant storm. The ship reached the southern end of the third and final line with the first launching taking place at 7:15 l. The 11 other OBS to be dropped along this line are now all ready and the stations are relatively close together. Hopefully the air guns will be in the water before the predicted gale arrives.

On the second launch Dave also did a test of his UDP sounder to determine if it was actually recording data. Meanwhile he was working with the Dalhousie group to ensure that an untried feature of the OBS (that it could be commanded to ping in order to locate it before release) could be tested.

Borden and the A team have the airgun array ready for the next deployment. Problems with the hydraulics continue to plague them. The yellow tugger motor blew its filter off again. More pieces of hose were found in it, this time in the pressure control valve. The hydraulics lines had been used for high pressure air and this may have caused this unusual deterioration.

The twelfth and final OBS on line 3 was dropped into the water after the barbeque. There was an hours steam to the end of the line and the complicated process of putting the air gun array into the water began. We started before dark and there was a gorgeous sunset. The currents here that run into the Bay of Fundy made the deployment difficult. The beams kept approaching each other risking tangling. After about two hours near 10:00 l a tired crew retired and the first shot took place.

Sunday July 8 Day 189
Sun and flat calm seas. All twelve airguns fired all night at a pressure of 1500 psi. About 20-40 pilot whales within a ship length of the airgun array for a minimum of a half hour from about 7:30-08:00 l. Studies show these whales are not sensitive to sounds below the KHz range. It is not unusual for dolphins to follow seismic ships but I do not know of documented cases of pilot whales trailing seismic ships.

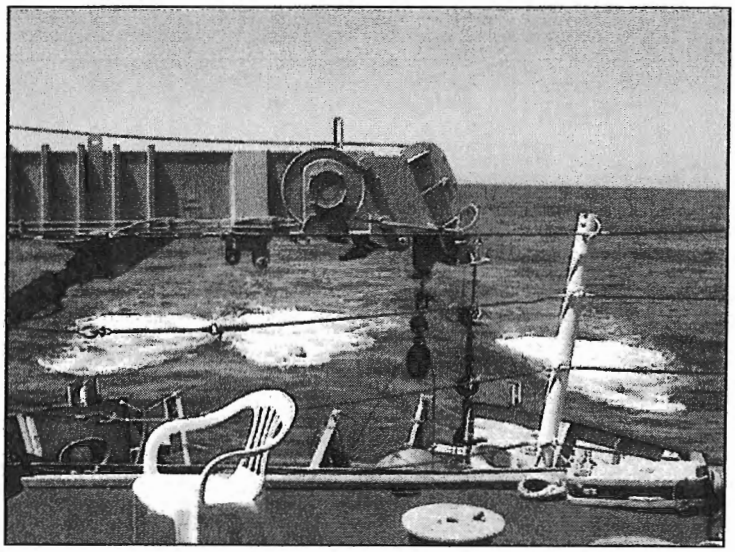
The ship's Health and Safety committee met today and I attended on behalf on the scientific staff. It was informative to hear about the concerns of the seaman and officers on the ship; particularly, their interest in heart smart meals. Next trip gelato will be available in addition to ice cream.

After supper the airgun were all firing and then silence. The motor on the diesel compressor had dome off its mount. This took several hours to fix including the repairing of a high pressure hose while the air guns were shut off. We circled and came back on line to prevent a significant data gap.

Monday July 9 Day 190

Bright with a calm sea. The guns fired all night. The currents were against us and we made only about 3.5 knots over the ground. Therefore the end of line is at about 15:00 l and the first OBS will be on time release for 17:00 l. If there are problems with getting the airguns on board or the bow thrusters do not work after their repair we could miss a timed released OBS. This area has strong currents and a small OBS would be difficult to find. In addition, an hour or two will not add enough length to get deep crustal arrivals on this line anyway so we shall be cautious.

Figure 10 The air bubbles from the air gun array reaching the surface.



At 12:30 l the end of line was declared and the airguns stopped firing. The array was retrieved in about two hours and we steamed to the first OBS position. The instrument released on command but was a half hour later reaching the surface than expected. It floated deeper in the water with one end more submerged than the other. On retrieval it was found one of the small floatation spheres had imploded.

July 10 Tuesday Day 191

Foggy and it's making the retrieval of the OBS more difficult. By 9:30 l two-thirds of the OBS were recovered. The secondary releases are set close to our arrival at each station and it is a rush against time to have them release on the primary. The pinger is not in operation if the instrument releases on the secondary making it difficult to track the OBSs as they rise through the water column and the down loading of the data is slightly more complicated.

The raw data from line three is being down loaded , converted to SEGY and displayed within hours. The first three instruments have excellent data, the next two were of lower quality with a high frequency noise. The airgun team is disassembling the guns and hoses on the stern in preparation for us tying up at the Coast Guard dock tomorrow.

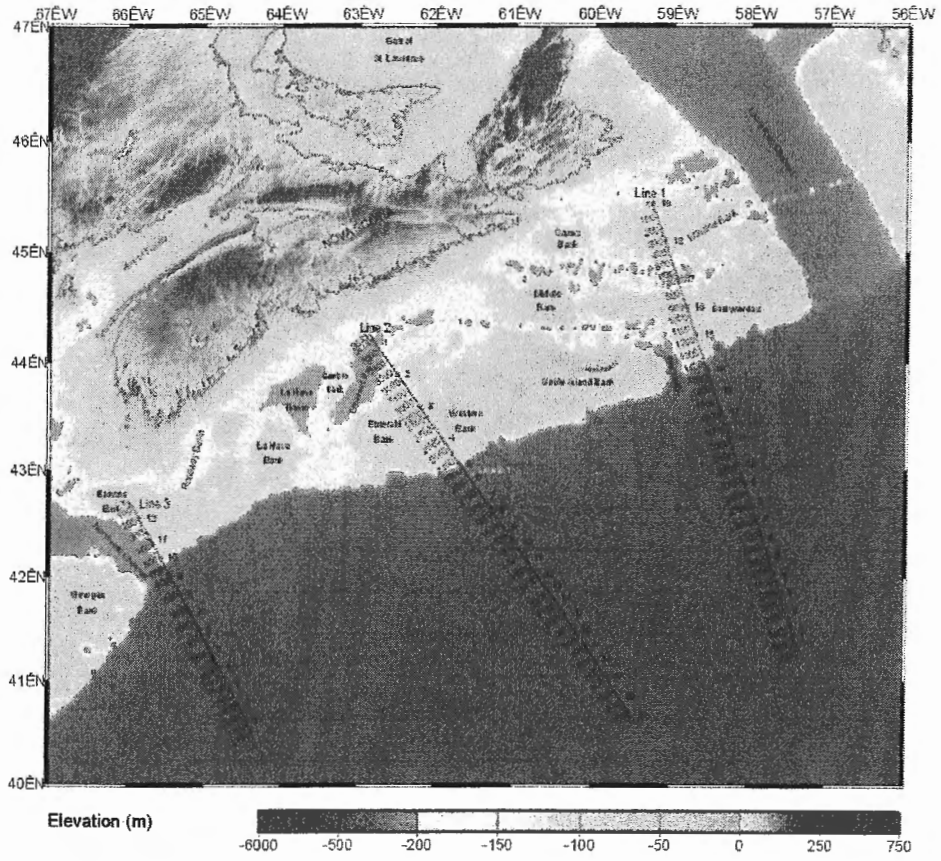
The fog gradually burned off as the last OBS came to the surface and was on the deck at 14:00 l. We had 52 deployments and 51 retrievals for a recovery rate of 98%. The data quality is good. Two

or three instruments may have had problems due to the battery pack's assembly. This will be considered for the next experiment..

Figure 11 Smiles on the party chiefs.

Wednesday July11 Day 192
The ship tied up at the Canadian Coast Guard dock in Dartmouth.

Cruise plot in colour. The seismic lines shown in black and OBS positions labelled.



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 summarizes OBS deployment and with the REGULUS digital chart. Note that the REGULUS chart is in fathoms , multiply by 2 (roughly) to get meters.

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 in yellow.

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.

7) Every 30 minutes , check radio on the starboard side at front of lab next to the Dal PC monitor. Numbers should flash and cycle through channels 1-7. If radio locks onto readjust find Keith (Cabin # 38 next to the library)

IF you have questions, ASK for help.

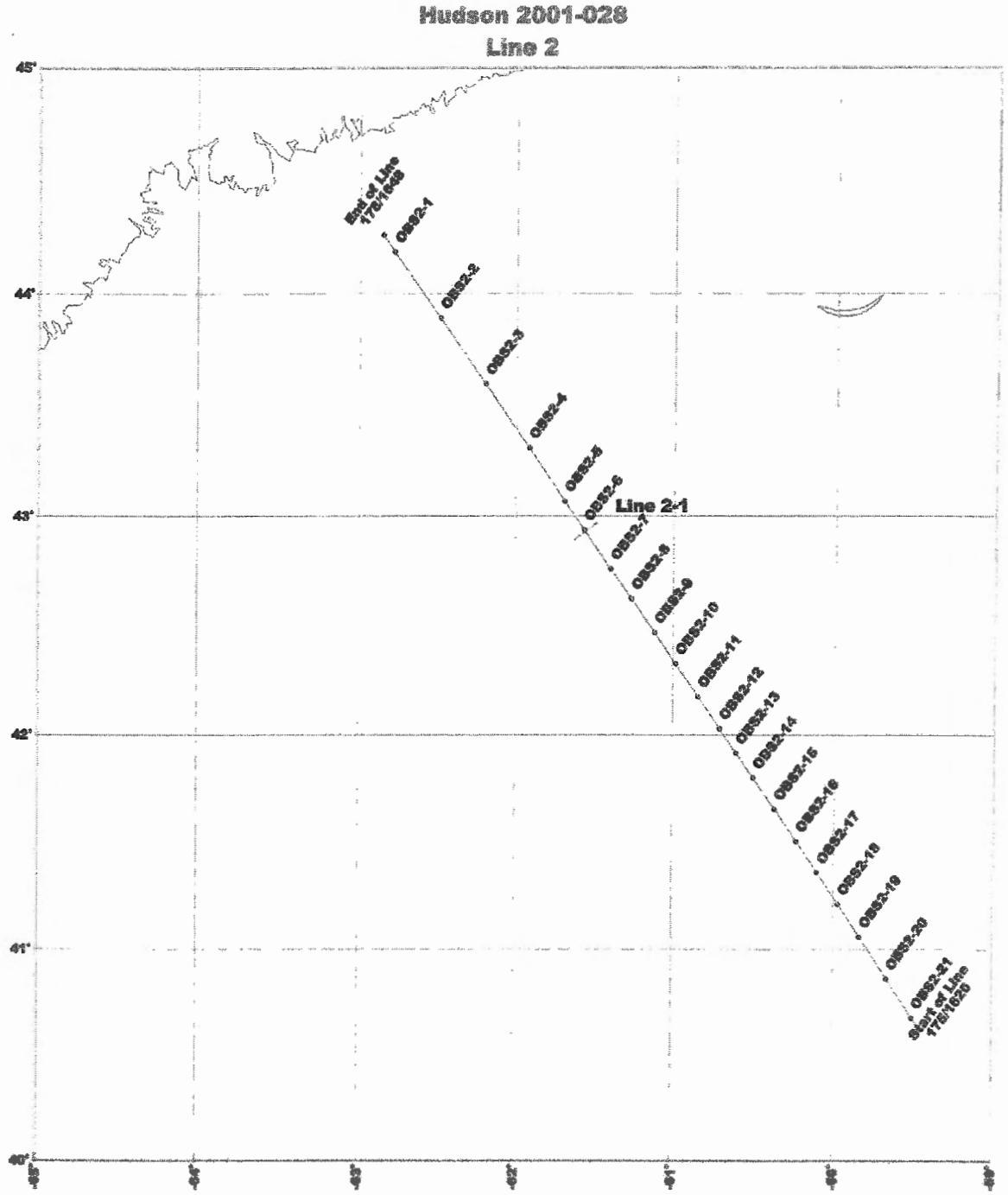
OBS Dropped Positions:

End of Line	44.26523	-62.85383
OBS2-1	44.186295	-62.780191
OBS2-2	43.891325	-62.485631
OBS2-3	43.595477	-62.194519
OBS2-4	43.307676	-61.914466
OBS2-5	43.068345	-61.684533
OBS2-6	42.936681	-61.558802
OBS2-7	42.760178	-61.3913
OBS2-8	42.624359	-61.263013
OBS2-9	42.469692	-61.119012
OBS2-10	42.326812	-60.986284
OBS2-11	42.17586	-60.846161
OBS2-12	42.02786	-60.709662
OBS2-13	41.915191	-60.606182
OBS2-14	41.799626	-60.500629
OBS2-15	41.655018	-60.36914
OBS2-16	41.506835	-60.235464
OBS2-17	41.360182	-60.103637
OBS2-18	41.212324	-59.9718
OBS2-19	41.059144	-59.835981
OBS2-20	40.861689	-59.66248
OBS2-21	40.676986	-59.49997
Start of Line	40.48226	-59.30977

Survey Line Segments:

Line 2-21	Start of Line to	OBS2-21	
Line 2-20	OBS2-21	to	OBS2-20
Line 2-19	OBS2-20	to	OBS2-19
Line 2-18	OBS2-19	to	OBS2-18
Line 2-17	OBS2-18	to	OBS2-17
Line 2-16	OBS2-17	to	OBS2-16
Line 2-15	OBS2-16	to	OBS2-15
Line 2-14	OBS2-15	to	OBS2-14
Line 2-13	OBS2-14	to	OBS2-13
Line 2-12	OBS2-13	to	OBS2-12
Line 2-11	OBS2-12	to	OBS2-11
Line 2-10	OBS2-11	to	OBS2-10
Line 2-9	OBS2-10	to	OBS2-9
Line 2-8	OBS2-9	to	OBS2-8
Line 2-7	OBS2-8	to	OBS2-7
Line 2-6	OBS2-7	to	OBS2-6
Line 2-5	OBS2-6	to	OBS2-5
Line 2-4	OBS2-5	to	OBS2-4

Line 2-3	OBS2-4	to	OBS2-3
Line 2-2	OBS2-3	to	OBS2-2
Line 2-1	OBS2-2	to	OBS2-1
Line 2-0	OBS2-1	to	End of Line

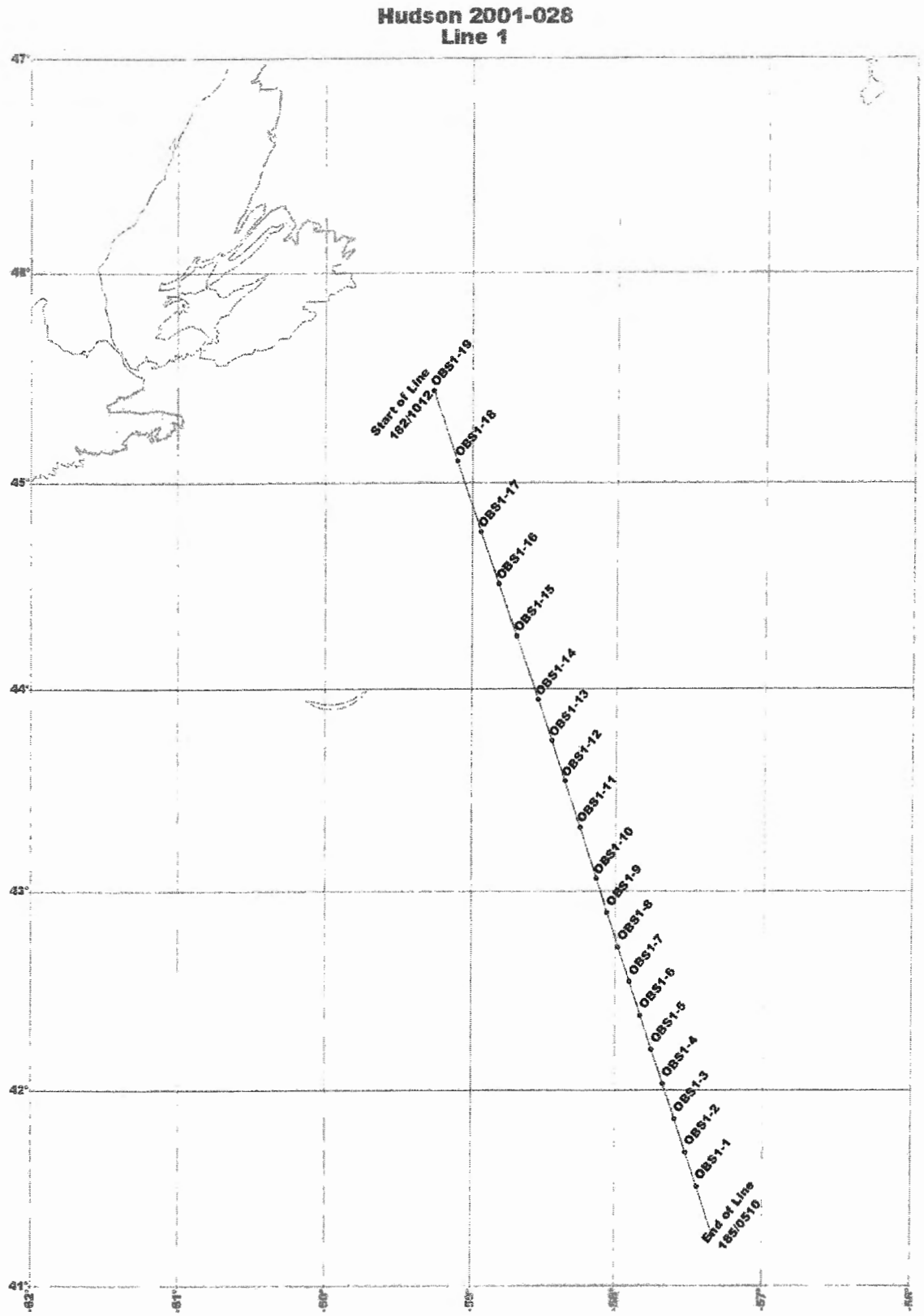


OBS Dropped Positions:

OBS1-1	41.509495	-57.444080
OBS1-2	41.683883	-57.519107
OBS1-3	41.856112	-57.594368
OBS1-4	42.036470	-57.672802
OBS1-5	42.205718	-57.749362
OBS1-6	42.378808	-57.826680
OBS1-7	42.547013	-57.902185
OBS1-8	42.720908	-57.980448
OBS1-9	42.894570	-58.059378
OBS1-10	42.326812	-58.136322
OBS1-11	43.320152	-58.252660
OBS1-12	43.549027	-58.361490
OBS1-13	43.746980	-58.452860
OBS1-14	43.946825	-58.547702
OBS1-15	44.260627	-58.696672
OBS1-16	44.513068	-58.817940
OBS1-17	44.764950	-58.939903
OBS1-18	45.104640	-59.105578
OBS1-19	45.440677	-59.273300

Survey Line Segments:

Line 1-19	Start of Line to	OBS1-19	
Line 1-18	OBS1-19	to	OBS1-18
Line 1-17	OBS1-18	to	OBS1-17
Line 1-16	OBS1-17	to	OBS1-16
Line 1-15	OBS1-16	to	OBS1-15
Line 1-14	OBS1-15	to	OBS1-14
Line 1-13	OBS1-14	to	OBS1-13
Line 1-12	OBS1-13	to	OBS1-12
Line 1-11	OBS1-12	to	OBS1-11
Line 1-10	OBS1-11	to	OBS1-10
Line 1-9	OBS1-10	to	OBS1-9
Line 1-8	OBS1-9	to	OBS1-8
Line 1-7	OBS1-8	to	OBS1-7
Line 1-6	OBS1-7	to	OBS1-6
Line 1-5	OBS1-6	to	OBS1-5
Line 1-4	OBS1-5	to	OBS1-4
Line 1-3	OBS1-4	to	OBS1-3
Line 1-2	OBS1-3	to	OBS1-2
Line 1-1	OBS1-2	to	OBS1-1
Line 1-0	OBS1-1	to	End of Line


Hudson 2001-028
Line 1
47°
46°
45°
44°
43°
42°
41°
-62°
-61°
-60°
-59°
-58°
-57°
-56°
Start of Line
162/1012
OBS1-19
OBS1-18
OBS1-17
OBS1-16
OBS1-15
OBS1-14
OBS1-13
OBS1-12
OBS1-11
OBS1-10
OBS1-9
OBS1-8
OBS1-7
OBS1-6
OBS1-5
OBS1-4
OBS1-3
OBS1-2
OBS1-1
End of Line
155/0510

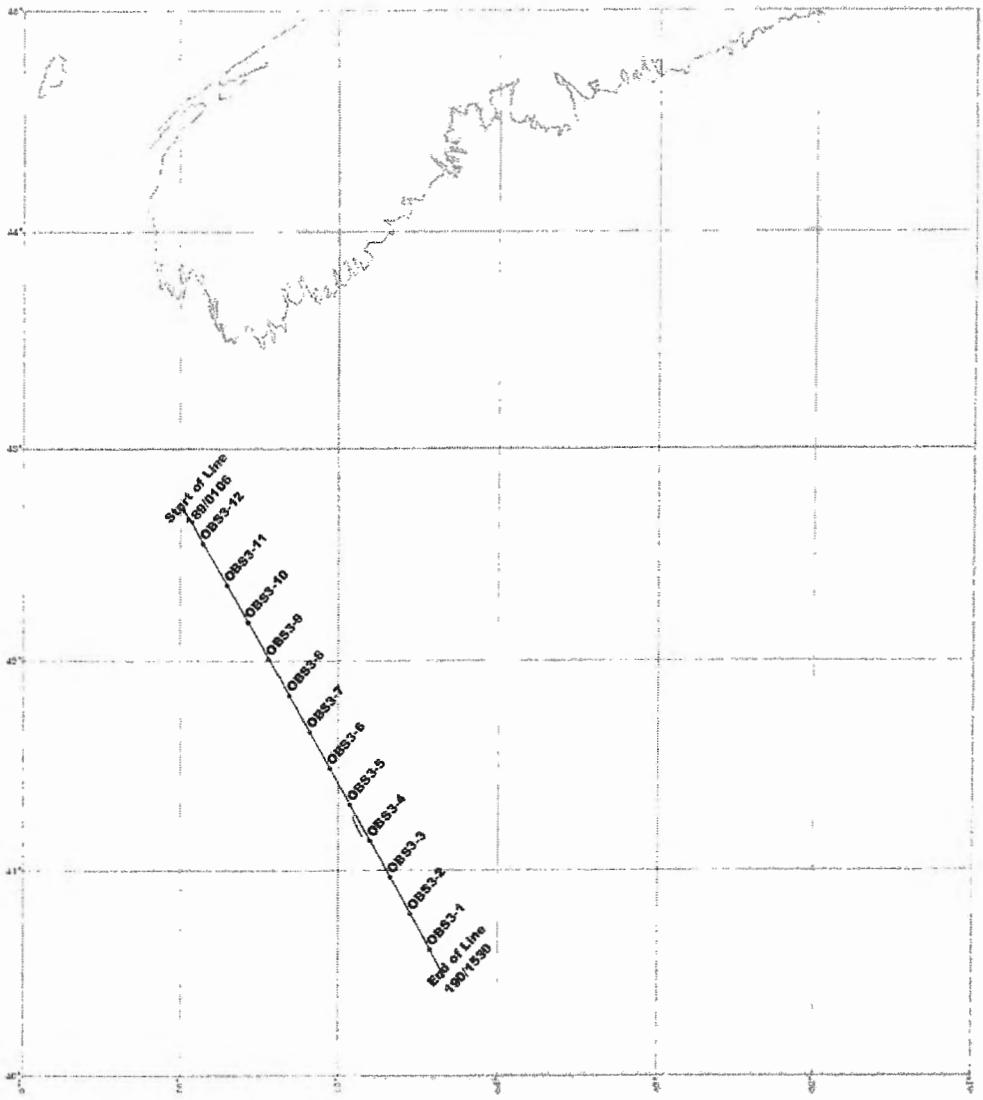
OBS Dropped Positions:

OBS3-1	40.619351	-64.433635
OBS3-2	40.794147	-64.556138
OBS3-3	40.968122	-64.680299
OBS3-4	41.143577	-64.805426
OBS3-5	41.316956	-64.931394
OBS3-6	41.490906	-65.058282
OBS3-7	41.66452	-65.185863
OBS3-8	41.838529	-65.315322
OBS3-9	42.012148	-65.444803
OBS3-10	42.185408	-65.576042
OBS3-11	42.358811	-65.707947
OBS3-12	42.555196	-65.859456

Survey Line Segments:

Line 3-12	Start of Line	to	OBS3-12
Line 3-11	OBS3-12	to	OBS3-11
Line 3-10	OBS3-11	to	OBS3-10
Line 3-9	OBS3-10	to	OBS3-9
Line 3-8	OBS3-9	to	OBS3-8
Line 3-7	OBS3-8	to	OBS3-7
Line 3-6	OBS3-7	to	OBS3-6
Line 3-5	OBS3-6	to	OBS3-5
Line 3-4	OBS3-5	to	OBS3-4
Line 3-3	OBS3-4	to	OBS3-3
Line 3-2	OBS3-3	to	OBS3-2
Line 3-1	OBS3-2	to	OBS3-1
Line 3-0	OBS3-1	to	End of Line

Hudson 2001-028
Line 3



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 forwarded to the Bridge AGCNAV system which, in turn, fed the sentences to a Black Box line splitter for distribution throughout the ship.

Both REGULUS and AGCNAV were operational on the bridge although AGCNAV was the system of choice for both navigation display and ship maneuvers. The simplicity of operation of AGCNAV and its Line Running and Station Keeping displays are preferred by both the watch officer and quartermaster. In addition, the location of the bridge REGULUS does not encourage its use by the watch officer as it is not part of the main cluster of navigational aids.

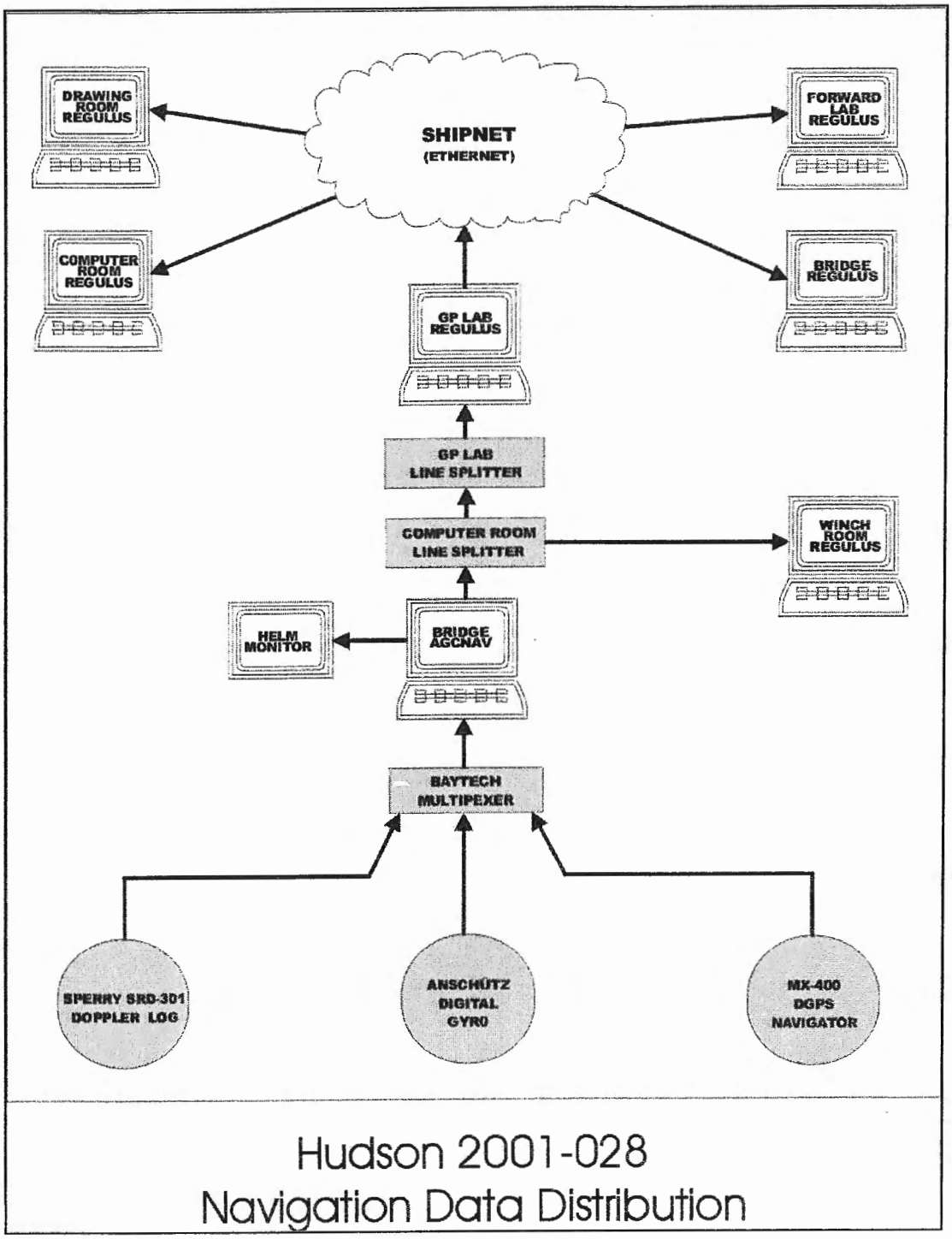
The scientific navigation was observed and logged on five REGULUS systems, running the latest version on the program, Build 20217. These were set up in the Drawing Room, Navigation Room, Forward Lab, Winch Room and GP Lab. The GP Lab REGULUS system was used as the primary data logger. The installation of additional network outlets has made access to the ship's network more convenient. The navigation data was logged from the ship's serial data distribution system by the GP Lab REGULUS system. It, in turn, redistributed the data over the ethernet network to the other REGULUS systems. 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 and cleaned and edited 10 second A-format files were saved on a daily basis and transferred to CD for GSCA archiving. In addition, daily 1 minute cleaned and edited A-format files were produced for immediate use by the scientific staff.

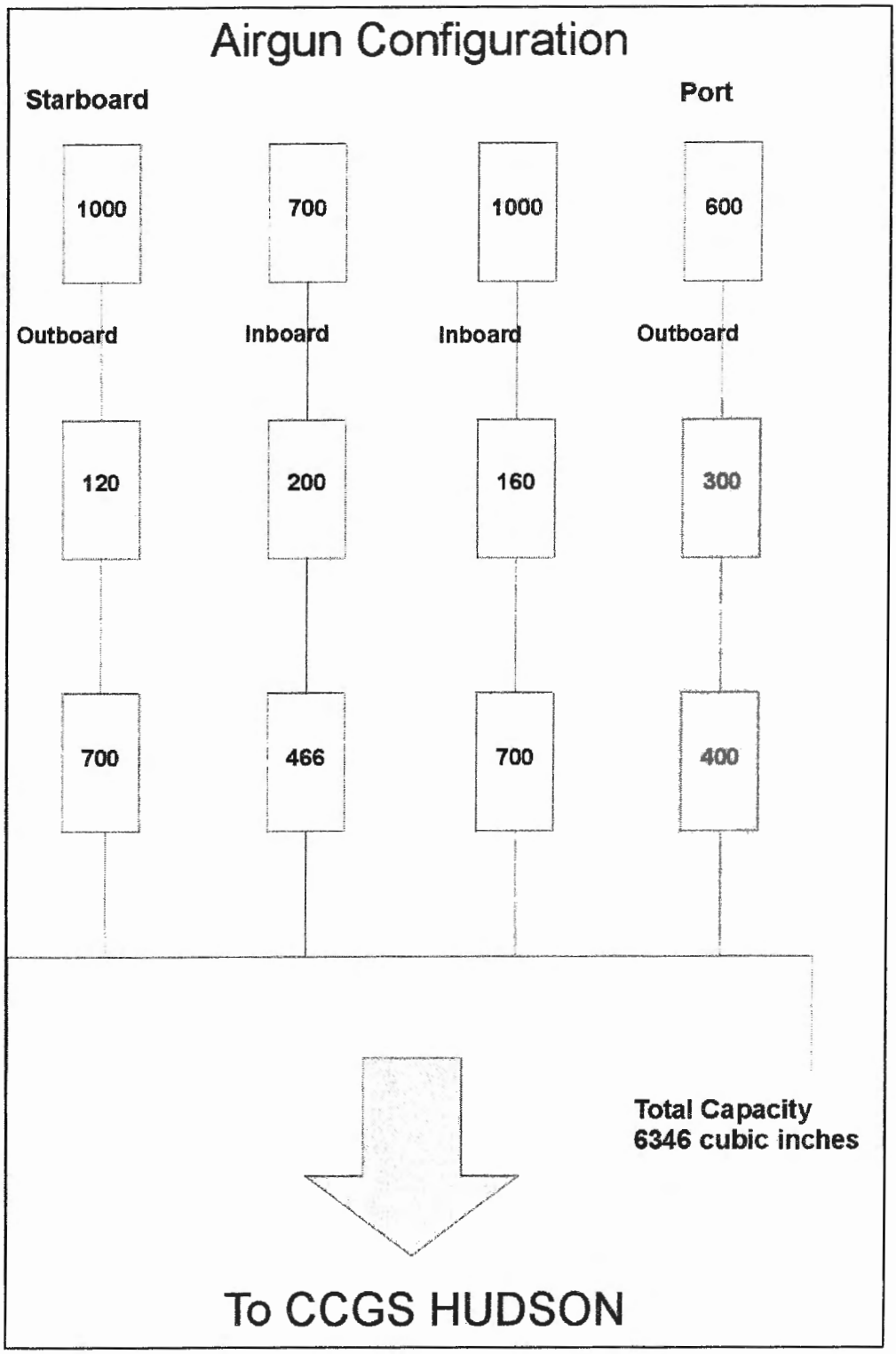
There are several bugs in Build 20217 of REGULUS:

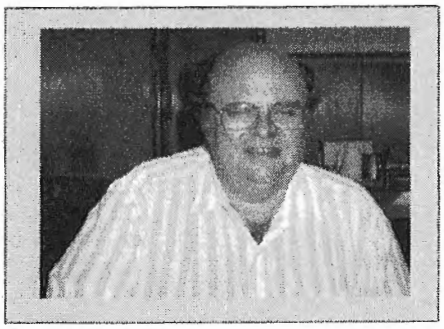
- The program does not open a new daily logfile until 0400 GMT.
- If logging is turned off for any reason (i.e.: copying the days logfile elsewhere), then turned on to resume logging, the program fails completely to switch to a new logfile at the end of the day and will continue to log to this file until it is manually changed or the program restarted..
- If the ship's shadow option is enabled, the system will crash and reboot after a short period of time.
- The inability to individually label the segments of a route can cause some uncertainty as to the identity of the leg presently being run and has the potential to cause discrepancies in line labels between the Bridge Log and Scientific Log.
- The program appears to pad the records it redistributes over the network to the other systems as UDP packets. This results in larger logfiles which can be difficult to process because of their size.

- The clock synchronization feature does not work. This should allow the program to regularly set its time to GPS time. This does not affect the logged data but does mean that the displayed time is not always accurate; it will drift with the computer clock.



Hudson 2001-028
Navigation Data Distribution

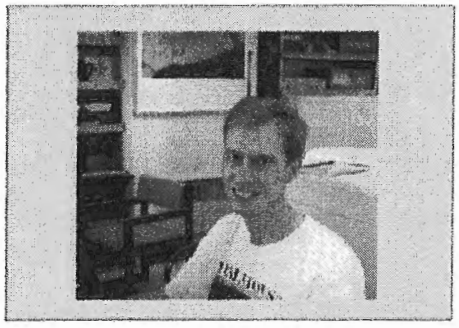

Airgun Configuration
Starboard
Port
1000
700
1000
600
Outboard
Inboard
Inboard
Outboard
120
200
160
300
700
466
700
400
Total Capacity
6346 cubic inches
To CCGS HUDSON



Asprey, Ken
Staff

Chapman, Borden
Staff

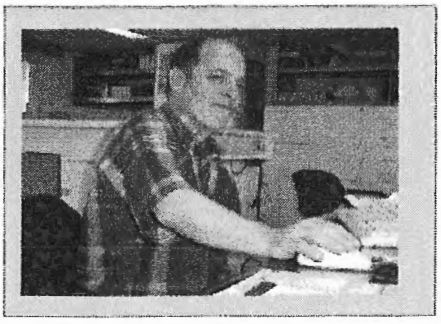
Dehler, Sonya
Staff



Funck, Thomas
Staff

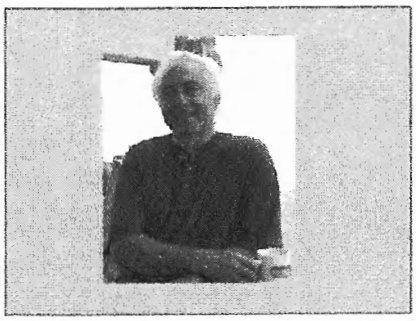
Gerlings, Joanna
Staff

Giles, Kristina
Staff



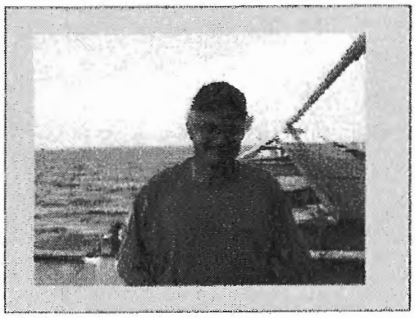
Girouard, Paul
Staff

Heffler, Dave
Staff

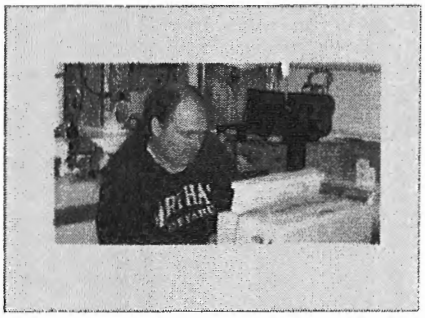


Iuliucci, Bob
Staff

Jackson, Ruth
Staff

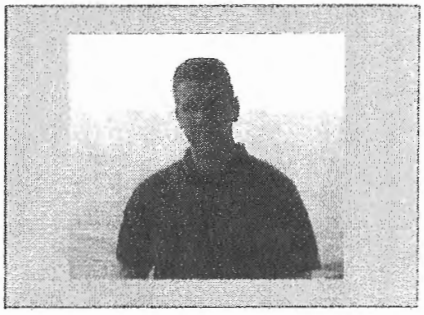


Johnston, Larry
Staff

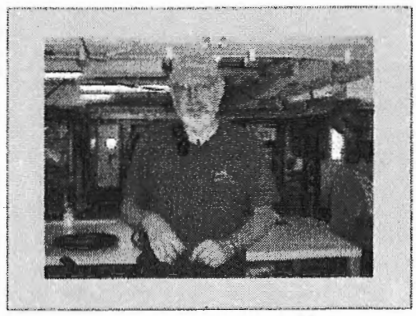


Judge, Walter
Staff

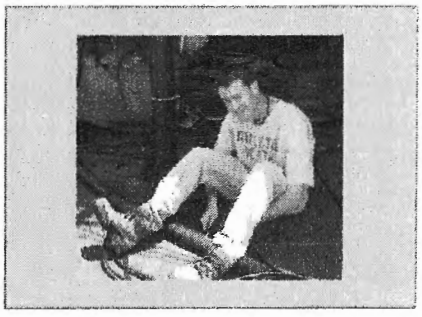
Lau, Helen
Staff



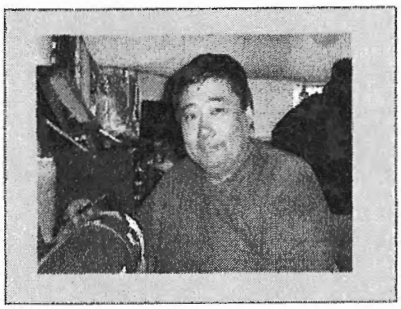
LeBlanc, Chris
Staff



Louden, Keith
Staff

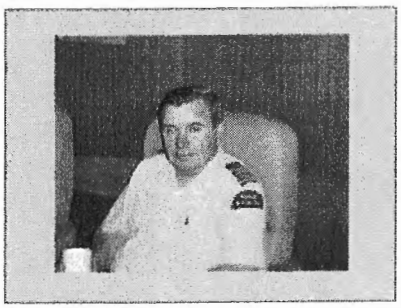


Nixon, Cory
Staff

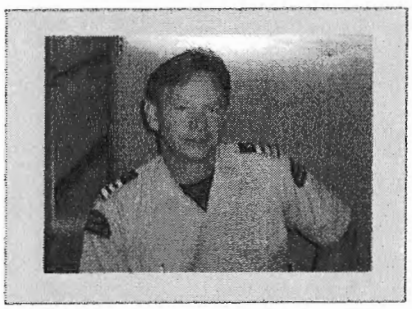


Uyesugi, Martin
Staff

Yue, Wu
Staff

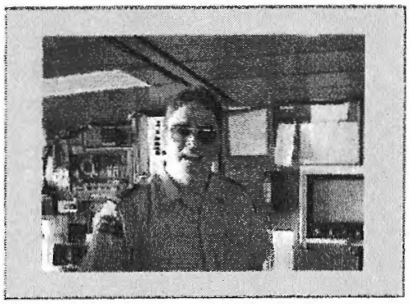


Champagne, Michel
Commanding Officer

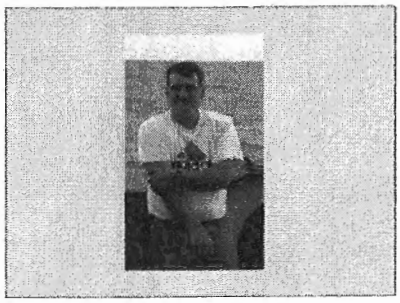


Miller, Craig D.
Chief Officer

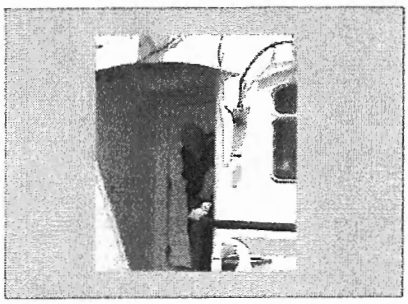
Adams, Glen C.
Second Officer



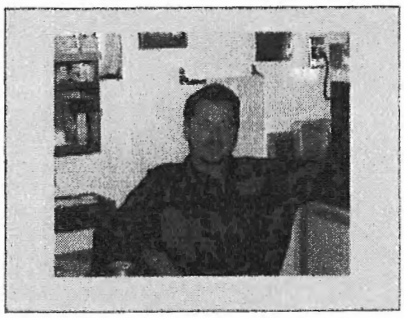
Boyd, David
Third Officer



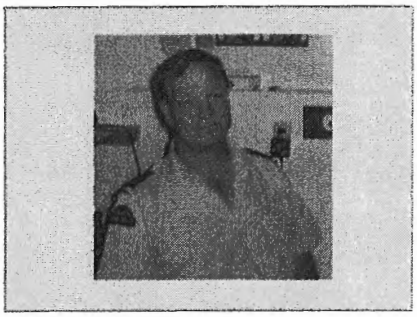
Blagdon, John
Chief Engineer



Cherny, Utad
Senior Engineer

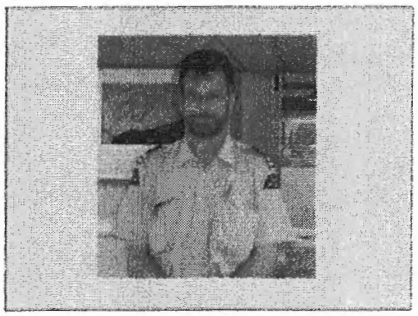


Dagley, Ronald
First Engineer



Cragg, Chester A.
Second Engineer

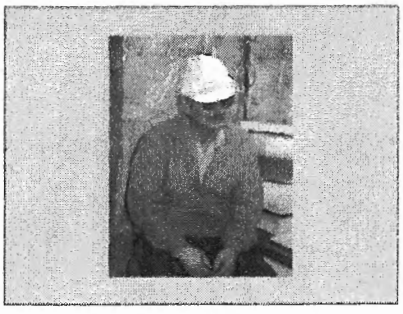
Boudreau, J. A.
Third Engineer



Fulton, Scott
Electrical Officer

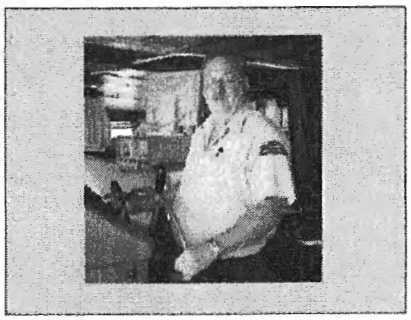
Marsh, Daniel
Logistics Officer

Cartier, Michael
Ship's Nurse



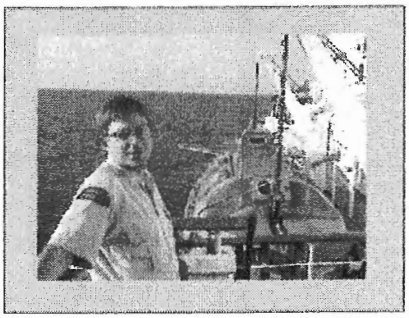
Warren, Claude
Boatswain

MacLellan, D. Gregory
Leading Seaman

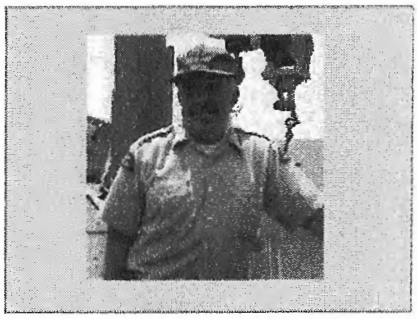


Rawding, Donald A.
Leading Seaman

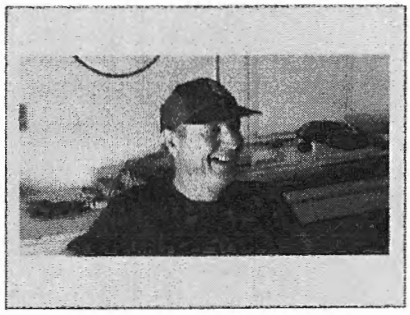
Stoodley, Darren D. A.
Leading Seaman



Ward, Andrew G.
Seaman



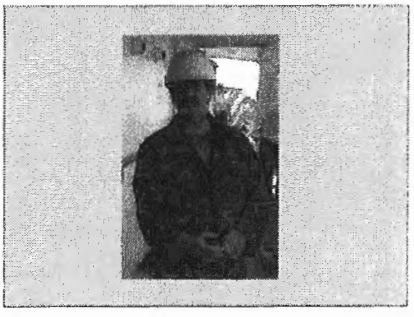
Worth, Michael G.
Seaman



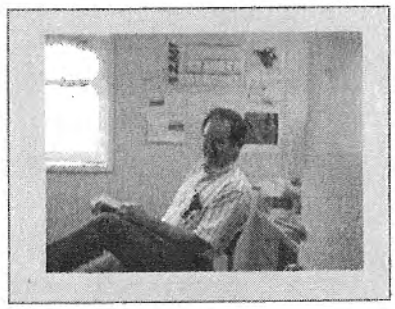
Cook, John D.
Seaman

Dobbin, Bill
Seaman

MacKenzie, Mike J.
Seaman

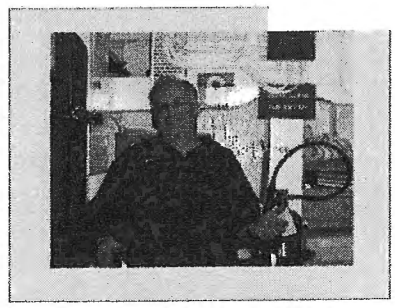


Wilson, Arthur W.
Seaman

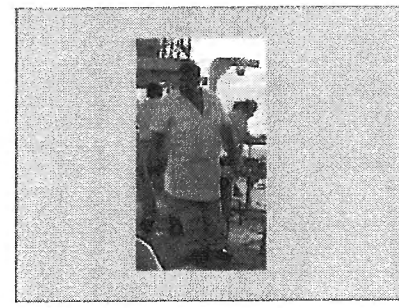


Eisner, Don R.
Electronics Technician

Haley, John F.
Oiler

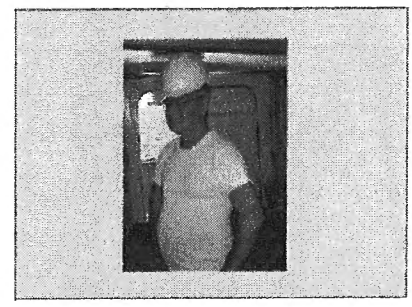


Ginter, E. A.
Oiler



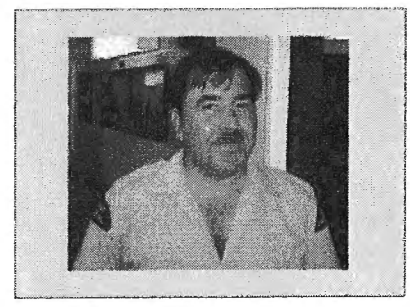
Saunders, Tyrone
Chief Cook

Beaver, Tom
Storekeeper



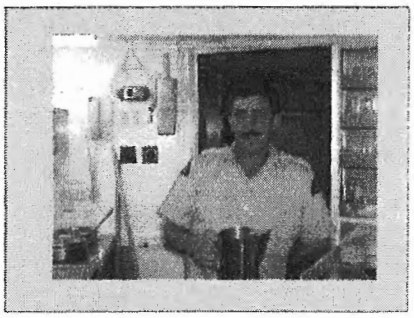
Johnston, William K.
Assistant Cook

Lindsay, James W.
Second Steward

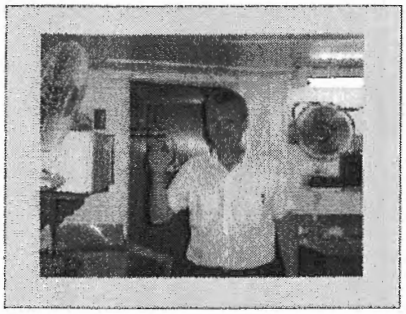


Haines, Alfred
Steward

Cameron, Ronald gentlemen.
Steward



Smith, Gary R.
Steward



Trainor, Bernard
Steward

Scotian Margin (Mariprobe) 2001 - Line 1

Pos.	Instrument	Deployment longitude	Deployment latitude	Deployment depth	Recovery longitude	Recovery latitude	Clock reset (JD:hh:mm)	Clock check (JD:hh:mm)	Clock drift (msec)	Drift rate (msec/hour)	Raw data files	Remarks
1	DAL-B	57.444080°W	41.509495°N	4945 m	57.483871°W	41.509990°N	180:15:44	185:12:28	+12.904	+0.11	000-149	Static shift: -2.855 msec 1)
2	DAL-G	57.519107°W	41.683883°N	4870 m	57.543475°W	41.688984°N	180:17:50	185:15:04	-3.529	-0.03	000-154	Static shift: -0.006 msec 1)
3	DAL-J	57.594368°W	41.856112°N	4806 m	57.601860°W	41.856100°N	180:18:05	185:17:32	+13.826	+0.12	000-158	Static shift: -3.178 msec 1)
4	DAL-H	57.672802°W	42.036470°N	4763 m	57.666372°W	42.037826°N	180:16:00	185:19:58	-5.573	-0.05	000-163	Static shift: +0.966 msec 1)
5	GSC-8	57.749362°W	42.205718°N	4689 m	57.737805°W	42.206521°N	180:23:20	185:22:57	-1.707	-0.01	000-169	Static shift: -0.463 msec 1)
6	GSC-6	57.826680°W	42.378808°N	4571 m	57.818627°W	42.379664°N	181:01:01	186:01:12	+19.470	+0.16	000-173	Static shift: +2.905 msec 1)
7	GSC-5	57.902185°W	42.547013°N	4427 m	57.899134°W	42.546316°N	181:03:28	186:03:53	+61.504	+0.51	000-178	Static shift: -2.792 msec 1)
8	DAL-K	57.980448°W	42.720908°N	4293 m	57.980555°W	42.721032°N	181:00:09	186:06:04	+4.966	+0.04	000-182	Static shift: +4.403 msec 1)
9	DAL-I	58.059378°W	42.894570°N	4055 m	58.061156°W	42.893138°N	181:00:38	186:08:17	+8.526	+0.07	000-187	Static shift: +3.558 msec 1)
10	DAL-E	58.136322°W	43.065417°N	3798 m	58.145923°W	43.062937°N	181:00:51	186:10:26	+0.339	0.00	000-190	Static shift: +1.370 msec 1)
11	DAL-F	58.252660°W	43.320152°N	3609 m	58.255569°W	43.314494°N	181:01:06	186:13:08	-51.794	-0.39	000-196	Static shift: +3.410 msec 1)
12	GSC-4	58.361490°W	43.549027°N	3049 m	58.361540°W	43.549010°N	181:04:30	186:16:09	-15.202	-0.12	000-202	Static shift: -1.006 msec 1)
13	GSC-3	58.452860°W	43.746980°N	2254 m	58.453849°W	43.748235°N	181:05:41	186:18:25	2)	2)	000-205	Static shift: -2.899 msec 1)
14	GSC-2	58.547702°W	43.946825°N	787 m	58.552513°W	43.949805°N	181:07:38	186:20:21	-13.768	-0.10	000-210	Static shift: -0.992 msec 1)
15	DAL-L	58.696672°W	44.260627°N	59 m	58.696198°W	44.264314°N	181:11:15	186:21:57	-3.636	-0.03	000-212	Static shift: -2.700 msec 1)
16	DAL-C	58.817940°W	44.513068°N	59 m	58.808191°W	44.525809°N	181:12:18	186:23:40	-6.652	-0.05	000-216	Static shift: -2.063msec 1)
17	DAL-D	58.939903°W	44.764950°N	247 m	58.928208°W	44.768330°N	181:12:28	187:01:32	+0.472	0.00	000-218	Static shift: +4.410 msec 1)
18	DAL-M	59.105578°W	45.104640°N	75 m	59.098041°W	45.103496°N	181:12:39	187:03:35	+1.410	+0.01	000-223	Static shift: -3.409 msec 1)
19	DAL-N	59.273300°W	45.440677°N	85 m	59.268698°W	45.438647°N	181:23:25	187:05:52	+3.408	+0.03	000-228	Static shift: +3.003 msec 1)

Sampling rate
GSC / Dalhousie instruments 139.00 Hz

Instruments
GSC = Geological Survey of Canada (Atlantic Division) three-component 4.5-Hz geophones + hydrophone
DAL = Dalhousie University (Dept. of Oceanography) three-component 4.5-Hz geophones + hydrophone

Clock drift
+ sign OBS clock is ahead of GPS clock
- sign OBS clock is behind GPS clock

1) There is an additional static shift of +2 ms for all instruments
2) Instrument probably had clock jump. Time check indicated a drift of -3580 ticks = -28.640 s. No clock drift applied to SEGY data other then static shift

Scotian Margin (Mariprobe) 2001 - Line 2

Pos.	Instrument	Deployment longitude	Deployment latitude	Deployment depth	Recovery longitude	Recovery latitude	Clock reset (JD:hh:mm)	Clock check (JD:hh:mm)	Clock drift (msec)	Drift rate (msec/hour)	Raw data files	Remarks
1	DAL-N	62.780191°	44.186295°	240 m	62.778871°W	44.187667°	171:15:00	178:12:32	+3.093	+0.02	000-234	Static shift: -
2	DAL-M	62.485631°	43.891325°	149 m	62.483028°W	43.893185°	172:00:20	178:14:32	+1.987	+0.01	000-238	Static shift: +3.588
3	DAL-D	62.194519°	43.595477°	98 m	62.192041°W	43.595367°	172:00:05	178:16:15	+3.672	+0.02	000-242	Static shift: +0.145
4	DAL-C	61.914466°	43.307676°	644 m	61.911990°W	43.307979°	172:03:22	178:18.11	-7.159	-0.05	000-245	Static shift: -1.892
5	GSC-1	61.684533°	43.068345°	131 m	-	-	171:21:56	-			-	Static shift: -2.085
6	GSC-2	61.558802°	42.936681°	860 m	61.558319°W	42.932475°	172:01:11	~179:00:30	-10.430	-0.06	000-511	Static shift: +0.688
7	GSC-3	61.391300°	42.760178°	1977 m	61.390165°W	42.760473°	172:03:55	~179:04:30	-601.152	Jump or	000-265	Static shift: +2.052
8	DAL-B	61.263013°	42.624359°	2660 m	61.257702°W	42.625841°	172:05:57	179:06:30	+20.621	+0.12	000-269	Static shift: +3.345
9	DAL-A	61.119012°	42.469692°	3447 m	61.117204°W	42.469988°	172:11:40	179:08:40	+8.121	+0.05	000-266	Static shift: +2.381
10	DAL-H	60.986284°	42.326812°	3727 m	60.993978°W	42.326812°	172:13:46	179:11:13	-8.317	-0.05	000-278	Static shift: +1.002
11	DAL-I	60.846161°	42.175860°	3978 m	60.851016°W	42.176335°	172:16:36	179:13:52	+10.696	+0.06	000-283	Static shift: +0.923
12	DAL-E	60.709662°	42.027860°	4052 m	60.717373°W	42.026323°	172:18:06	179:16:29	+3.733	+0.02	000-289	Static shift: +1.985
13	GSC-4	60.606182°	41.915191°	4251 m	60.622189°W	41.910139°	172:08:32	~179:19:00	-16.748	-0.09	000-293	Static shift: +3.810
14	GSC-5	60.500629°	41.799626°	4432 m	60.508872°W	41.798674°	172:12:14	~179:21:15	+90.549	+0.51	000-298	Static shift: +1.052
15	GCS-6	60.369140°	41.655018°	4588 m	60.372090°W	41.653673°	172:23:32	~179:23:45	+24.357	+0.14	000-303	Static shift: +2.195
16	GSC-8	60.235464°	41.506835°	4698 m	60.239610°W	41.504475°	173:01:19	~180:02:30	-23.000	-0.14	000-308	Static shift: -2.170
17	DAL-G	60.103637°	41.360182°	4778 m	60.110407°W	41.361687°	172:22:19	180:05:24	-3.716	-0.02	000-313	Static shift: -0.784
18	DAL-J	59.971800°	41.212324°	4838 m	59.977192°W	41.212690°	172:12:00	180:08:03	+21.157	+0.11	000-318	Static shift: -0.513
19	DAL-L	59.835981°	41.059144°	4881 m	59.843440°W	41.059725°	173:01:47	180:11:00	-5.045	-0.03	000-312	Static shift: -2.070
20	DAL-K	59.662480°	40.861689°	4935 m	59.672575°W	40.852678°	173:07:19	180:14:05	+7.474	+0.04	000-318	Static shift: -1.449
21	DAL-F	59.499970°	40.676986°	5005 m	59.508038°W	40.668833°	173:05:59	180:16:48	-68.764	-0.38	000-323	Static shift: +2.710

Sampling rate

GSC / Dalhousie instruments 139.00 Hz

GSC-2 278.00 Hz

Instruments

GSC = Geological Survey of Canada (Atlantic Division) three-component 4.5-Hz geophones + hydrophone

DAL = Dalhousie University (Dept. of Oceanography) three-component 4.5-Hz geophones + hydrophone

Clock drift

+ sign OBS clock is ahead of GPS clock

- sign OBS clock is behind GPS clock

1) There is an additional static shift of +2 ms for all instruments

Scotian Margin (Mariprobe) 2001 - Line 3

Pos.	Instrument	Deployment longitude	Deployment latitude	Deployment depth	Recovery longitude	Recovery latitude	Clock reset (JD:hh:mm)	Clock check (JD:hh:mm)	Clock drift (msec)	Drift rate (msec/hour)	Raw data files	Remarks
1	GSC-2	64.433635°	40.619351°	4347 m	64.451033°W	40.622817°	187:19:57	190:19:48	-1.201	-0.02	000-087	Static shift: +2.031
2	GSC-3	64.556138°	40.794147°	4112 m	64.567846°W	40.801305°	187:20:22	190:22:22	+8.709	+0.12	000-092	Static shift: +0.788
3	GSC-4	64.680299°	40.968122°	3851 m	64.683338°W	40.970804°	187:21:27	191:00:50	-9.755	-0.13	000-096	Static shift: +3.603
4	DAL-K	64.805426°	41.143577°	3548 m	64.805426°W	41.149651°	187:18:12	191:03:19	+10.653	+0.13	000-099	Static shift: +2.052
5	DAL-H	64.931394°	41.316956°	3189 m	64.926807°W	41.321401°	187:18:27	191:05:16	-5.477	-0.07	000-102	Static shift: +0.127
6	DAL-G	65.058282°	41.490906°	2810 m	65.055705°W	41.492508°	187:18:34	191:07:08	+5.473	+0.06	000-106	Static shift: -3.199
7	GSC-5	65.185863°	41.664520°	2379 m	65.187119°W	41.664761°	187:22:33	191:08:59	+39.255	+0.48	000-111	Static shift: -1.456
8	GSC-6	65.315322°	41.838529°	1926 m	65.310990°W	41.842455°	187:23:04	191:11:10	+13.325	+0.16	000-115	Static shift: +0.366
9	GSC-8	65.444803°	42.012148°	1180 m	65.454144°W	42.006809°	188:00:04				No data	Static shift: +1.795
10	DAL-B	65.576042°	42.185408°	112 m	65.584332°W	42.186137°	187:18:48	191:14:32	+9.068	+0.10	000-121	Static shift:+3.509
11	DAL-J	65.707947°	42.358811°	102 m	65.705380°W	42.362026°	188:12:41	191:16:00	+8.629	+0.11	000-125	Static shift: -2.740
12	DAL-I	65.859456°	42.555196°	80 m	65.861733°W	42.556234°	187:19:04	191:17:06	+5.209	+0.06	000-127	Static shift: +1.816

Sampling rate
GSC / Dalhousie instruments 139.00 Hz

Instruments
GSC = Geological Survey of Canada (Atlantic Division) three-component 4.5-Hz geophones + hydrophone
DAL = Dalhousie University (Dept. of Oceanography) three-component 4.5-Hz geophones + hydrophone

Clock drift
+ sign OBS clock is ahead of GPS clock
- sign OBS clock is behind GPS clock

1) There is an additional static shift of +2 ms for all instruments