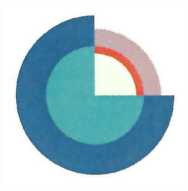

GEUS

GEOLOGICAL SURVEY OF CANADA

OPEN FILE 5391

Field Report for LORITA (Lomonosov Ridge Test of Appurtenance)

H. Ruth Jackson, Trine Dahl-Jensen, Editors

2007

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Canada

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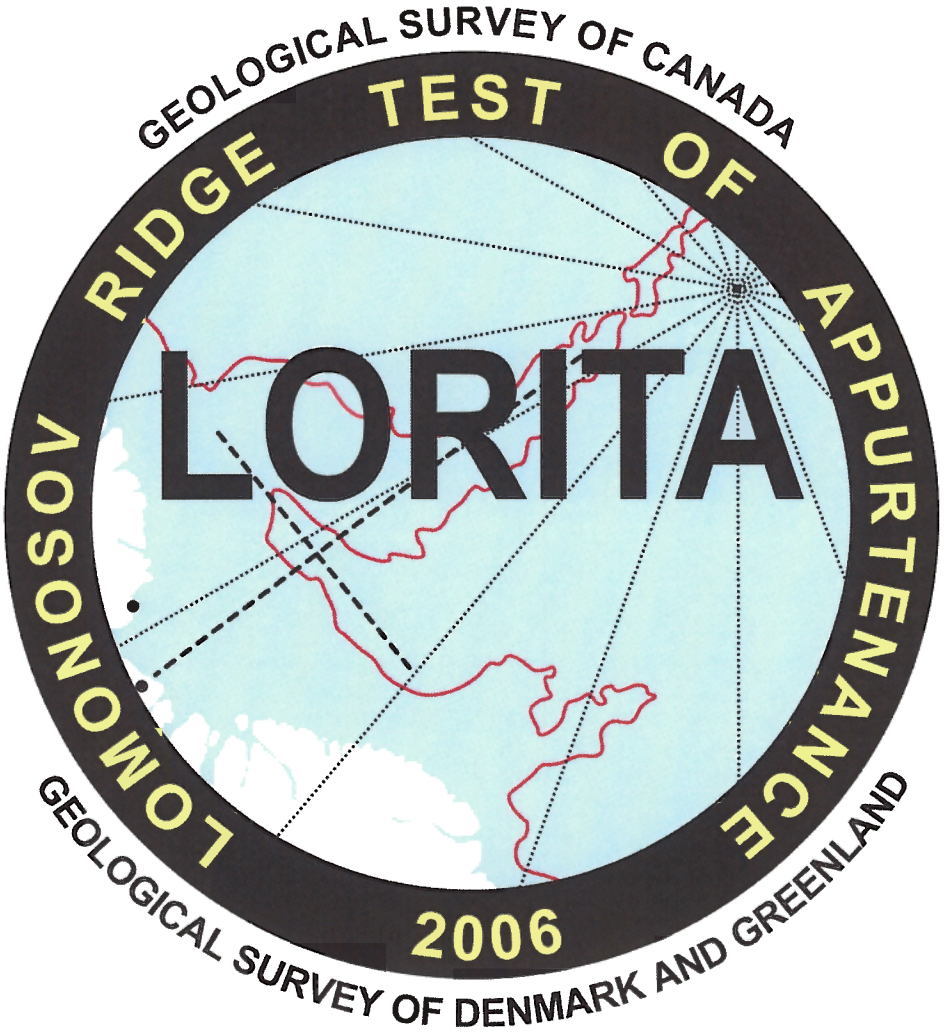
Lomonosov Ridge Test of Appurtenance

(LORITA)

Field Report

March 23 – May 6, 2006



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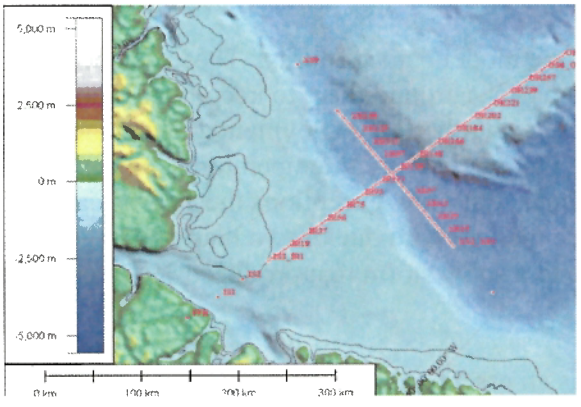
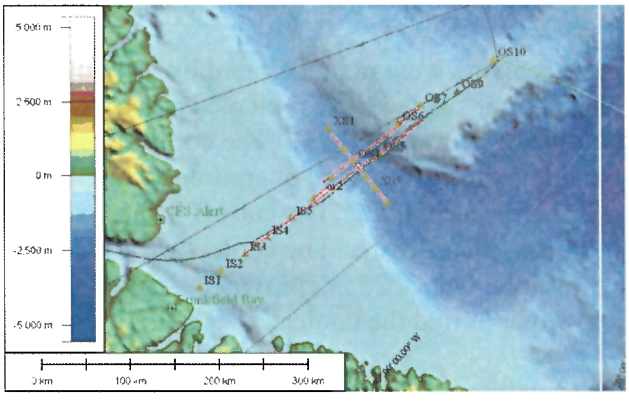
Executive Summary

Trine Dahl-Jensen, Geological Survey of Denmark and Greenland
H. Ruth Jackson, Geological Survey of Canada (Atlantic)

The goal of LORITA was to perform a test of appurtenance, on the Lomonosov Ridge in regard to continental shelf of Greenland/Ellesmere Island. This investigation is based on conditions of Article 76 of the United Nations Convention on Law of the Sea. To do this assessment we acquired wide angle seismic reflection/refraction profiles along a 440 km long line (from inner to outer most shot) from the near the coast onto the Lomonosov Ridge and a cross line of 100 km length in the trough between the shelf break and the Lomonosov Ridge. These profiles will give us information on the crustal structure from the inner shelf, across the bathymetric trough and onto the Lomonosov Ridge proper.

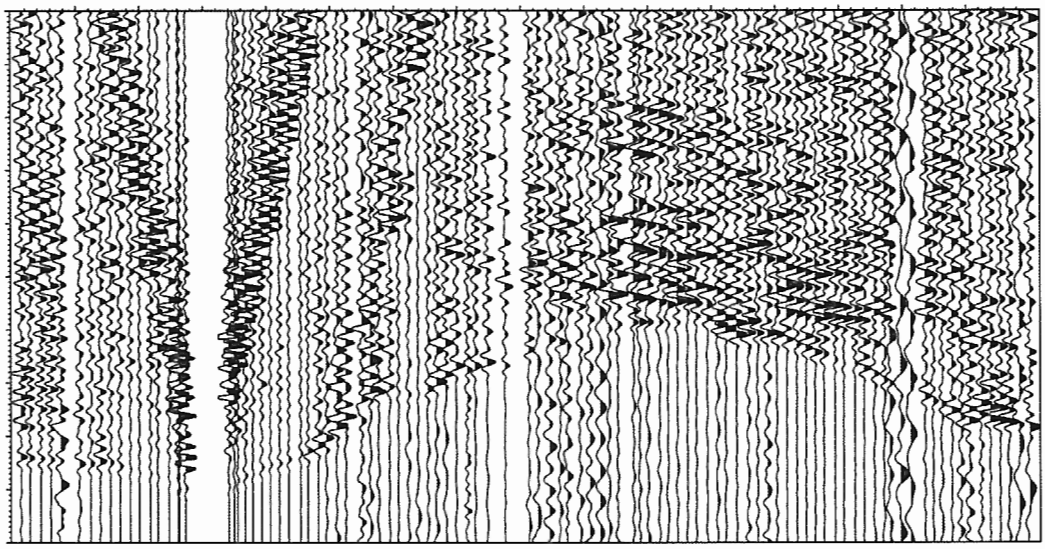
The figure below shows the planned wide angle survey on the left; the acquired data on the right. The near North-South line was acquired in two parts, but neither was as long as intended (both 200 km of receivers, 7 shots on the line and 2 offset shots on either end). The inner part of the line we acquired was 130 km in length, with receivers at a spacing of 1.3 km with 4 shots on the line and 2 offset shots to the south. The receivers on outer line overlapped by 32.5 km with the inner line (due to lack of offset shots north of the inner line) and extended over a length of 150 km with a receiver spacing of 1.5 km. On the outer line we fired 10 shots, 1 offset shot to the south, 6 shots along the receivers and 3 offset shots to the north. On the combined North-South line we deployed receivers at 183 locations and recovered receivers at 181 locations. The cross line was shot in a single day. On it there were 72 receivers spaced 1.5 km apart over a length of 100 km with 6 shots at 20 km spacing. In all, a total of 6.6 tonnes of explosives were detonated at 22 sites on the lines plus a test site. The sizes of the blasts were 175 kg and 350 kg.





The quality of the data is good with an excellent signal to noise ratio (see figure below). There are clear sedimentary, crustal and mantle diving waves and reflections from sedimentary and intra crustal interfaces as well as from Moho. On some segments of the data, noise assumed to be generated by moving ice, is prominent but does not interfere with identifying the phases.

Our evaluation in the field is that the data contain sufficient information to make a model of seismic velocities of the entire crust from the inner shelf, over the bathymetric trough and out onto the Lomonosov Ridge proper, thus accomplishing the main objective of the project.



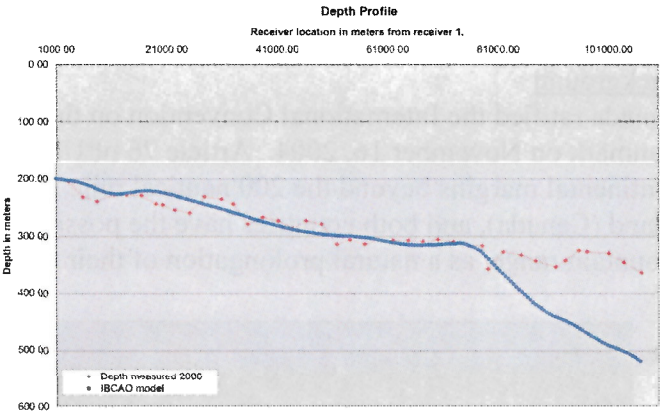
In order to get the sound source into the water, we first drilled holes through the ice. The augering proved easy this year, as re-frozen leads with ice 1-2 m thick were relatively easy to find. Loading the holes also went well, the design of the individual charges functioned as intended and they were easy to thread on the rope and primacord before lowering down the hole. The 10 charges per rope fell gently under their own weight, secured from a pickaxe handle across the hole. A geopositioning unit (satellite tracker) was left at each site to ensure relocation of the sites. Firing the charge worked as planned, barring small problems with the shot boxes. Nothing was left at the shot sites after blasting.

The receivers were manufactured by Nanometrics under the model name, Taurus. These data loggers where packed in insulated boxes (picnic coolers) with thawed ice packs around them to keep them from dropping below approximately -3°C. The coolers were taped securely shut before deployment and depending on outside temperature were operational from 4 days (-40°C) to over 7 days at temperatures during acquisition (-20°C to nearly 0°C). The cut-off is due to battery lifetime. With few exceptions the Taurus data loggers performed faultlessly. The coolers were placed on the ice marked with one or two black garbage bags filled with snow. Out of 255 deployments only 2 were lost due to a snow storm that produced 10-20 cm of new snow that buried the coolers.

The satellite trackers at the shot sites were left in place as an essential aid in finding data recorders for recovery. Prior to the experiment we had 11 trackers built. This technology played a critical role in our ability to complete the profiles after numerous days of poor weather interrupted the work and ice drift of up to16 km. A satellite tracker and five coolers were left at the far north of the outer line over 300 km North of Alert until May 6 when the weather cleared sufficiently to retrieve them.

Bathymetric and gravity data points were collected on every other receiver position over a distance of 106 km on the North-South line. The northernmost point was on the verge of the bathymetric trough. In all, 67 locations were measured on the shelf. Bathymetry was measured by placing a sound transducer on the surface of the ice. One CTD cast was made at the location of the ice camp for calibration. The technique for the collection of the bathymetry and gravity was successful. However weather conditions which plagued all aspects of the project prevented the collection of all the required information.

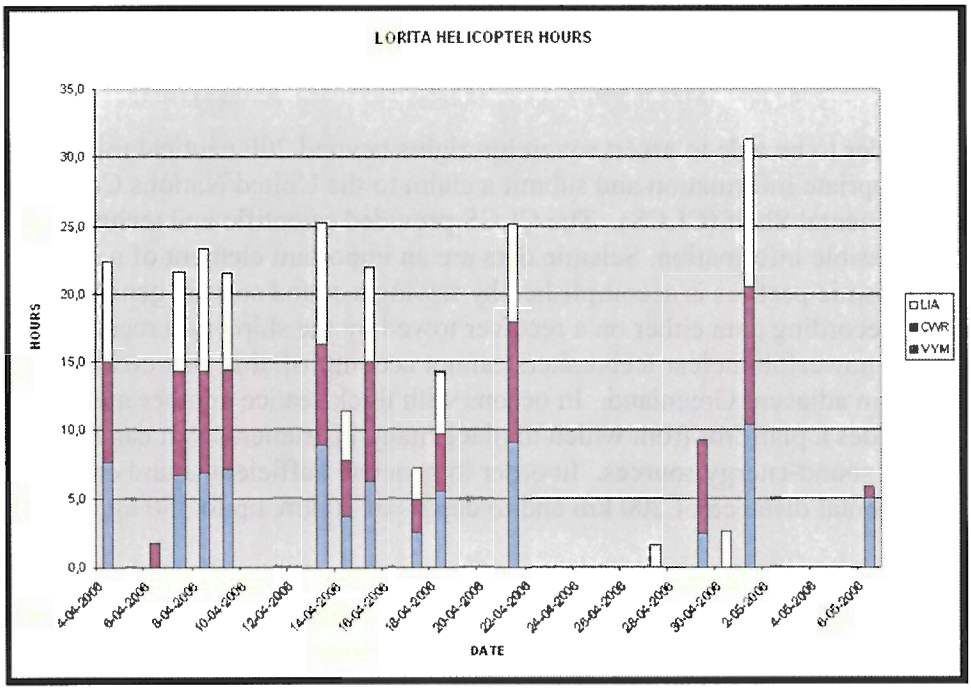
As may be seen from a comparison between the acquired depth measurements and a profile taken from the International Bathymetric Chart of the Arctic Ocean (IBCAO) the inner part of the line matches reasonably. However on the outer end, we see a depth difference of approximately 150m. This means the inner continental shelf reaches further seaward than the IBCAO model shows. We believe that this is not caused by inaccurate depth measurements but is rather a question of the position accuracy in the historical data.



An ice camp manned by three people was in operation from April 2 to April 28. Weather reports from the camp were essential for flight planning. The Twin Otter landing strip was used for carrying instruments, explosives and fuel out into the working area. The camp drifted a total of 127 km in an overall westward direction (from 85.00°N 59.25°W to 84.9°N 66.7°W). At the camp an airgun and hydrophone were deployed and activated to acquire a seismic reflection profile as the camp drifted. During this period we recorded 58.2 km of seismic reflection data.

During the project we established three additional fuel caches (southern cache, northern cache and cross line cache) where the Twin Otter could land and ferry fuel and equipment out to the helicopters.

The weather and ice were difficult this year. In particular the weather was the limiting factor on the amount of data collected. There were long periods of fog and low clouds over large parts of our working area. Of 31 possible flying days with the helicopter, we were only able to operate 8 full days and 4 partial days. The Twin Otter was able to function full time or for a portion of 24 out of a possible 41 days.



Purpose of the Project

Background

Canada ratified the International Convention on the Law of the Sea (UNCLOS) on November 6, 2003 and Denmark on November 16, 2004. Article 76 of UNCLOS specified a mechanism for defining the continental margins beyond the 200 nautical mile limit. Greenland (Denmark) is adjacent to Ellesmere Island (Canada), and both countries have the possibility of claiming the Lomonosov Ridge, a submarine mountain range, as a natural prolongation of their territory (Fig.1).

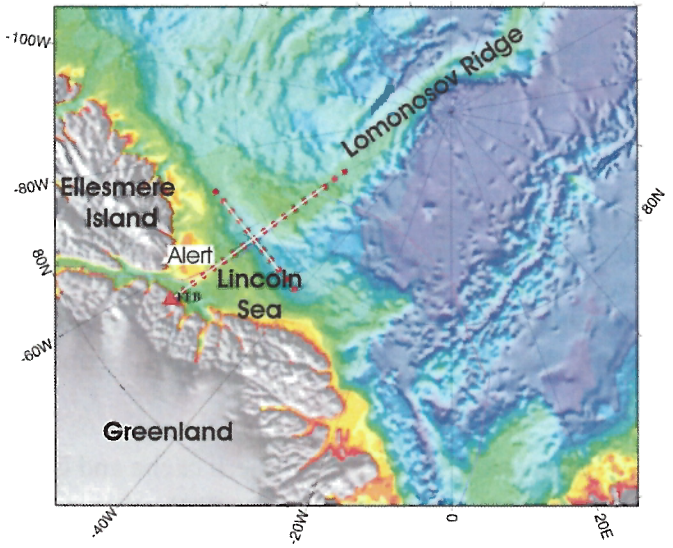


Figure 1 The red dots show the planned location of the sound sources and the white line the location of the receivers. The gray colour indicates the landmass. The shallow continental shelf is yellow and green the deeper waters blue and purple.

In order to be able to assert sovereign rights beyond 200 nautical miles a country has ten years to collect the appropriate information and submit a claim to the United Nations Commission on the Limits of the Continental Shelf (CLCS). The CLCS provided scientific and technical guidelines on scope and depth of admissible information. Seismic data are an important element of a claim. In ice-free oceans the collection of seismic profiles is accomplished by towing a sound source, generally an air-gun array, through the water and recording data either on a receiver towed by the ship or on recorders place on the sea floor. Even the most powerful nuclear icebreakers cannot accomplish this task on eastern portion of the Canadian polar margin adjacent Greenland. In oceans with thick sea ice another method must be used. The sea ice provides a platform from which to place many instruments that can record signals that are created by a few large sound-energy sources. In order to generate sufficient sound energy to reach the recorders over a horizontal distance of 200 km and to depths of 30 km, up to 350 kg of explosives are required.

If Canada and Denmark can claim the Lomonosov Ridge as a natural prolongation of their territories, they can exercise specified sovereign rights out to a distance of 350 nautical miles or further. These rights include powers over mineral and biological resources on and below the seabed and jurisdiction in matters related to environment and conservation. If the Lomonosov Ridge is deemed not to be part of these countries, all mineral and living benthic resources will revert to the United Nations for perpetuity. International environmental regulations will be applied not national.

The geologic and hydrographic institutions of the two countries have similar responsibilities and organized a joint survey. This cooperative project has the additional benefit of reducing any environmental impact from the seismic survey by half.

Factors affecting the design of the field work

We proposed the wide-angle reflection/refraction technique with explosives as the sound source due to the restrictions imposed by the sea ice and due to the need to present particular types of data sets to CLCS. The seismic refraction method provides detailed information on the distribution and thickness of subsurface layers with characteristic velocities. In order to have sufficient information with which to make the case that the Lomonosov Ridge has a velocity structure similar to the polar margin, 11 shots per line were planned. We designed the offset shots and the two furthest shots at the end of lines to be 350 kg, and the middle shots of 175 kg. After careful consideration of both the need for a sufficient sound to be produced and potential environmental impact, Pentolite® explosives with an additive that made them biodegradable, and Primacord® were chosen to be suspended 100 m underneath the ice. The sound after it has been reflected and refracted through the layers in the earth was to be recorded on 150 instruments (digital seismometers) on the sea ice purchased for the experiment with design criteria based on the extreme conditions. The recording instruments also had to be small and light, so that they would fit in the helicopters. The contract to build them was won by Nanometrics and their model name is Taurus.

A plan for acquisition of seismic refraction data from the Canada/Greenland shelf out along the Lomonosov Ridge (approximately along the unofficial median line) was drawn up, crossing over the bathymetric trough and also covering the area where the ridge abuts the shelf. Operations were to be based in CFB Alert, Nunavut on the northern tip of Ellesmere Island, with up to 32 people. A small emergency camp with 3 individuals on the sea ice in the middle of the working area for safety, fuel and explosives storage, and the acquisition of weather information was deemed necessary. Transport of personnel and equipment from Alert to the sea ice was planned to be by a Twin Otter and three helicopters, all dedicated to the project. About 76,000 liters of fuel were required. The fuel was stored in specifically designed facilities for holding volatile materials at the Department of National Defense base at CFBAlert. About 16,000 liters were in barrels. Contingency plans for spills were prepared in a separate document, as well as a safety manual specifically for the LORITA program. In addition permissions for shipping and storing about 10,000 kg of explosive were obtained. This hazardous material was to be handled by trained personnel and stored in dedicated facilities at Alert.

Figure 1 shows the anticipated lines (receiver line in white, shots in red). The data was to be acquired in one season estimated to be 6 weeks from April to early May. The data loggers were to be spaced at 1.3 km interval over 200 km, shots were to be fired at 11 locations for each of the three sections. Some shot locations were to be use twice. The line along the Lomonosov Ridge was planned to be 400 km long, and to be acquired in two sections; the line crossing westwards 200 km long and acquired in one section. The field activities were planned to start from Alert and work north over the sea ice. Figure 1 shows only 27 not 33 shot locations due to the overlap in shot positions.

Participants

Name	Affiliation	Role
Ruth Jackson	GSC	chief scientist
Trine Dahl-Jensen	GEUS	co-chief scientist
Dave Maloley	CALC	aircraft control and communications
Jim Milne	DRDC	CFS Alert scientific/military liaison
Isa Asudeh	GSC	instrument set-up/data
Thomas Funck	GEUS	instrument set-up/data recovery/ processing/archiving
Christian Marcussen	GEUS	deployment/recovery; safety officer
John Shimeld	GSC	instrument deployment/recovery; safety officer
Dave Snyder	GSC	instrument set-up/data recovery/ processing/archiving
Peer Jørgensen	GEUS	deployment/recovery; explosives
Ron Verrall	CALC	deployment/recovery; drilling, reconnaissance
John Boserup	GEUS	instrument deployment/recovery; drilling
Dave Forsyth	CALC	instrument deployment/recovery; explosives
Søren Bredvig	POLOG	deployment/recovery; explosives
Tim Cartwrigh	GSC	deployment/recovery; explosives
Jon Biggar	CHS	gravity and bathymetry measurements
Arne Olsen	DNSC	gravity and bathymetry measurements
Morten Sølvsten	FRV	gravity and bathymetry measurements
Jørgen Skafte	DPC	ice camp manager
Greg Middleton	GSC	ice camp seismic reflection data acquisition
Mike Gorveatt	CALC	ice camp seismic reflection data acquisition
Douglas Briscoe	CALC	general duties,
Sean Williams	CALC	general duties, CFS Alert
Ken Asmus	CIS	weather analyst for 3 weeks at Alert
Leslie Milne	CALC	general duties
Dorothy Edwards	CALC	cook's helper/ general duties
Jopee Kiguktak	Grise Fiord	observer
Kelly Bentham	GSC	photographer/videographer
Bob Schieman	GSC	engineer
Søren Rysgaard	Grønlands Naturinstitut	associate program
Martin Emil Blicher	Grønlands Naturinstitut	field assistant to Søren Rysgaard

Aircrew

Please note air crews were rotated:

Paul Rask	Ken Borek	Pilot
John Kominko	Ken Borek	Pilot
Rodney Fishbrook	Ken Borek	Pilot
Mark Vink	Ken Borek	Pilot
Jim Haffey	Ken Borek	Pilot
Gabriel Lluberas	Ken Borek	Pilot
Kevin Riehl	Ken Borek	Engineer
Gerard Hartery	Universal Helicopters	Pilot
Bill Denomme	Universal Helicopters	Pilot
Colin Lavalee	Universal Helicopters	Pilot
Mark Foley	Universal Helocopters	Engineer
Steve King	Ken Borek	Pilot
Rory McNichols	Ken Borek	Pilot
Brad Belan	Ken Borek	Engineer
John Innes	Universal Helicopters	Pilot
Gerry Nuttal	Universal Helicopters	Pilot
Jim Barry	Universal Helicopters	Pilot

Abbreviations

GSC Geological Survey of Canada
GEUS Geological survey of Denmark and Greenland
CALC Canadian Arctic Logistic Corporation
CIS Canadian Ice Services
DRDC Defense Research and Development Canada
CHS Canadian Hydrographic Service
DPS Danish Polar Centre
DNSC Danish National Space Centre
POLOG Polar Logistics Group
FRV Royal Danish Navy Administration of Navigation and Hydrography

LORITA team


LORITA
Christian Marcussen
Dave Forsyth
Dave Maloley
Dave Snyder
Dorothy Edwards
Greg Middleton
Isa Asudeh
John Shimeld
Martin Blicker
Mike Gorveatt
Morten Solvsten
Ron Verrall
Søren Bredvig
Søren Rysgaard
Tim Cartwright
Trine Dahl-Jensen
Mark Foley
Aircew
Jim Haffey
Gabriel Lluberas
Kevin Riehl
Bill Denomme
Colin Lavalee
Gerard Hartery

Journal of the Chief Scientist

Ruth Jackson, Geological Survey of Canada (Atlantic)

Wednesday, March 29, 2006

The first seven participants of the LORITA project have been at Canadian Forces Station Alert for several days. CFS Alert is located on the shores of the Arctic Ocean on Ellesmere Island 84.0°N, 64.20°W (Fig.1). It was established as part of the Joint Arctic Weather Station System in the early 1950s. The Canadian military station was established in 1958. It takes its name from a British military ship that wintered in the region in1875-1876.

The first group consisted of: Doug Briscoe; Dorothy Edwards; Dave Maloley; Jim Milne; Leslie Milne; Jørgen Skafte; Sean Williams.

Their trip north was interrupted by a four day lay over in Iqaluit because of a storm in Resolute Bay. This delay in their travel itinerary is not unexpected in the Arctic, at any time of the year. They eventually flew to Resolute Bay on a commercial First Air flight. In Resolute Bay they met the chartered Twin Otter from Ken Borek and flew on to CFS Alert.

Satellite imaginary on March 23 showed a mayor system of leads forming north of the eastern section of the Canadian Arctic Archipelago and growing rapidly northeast across the Arctic Ocean to intersect our planned lines. This was in keeping with the first reconnaissance of the ice from the Twin Otter that showed significant leads with strips of open water. The ice along the inner refraction line is cut by many leads and without ice that is suitable for a Twin Otter landing strip. Katabatic winds blowing from Greenland to the North have caused the usually tightly packed sea ice to be blown away from the coast. The east-west line has conditions that are suitable for running our refraction survey at this point in time.

At 14:00 hours the group of 16 Canadian and Danish scientific staff boarded the Boeing 737 flight 6500 from Edmonton to Alert at the Edmonton International Airport. Since most long range scientific Arctic travel is done in a slow, noisy and uncomfortable C-130 Hercules, we were pleased. We had a pleasant flight to Resolute Bay. Trine and I sat together on the aircraft and put together an agenda for our first meeting in Alert, we made sure that everybody was aware of the team they were associated with and set up a series of initial tasks.

In Resolute Bay we picked up Jopee Kiguktak our official marine mammal observer from Grise Fiord. The aircraft was refueled and we flew off to Canadian Forces Base Alert. Total flying time was 5 hours for the trip. We landed at about 21:30 in the dusk and saw leads with associated ice fog. Ron Verral who had worked at Alert for many years had never seen ice conditions like these (i.e. with so much open water).

Our group of seventeen new arrivals were driven from the runway to the Orderly Room at the base and signed into our rooms. We are billeted in a wing of a two story building affectionately know as the Manor. About an hour later our bags were delivered and we unpacked. We had a brief discussion with Dave Maloley and Jim Milne who have been working hard to get the project underway.

The field base camp had been established at a distance of 1 hour and 5 minutes from Alert by Twin Otter. This is the second location, the first location, where fuel drums and a beacon were left was abandoned due to too much motion. The approximate location of the camp is 84°N and 57°W.

Thursday, March 30, 2006 - Camp 84°59.51N, 57°39.84W

The motivated scientific staff was at breakfast sharply at 07:00 hours in the world's most northerly dinning room. We noticed there were not many military personnel in the mess. We learned that the residents here have common rooms with a store of food supplies and can prepare their own breakfast.
Due to operational considerations the meeting of the scientific staff was scheduled at 10:00. Dave Maloley needed to get the Twin Otter crew in the air to continue the build up of supplies for the ice camp. The scientific personnel were asked to stay away from the staging area for flights (the Spinnaker Building run by DRDC (Defense Research Development Corporate) until after Dave and Jim's staff have the equipment sorted and ready to be unpacked and set up inside. Mike Gorveatt and Greg Middleton were requested to go to the Spinnaker building in order to choose which items of their gear was to be put on the Twin Otter. The Twin Otter will be flown to camp today by the experienced pilot Paul Rask.

By 10:00 Dave Maloley and Jim Milne were available for the staff briefing. We began with the safety officers identifying themselves, John Shimeld and Christian Marcussen. They reminded every one of the importance of this fundamental issue. Ken Asmus, our weatherman, described his role and the variety of weather and ice services being provided. He will provide a briefing by 07:00 hours that will be available for the pilots. He commented that he had never seen so many weather and ice products available for any experiment. He has at least thirty years of experience in this field. I hope that during our experiment I will get feed back from the pilots and Dave Maloley on which of the products are most valuable.

Trine and I listed the teams and suggested a few tasks that should be started immediately. We plan to meet regularly with Dave and Jim in the evening at 18:00 hours.

After lunch the acting Commanding Officer (CO) Lieutenant C. Cunningham and his senior staff gave the scientific staff and the new military personnel that arrived on the Hercules C-130 at 10:30 an introduction to the base. When this was over the scientific staff went down to the Spinnaker building to unpack their equipment. Isa and his team have 150 seismometers built by Nanometrics called the Taurus, a raft of computers and a network to set up. The shooters went of to inspect the explosives. They had one complaint with the manufacture that the charges were shipped on light weight pallets so they were difficult to maneuver with the fork light and not well shrink wrapped. Christian did an inventory of charges, 570, primacord 57 roles and caps 200. His numbers matched the order. Dave Forsyth has located all the axe handles, rope and disks for the bases of the charges. He has to fabricate handles for the primacord reels so it will spool smoothly on loading of the charges.

Ron Verrall and John Boserup were busy unpacking, assembling and running up the first Stihl auger. They are planning to cut ice with it tomorrow.

John Shimeld and Jopee Kiguktak worked at getting the CarteNav ETS -1500 Ice trackers beacons that will be used to follow the ice motion unpacked, assembled and set up outside over night. They finished their task after supper. John was concerned that there were no spare batteries. They were purchased with the specifications that they would have the power to run for the entire experiment. The mounts for holding the antennae several feet above the ice did not fit the rods supplied. The rubber had to be removed from the u-bolts and that solved the problem.

After supper Trine, Dave, Jim and I met to plan tomorrow's activities. Ken's weather report suggests the weather will remain constant for several days. There is concern about ice fog in the morning. Only one flight is planned for the air craft, it is loaded with plywood for the ice camp. The military personnel at base scheduled a "meet and greet function" for every one tomorrow at 15:30 and all personnel are strongly encouraged to attend.

I had a request from Dave Maloley and the helicopter pilots to write a letter on official letter head to explain that they were handling explosives for a legitimate government operation in case traces of it are found at a border crossing. Dave will also pay for dry cleaning their parkas.

To date only one piece of equipment is known to be left behind and that is the cartridges for the colour printer.

Friday, March 31, 2006 - -29-31°C - Camp 84°59.51N, 57°39.84W
After breakfast we had our first daily meeting. A number of points were brought up by the group. They voiced concerns about finding appropriate locations around the base for testing equipment or assisting other researchers at Alert to get samples of snow for monitoring for air borne contaminants. Most of the scientific staff walked down to the DRDC facility at the runway. There are various problems with the local transportation. The truck that Leslie usually drives has faulty steering and is not safe to drive. The truck with the tracked wheels was not heated last night and has to be warmed up. The only truck that is operational can only be driven by Jim who has a military driver's license.

The CarteNav ice trackers were left running for the evening. They worked well until 22:00 hours when they suddenly transported themselves back to Halifax. This was troublesome. As John Shimeld was preparing an email to send to CarteNav it was noticed the positions were now indicating the trackers had returned to Alert. It appeared that the company noticed the software problem and corrected it. The pilots took tracker lucky number 7 to the ice camp to record its motion. I called Borden Chapman at the Geological Survey of Canada (Atlantic) and confirmed for John Shimeld that the ice trackers required no more batteries because the lithium batteries were tested and predicted to last for 60 days. When taken directly out of their boxes at -30°C, the batteries were delivering full power of 3.67volts.

Our work shop at the runway was bustling with activity. Ron and John Boserup tested the first Stihl auger from TFSS in Ottawa and it worked surprising well. It was discovered to be rotating at the ideal 333 turns/minute. We thought all of these drills had been disposed of. Its serial number is 114 036935. Excellent care must be kept of this transmission. Mike and Greg were unpacking the other TFSS augers with the slower RPM of 150 U/minute and putting on the handles and filling the transmissions, etc.

The most labour intensive activity is preparing the Taurus seismometers and their insulated boxes for deployment. They have to be repacked with their cables connected properly, the seismometers stored separately and external cables coiled neatly out side the boxes. Dave Snyder, Thomas Funck, John Shimeld and Jopee Kiguktak are busy with this task. There are 150 instruments to be prepared for deployment. Isa Asudeh meanwhile is setting up the local area network.

The shooting team has discovered a problem with the GPS in the shot boxes. Tim Cartwright has put them in a warm location and to look into the receiver variables to ensure they have all proper variables to initiate. He also called their designer Bob Schieman to assist with the problem solving.

Trine has completed the photo shoot of all individuals in the scientific staff. She is also conferring with John Shimeld about the official location of the shoots for all three lines. They must be given to Dave Maloley and the aircraft team.

Chatting with Dave Maloley, I learned that a total of about 55,000 lbs (25,000 kg) or 25 metric tons had been shipped to Alert for the experiment:

38,500 lbs of the C130
13,500 lbs on the 737
1,500 lbs on the Rotator
500 lbs on the Twin Otter

The cartridges and print heads for the colour printer cannot be located. I called Nelly Koziel and gave her the serial numbers (all HP88 numbers). I asked for two of each and that the items be sent Fedex to the following address:
Ruth Jackson
P.O Box 5210
Station Forces
Belleville, ON K8N 5W6

The helicopters are still unable to fly from Pond Inlet to Resolute Bay due to poor weather, including freezing fog.

All the staff showed up for the informal but mandatory get together at the base bar. Therefore all flying activities were stopped and the military personnel and scientists mingled. The senior military staff from Hut 53 prepared the pizza and delivered the food to the hungry crowd. Trine and I took the opportunity to converse with the CO Colin about the project. We will give a presentation to the base next week at their convenience.

Dave Maloley, Jim Milne, Trine and I had an hour long planning session for tomorrow's activities. We are trying to get sufficient material stored at the camp site to begin erecting the camp and populating it. The problem is complicated by the fact that only Jim can drive the truck to ferry flight crews around due to the requirement for a military driver's license. Thus Jim who knows where all the equipment is stored is constantly pulled away from tasks of preparing for the camp. All other vehicles that are available to us are not working at this time; therefore, all staff will be asked to walk wherever possible.

We believe we can have three loads for the camp tomorrow consisting of the skidoo, generators, kitchen, tents, sleds, and food. Each item requires preparation: the food must be separated into weekly lots, the skidoos must be checked out mechanically and electrically. The three loads tomorrow are aimed at having three personnel at the ice camp on Sunday and the test shot completed. One load of the three Twin Otter trips will be 2400 lbs of explosives in preparation for the test shot on the following day.

Saturday, April 1, 2006 - sunny light winds, -32°C
The scientific staff had breakfast in our common room organized and prepared by Dorothy Edwards at short notice. We were not fully aware that only two meals are served in the mess during the weekend. Ken Asmus, our favorite weatherman, had already down loaded the weather. Sunny and bright in Alert except for sea fog at the coast. Unfortunately the only place with unflyable weather is Resolute Bay and the helicopters are still on the ground in Pond Inlet. They must pass through Resolute to travel to Alert.

We are now able to pin up printed weather notices and the plans for the day in our common room because we have one printer in operation and access to others in the building. We had an early group meeting to discuss the possibility of three flights today. The pilot warned of possible delays due to the Saturday schedule at the base. Dave Forsyth and Paul Rask discussed the topography of the ice near the camp to determine if a suitable location for the test shots to monitor the absolute noise levels of the blast could take place. There are not a lot of options in the region due to the ice configuration. The other reason for the shot

is to be sure all shooters were familiar with all aspects of the blasting.

John Shimeld down-loaded the Ice Tracker data. The ice camp is moving due west at greater than 200 m hour 4.6 km in 21 hours. This is useful information and we are pleased that this new technology is working without too many teething pains. John contacted CarteNav and they are sending us an additional instrument to replace the one that is not operational and additional lithium-ion batteries. The software problems have been fixed.

The first load of gear out on the Twin Otter today was a load of explosives. The important camp gear the skidoo, food and tents etc. takes more time to prepare in the morning. Greg Middleton worked on the skidoo and had it tuned so that it was ready to make the second load. Mike Gorveatt worked with Ken Asmus to learn how to set up the portable weather station that will be eventually be set out at the northern end of the line. It will be sent up in the ice camp until that time. In addition Trine and I are checking that we have waivers from all staff that will fly on the aircraft. They were handed to Dave Maloley to send to PCSP in Resolute.

The lack of trucks to transport people back and forth between the main base and the run way is alleviated by most of the science staff being ready at pre-determine times or walking. Tim Cartwright had a look at the disabled truck and diagnosed the problem. However we have to wait until Monday to get support from the Base for parts. Fortunately, Chuck, from the Base volunteered to drive a truck on the weekend to help us out.

Three trips in all were made by the Twin Otter. There is now enough equipment on the ice for the 3 person team to be safely left there. In addition 60 charges and 6 rolls of primacord have been placed at the ice camp for the test shot tomorrow. After Christian inventoried the explosives here, the book keeping and monitoring will be done by Dave Maloley who will keep the spread sheets and controls the Twin Otter loading.

Isa Asudeh, Dave Snyder and Thomas Funck have completed preparing the instruments for deployment, all 150 of them. The only problem with the equipment at this point is the blasters cannot get a GPS time for their shot. Isa has requested a clock from Ottawa and spare parts for the blaster boxes to be sent to Resolute Bay and transferred to us through Eureka. If the problem is not corrected a Taurus seismometer can be placed at each shot.

The new Radarsat images today showed the lead along coast of Northwest Greenland increasing in size. The thin ice and open water must be 10 nm across. It was on this photo that I noticed a large irregular flow that had parallel sides. All the major cracks in our region radiate from the corners of this flow. The ice at the northern end of Nares Strait in the Lincoln Sea has been churned into little chunks.

By 18:00 hours the weather had cleared in Resolute Bay. We all hope a window of opportunity will open for the helicopters to fly through.

Sunday, April 2, 2006 - light winds from the north, -27 to -34°C
Ken Asmus held his weather briefing as we were eating our breakfast in the common room of Manor House. Dorothy Edwards provided eggs and bacon, much appreciated by those who would fly to the ice camp this morning: Jørgen, Mike and Greg supported for the day by Ron and Jopee. The Twin Otter left promptly at 09:00.

The weather forecast for our helicopters that are in transit is hopeful, they left Pond Inlet yesterday but had to set down near Nanasivik. There are several lows in their region but there may be a small window that can found for them to continue their flight.

The Twin Otter reached the ice camp mid-morning and reported that the conditions are not suitable for three flights today, low cloud. This means that the test shot will have to be postponed for another day because there is no guarantee that the group of 7 including shooters, observers and instrument deplorers' would be able to return. The ice camp personnel are just setting up the first tent. Therefore there are insufficient accommodations for the entire group if they were left at the camp and the safety margin is too small. The second flight of the Twin Otter contained spill kits, water, explosives etc. On the return flight Ron and Jopee came back.

By the time the Twin Otter was making its final trip of the day, three octagon huts had been erected and the stove was running in one of them. Ron told us there were mutterings that it was too warm inside when they ate their lunch. Greg who is an amateur motor cycle mechanic had trouble starting the skidoo at the camp. Ron provided him with his years of experience and primped the engine three times; at thirty below you cannot flood the engine. This is the learning scenario we had hoped for, the experienced individuals passing their knowledge to the neophytes.

It was actually rather windy at the ice camp and the clouds were coming in adding moisture and the wind chill was increasing. Jopee said he found it cold at the ice camp. The ice camp is situated on the most promising flow that the veteran pilot Paul Rask could find. It is probably only 2 m thick if possible ice twice that thickness would have been chosen. However it is the only flow located close to where we need our ice camp; that is, near the position where our survey lines cross.

Ron took pictures of the ice as he flew home. We all gathered round and compared the Radarsat pictures with the photographs. The major recently refrozen leads provide tie points. The vast majority of the ice is either frozen this winter or young flows. Little multiyear ice was spotted. From the point of view of running the refraction lines if we can find a few runways and make extensive use of the helicopters we should be able to operate efficiently in this area. At least augering through the ice should be easier than was anticipated.

Our helicopters are still grounded near Nanasivik between Pond Inlet and Resolute Bay. The weather predictions indicate little hope of improvement in this region to the south of us. In fact the weather is deteoriating at the ice camp and it is unlikely we will get a test shot off tomorrow. Our 18:00 planning meeting was short. If the weather does not improve there will be no flights tomorrow. The only progress that can be made is by the three personnel at the ice camp. They have to set up a total of five buildings, get the stoves running in all of them, sort out the scientific gear, warm it up, assemble the electronics and set up the air gun system. The have about 4 days work ahead of them if no major problems are encountered.

Supper for 100 hundred last night was provided by only two cooks. One military personnel and Dorothy provide a roast beef or stuffed sole entrees for all. It was an impressive effort.

After supper I took the opportunity to use the telephones that are provided to call home, they are labeled morale boosters. Calls are free; however you have to pre-book a time slot. As the base personnel have telephones dedicated to their own use and this set of phones cannot be used to call Denmark it is rather easy to find time to call. John Boserup fortunately discovered there is a telephone that can be used to call Denmark as well. Internet is available and again all that is required is to find a time when the computer is

free.

Monday, April 3, 2006 - sunny, bright, -26 to -34°C, sunrise 02:37 sunset 21:47
The day dawned with unexpected good weather for flying to the ice camp. The schedule communications with the remote site takes place at 07:30 by this time breakfast is over.

The ice camp is already achieving its purpose of providing of accurate weather data to make interpretation of the information sent to us easier. As soon as the report was relayed from Dave Maloley to the common room of Manor House, the pilots left for the runway. The 7 scientific staff required for blasting, monitoring, cutting the hole and training were in motion. Lunches were packed, hot coffee poured into thermoses and full survival gear taken to the back door for transport to the runway. The Chosen Frozen are an enthusiastic troop leaving for their first task.

Those left back at Alert were working on preparations for data processing such as preparing scripts for handling the data when down loaded. A heated discussion took place over the naming conventions for the instruments positions on the ice. John Shimeld will prepare a template for those who will place the Taurus on the ice. Only a few numbers are required: the way point, the box number the Taurus is in, its sequence number on the individual GPS units and the actual position. John also took ice tracker 12 into the laboratory. He checked the batteries, the seating on the boards and looked for loose wires. Nothing was obviously wrong with it; the instrument was packed and labeled. It will be shipped south on the next available flight and a spare is being shipped to us. The other ice trackers are working well. The one at the ice camp is accurately tracking it. We can see that the motion of the camp to the west has slowed slightly over night and there is now a component of motion to the south. Danish Meteorological Institute (DMI) predicts this will continue.

The weather has cleared near Nanasivik and the helicopters are able to fly towards Resolute Bay. After several predictions that they would reach Resolute, I am only indicating a direction not a final destination. When they reach Resolute they have to remove their floats before they can move on.

Today is official cleaning day at the base. As there is no one assigned this task each house has to ensure the living quarters are clean. We are fortunate that Leslie and Sean have this task well in hand.

Mid-afternoon the team that was firing and monitoring the explosive charge arrived back at Alert from the ice camp. They were pleased with the results. Tim had captured the sound on the blast phone. I was surprised that at 100 m distance from the shot the sound was 80db for the smaller detonation and 101 db for the 375kg charge. This seems unreasonably low. And not the case in fact; should add that there was a calibrations error.

Table 1. Common Sound Sources and Levels

Sound Source	Noise Level dB	Reference
Motorboat outboard	80	www.nonoise.com
Motorboat inboard	110	www.nonoise.com
Gun Shot	140	www.nonoise.com
Ice Breaker	180-185	Richardson et al. (1995)
Natural Background -	180	Greening and

Pack-ice Breaking		Zakarauskas (1994) Richardson et al. (1995)
Bowhead Whale Song	158-189	Richardson et al. (1995)
Beluga echolocation	206-225	Richardson et al. (1995)
Canadian Polar Margin Seismic Air-gun Array	230	Canadian Polar Margin report
Sound Level at periphery of Safety Zone	170	Canadian Polar Margin report

Many pictures and videos were taken of the charge. Dave Forsyth carefully instructed his crew on the nuisance of how to prepare the charges. John Boserup's drill worked well in the 1.7 m ice thickness. It took little time to drill the hole and about ten minutes to load each one. Of course additional time is required to position the charges at each site that will be 30 km apart.

Jopee took a number of pictures of the operation and walked around the sight looking for signs of animal tracks such as foxes or bear. He saw no evidence of animals at this sight. Dave Forsyth asked him for permission to fire the charge before detonating the blast.

The Taurus have all recorded data including the instrument left turned on in the Spinnaker building. The quick look program only showed data on seven. So Isa and team are busily looking at their techniques for reviewing and playing back the data
The helicopters made it to Resolute Bay!

My wildlife count at the Alert station from the road from the barracks to the runway is one Arctic hare, one wolf and a single ptarmigan.

Tuesday, April 4, 2006 - sunny, bright, -26 to -34°C
The ice camp is now officially reporting weather to be added to the national database. The ice tracker buoy at the camp indicates that drift has slowed down to a few meters per hour. The weather for our sphere of interest is flyable every where. At 08:10 Ron and Jopee were called to the runway to get on the flight that will be taking equipment to the ice camp. On the return flight the Twin Otter will fly low along the Inner Refraction line. Ron will be doing a reconnaissance for ice characteristics and Jopee for signs of animal life.

At our regular meeting there were a number of topics discussed that needed further attention. Why did the blast phones measure only 101 db? Tim will be trying to sort this out. Why was the play back of the data not as easy as expected? Isa is already working diligently to solve this problem. Dave Snyder will look at the data to get water depth and sediment thickness. What auger is the best for the task of drilling holes for the explosives? John Boserup and Dave Forsyth are to write a report with all the technical specifications and recommendations.

Tim called Rob Cyr who set up the blast phone for us. He believes that the configuration is wrong and the reading should be in psi. Tim will go over the parameters and physical configuration and get back to him to determine what can be done to correct the problem.

Trine and I went to talk to the Station Warrant Officer (SWO), Steve by name, to determine the time for our

presentation to the Base. It was agreed that it would be scheduled for 08:00 hours on Thursday.

At the Spinnaker lab Isa, Thomas and Dave were busy sorting out the playback problems. Isa called Nanometrics (the company that built the Taurus) and sent them copies of the data so that they could address the software problem. The large amplitudes of the shots are not being displayed. It is not a gain problem with 32 bits available. However, the problem is not simply related to the large amplitudes because the Taurus at the Spinnaker building recorded data but not its position. None of these problems of course occurred in the tests in Ottawa. Dave Snyder used the water bottom bounces to determine the water depth and determine 1300 m. After more thought it was decided that the number needed to be divided by 2 and this is consistent with the most recent bathymetric map of the ocean (IABCO).

Ron came back from over flying the Inner Refraction line. There is a significant amount of ice fog due to the open water. This means there is no choice but to run the cross line that we have been preparing for. We hope that now the winds are from the north the leads some of them a mile across will close a little and begin to freeze up.

At the ice camp there are busy preparing the ice hole for the airgun. Ron reported that Jørgen, Mike and Greg were happy to be at the camp. He was at the camp when the Twin Otter delivered supplies to them. Communications by radio are difficult and the Iridium phones only work briefly when directly overhead. Therefore details about what is happening out there are limited. Jopee was on the Twin Otter flight to the camp and then along the inner refraction line so that he would have a chance to observe the ice and see if any animal life could be spotted. Fog reduced the visibility so it was difficult to distinguish anything even though the Twin Otter was flying low.

Just after lunch there was a practice alarm and all the scientific staff had to meet in the club over the mess hall. The drill lasted about 40 minutes. The high light of the event was the wolf that was trotting around just outside the building.

After the drill Trine and I met with the blasting team to determine how we would manage the augering, transport and loading of the charges. Ron's initial suggestion of helicopter one carrying three people, two drills and the ice trackers carried the day. This helicopter requires a basket. Helicopter two will ferry the charges 350 kg, rope, etc and one person Christian. The third helicopter will load the charges and carry three people Dave Forsyth, Peer and Tim. John Shimeld briefed helicopter one team on how to deploy the ice trackers.

The 3 helicopters arrived tonight at about 19:30. They were 9 days in transit from Goose Bay, Labrador not counting the 3 days they waited for weather to fly out of Goose Bay. Normally the trip takes about 4 days. They did not arrive in time for supper in the dining hall. Dorothy put together a quick meal that was appreciated. Jon Biggar arrived on the Twin Otter from Resolute Bay late this afternoon but I have not seen him yet.

After supper Jopee and I talked about UNCLOS. I showed him the presentation I had given to his community and explain why and what we are doing. He was pleased to learn that the project he was taking part in was important for Canada.
Based on the ice trackers, the ice camp has stopped moving west and is now headed south. This is probably a good thing because we did not want the camp to move so far to the west that it was not a suitable base to operate out of for the planned refraction profiles.

Alert terminology:

Wally	the person in the room adjacent to you, the walls are thin
Hally	one who shares a room; across the hall
Boom Boom	room where I reside-next to the common room where parties are held.

Wednesday, April 5, 2006 - sunny, snow early in the morning, no visibility at the ice camp

The weather report was not encouraging for flying this morning and only vaguely hopeful for this afternoon. The positive information from the ice camp is the seismic reflection system had been assembled. By the 08:00 meeting Isa and Tim were already at the lab working on the shot boxes with the spares that came in on the Twin Otter yesterday. John Shimeld has got the way points and software working so he can upload all the way points to the individual GPS and that will be done today. Jon Biggar has to find and unpack the equipment he sent up on a previous Hercules C-130 flight to Alert. He would like to practice with his echo sounders at camp. The rest of the bathymetry and gravity team will be in late tomorrow so waiting may be practical.

The helicopter pilots gave us a brief on how to behave around the helicopters. All personnel attended and paid strict attention. The opportunity was taken to load the helicopter with the Taurus coolers. It is possible to put 15 instruments in the helicopter two boxes of geophones in the baskets and two passengers. The GPS will be mounted in the front near the passenger and kept warm. We did an inventory of AA batteries for the hand held instruments (32, enough for 4 replacements per unit). We should have more sent up. There is a possibility that the could be carried up by Bob Schieman

Bob is the electronics engineer who designed the shooter boxes that are not receiving there GPS signal properly. He has agreed to fly to CFS Alert to work on the problem. The instruments were tested and worked well in the south. Here they can receive so many satellites that it is apparently causing a problem; however, limiting the number that are visible does not correct the fault. His boss, Phil Munro, is supportive of this movie. I have asked Jim Milne to get check with George Stewart to get him permission to come to the Base.
We have been refining the weight, equipment, and people in the three helicopter and Twin Otter that will be used to deploy the explosives and drill the holes. Helicopter one, the augering team, with Colin as pilot can only carry 2 people and their drilling equipment for a maximum 800 lbs. They will also be able to load a charge if they get ahead of the "assembly line" operation. One of augering crew will have to be carried in the 206L4 which can carry 1100 lbs. This helicopter, piloted by Gerard, transports explosives to the drilled holes. It must rendezvous with helicopter one before the drilling begins. Helicopter three, flown by Bill, has the three people that load the holes. They will also be carrying an auger in case the hole has partially frozen in. The Twin Otter leaves camp first with 60 charges (1050 kg). It must find a runway near the west end of the cross line. It will then be moving fuel for the helicopters.

Thursday, April 6, 2006 - sunny, no visibility at the ice camp in the morning improving during the day

Ken was up early to get the weather, we are all anxious to start the first line. The satellite images show the camp surrounded by low cloud only the western two shoot points of the cross line are flyable.
Unfortunately the weather is supposed to deteriorate at Alert during the day. Both your starting point and end point must have flyable weather. At home base as the scientific staff is on stand-by ready to move at any moment for the refraction line, they kept are busy by cleaning Manor House. The wash rooms are spotless and the carpets vacuumed.

Near lunch time I went to the CO Mike Hillaker office to be interviewed by the radio show As It Happens. The interviewer was Christopher Thomas and the person I spoke with prior to it was Josh Kilberg. Due to the fact there are 8 transfer stations for the telephone station they could not interpret my responses. I think my replies were not spontaneous. Out of 18 minutes they will reduce it to 8 minutes.

After lunch Trine flew to Frankfield Bay, Greenland by helicopter to refurbish the permanent seismometer that will form the southern end of the Inner Line and usually records earthquakes. She reset the power button so the instrument was active and changed the sampling rate to ensure sufficient resolution for refraction rather than long range seismicity. She also down-loaded the data that was stored on the instrument that she now has safely in hand for processing at a later date.

I flew out with Jopee on the Twin Otter along with several barrels of JP8 to the ice camp. I had time to see the seismic reflection set up. Greg fired the air gun twice while I was there. Mike, Greg and Søren augered holes to put the hydrophone through the ice. I brought back hose that needed a smaller hose clamp and requests for various items such as a computer for Mike. The Twin Otter flew off to the west to establish a fuel cache for the cross line. It landed but felt the runway and flow were not suitable for storage of the fuel. The fuel drums were rolled off the Twin Otter at the ice camp. Jopee had a chance to walk around the camp to inspect for wildlife. He pointed out that the cracks in the ice about 6 inches and wide full of snow were where the seals if they existed would have their holes.

On the return Trine, Dave and I held a meeting and we decided to attempt the southern line, correct terminology is the inner line first. The weather forecast is fine tomorrow and Ken predicts it will hold until Saturday. We have problem ice in the mid section i.e. ice that is so broken up it is a rubble field and we are uncertain if a landing strip can be found for the Twin Otter. If there is no runway the 204 L4 will be forced to sling fuel and cargo. This will slow down the operation considerably. The plan is to start on the most seaward end of the inner line and work onshore.

Friday, April 7, 2006 - sunny, -34 to -24°C at Alert, -26°C at the ice camp at 07:30
The breakfast table in the dining hall that seats scientific staff and air crew was completely full. With the additional air crew from the Greenlandic Twin Otter our number totals 36 until they leave this morning. Ken verified the weather was clear with just traces of fog along the southern portion of the inner line. It should burn off during the day.

With 3 helicopters and a Twin Otter to load this morning, it was more chaotic than professional. I hope all the necessary equipment has departed with the teams. After the aircraft left I talked to Dave Maloley, Jim Milne, Thomas Funck and Dave Snyder about how to improve the situation.

* lunches will be delivered to Dave's outer office area to be picked up by staff
* helicopter pilots are to meet briefly with their team e.g. at breakfast and determine where and when to meet
* the loading of the helicopters will be done by Dave M and team i.e. Doug
* check list of what is going on the aircraft is to be prepared the evening before Dave, Trine and Ruth
* the scientific staff have the check list to review before getting into the aircraft
* Dave Snyder will hand the coolers to Doug who will take them to the aircraft
* all scientists should have their own checklist e.g.

Check list for Taurus deployment team
Helicopter call sign_____ Pilot_____

Helicopter call sign_____ Pilot_____
Helicopter call sign_____ Pilot_____

GPS with way points for the day _____
Spare warm batteries _____
Iridium phone and number _____
Pencils 2 each _____
Garbage Bags _____
Shovel _____
Coolers # _____
Geophones # _____
Lunches _____
Extra clothing _____
Mittens hat _____
Something to drink _____

Team 1 preparation for shooting
Helicopter call sign_____ Pilot_____
Name _____
Name _____
Name _____
Power head for the auger _____
Flight for the Auger # _____
Cutting bit _____
Rope with weight to test for ice rafting _____
Garbage bags _____
Cartenav Beacons _____
List of way points _____
GPS _____
Iridium phone and numbers _____

Team 2 preparation for shooting
Helicopter call sign_____ Pilot_____
Name _____
Explosives charges # _____
Primacord # _____
CarteNav beacon # _____
List of way points _____
GPS _____
Iridium phone and numbers _____

Team 3 Preparation for shooting
Helicopter call sign_____ Pilot_____
Name _____
Name _____
Name _____
Rope coils # _
Plywood disks # _
Axe handles # _

List of way points _____
GPS _
Iridium phone and numbers _____

Twin Otter
Number of people# _____
Name _____
Name _____
Name _____
Name _____
Name _____
Name _____

Number of drums of fuel # ____
Number of explosive charges # ____
Number of rolls of primacord # ____
Number of axe handles # ____
Number of end caps # ____
Number of detonators # ____
Number of Coolers # ____

Supplies for camp
Item_____
Item_____
Item_____
Item_____
Item_____
Item_____
Item_____
Item_____
Item_____
Item_____
Item_____
Item_____

The 3 team assembly line of loading the charges had a few problems to start with. The augering team did not have sufficing extensions so had to fly back to camp to pick up the missing pieces. This of course backed up the production line. Communications has proven to be difficult as well. Iridium phones do not work well at Alert because all the phones have to go through the base exchange. Therefore the HF radios on the helicopters are our prime communication link. They work best when the aircraft are off the ground. The L4 has the best radio. The communications we have here are no better than we had twenty years ago. This is frustrating.
The Twin Otter pilot Rodney did find a place to land near the mid-point of the Inner Refraction (IR) line so we will have a reasonably efficient way of ferrying fuel and explosives to the helicopter.

Isa, Dave and Thomas continue checking out the Taurus prior to deployment. Isa checks every Taurus

recorder before allowing the cooler box to be sealed. However he has a limited number of LAN connections and this is causing bottle necks. The instruments will not be connected to their batteries and the box tops sealed until 12 hours before deployment. At -40°C the Taurus in the cooler boxes have 4 operational days. Therefore they should not be drawing on their batteries until the time of deployment is predictable. On a positive note the new Nanaometrics software that Isa down loaded from the internet (44 Megabytes totally surprising he could do it here) has solved the playback problem with the data.

At the end of the day shot point 11, 10, 9, 8, 7, 6 were loaded. There are 60 charges near shot point IR04. The helicopter and science staff teams are ready to start tomorrow. The teams arrived home from 19:00-20:00. They were flushed with excitement and ready for the debriefing to describe their successes and work out the teething problems.

Problems with communications were obvious during the first operational day. One was the pilots were not given proper instructions on how to dial the Alert telephone number on their Sat phones. It is exactly the same problem I had calling Alert until I realized the second number in the manual works and then you ask for extension 3363. The HF connector is broken on Colin's helicopter and the spare parts are ordered. At the ice camp the radio will be put in the seismic building so it can be constantly monitored. Dave's iridium phone does not work because of the short antennae that are in the shadow of the Spinnaker building. Bob Schieman has been asked to find a longer cable for the antennae. I hope he also remembers to buy lots of AA batteries. Christian's barely lasted a day.
Saturday, April 8, 2006 - sunny, -29°C at Alert, -33°C at the ice camp at 07:30
The weather report from Ken was clear skies and the forecast is for the good weather to continue along the Inner Refraction line. At Resolute Bay there is a snow storm; luckily, the low tracked to the south of us. Ken found that several of DMI's excellent coloured ice and cloud products were arriving too late for our morning briefings. He requested, through Bruce Ramsay, that they be sent earlier. They were here in time this morning.

As usual most people one were up long before the scheduled breakfast at 0800 and Dorothy provide eggs and bacon on request in the Manor House common room as there is no breakfast.

The Twin Otter flight to the fuel cache at IS04 will give Jopee the opportunity to see a section of the sea ice that he has not had a chance to check. The last time he flew over it there was low cloud.
The hydrographers Jon Biggar, Martin and Arne tested the sounders and gravity meter at the ice camp. They had good success with a minor problem with one of their sounders. Prior to this test their had been concern that their sounders would not operate due to problems encountered at the Green Ice camp several years ago.

Sunday, April 9, 2006 - sunny at Alert, weather deteriorating at the ice camp at 07:30

The weather report from the North end of the line is not good and getting worse. We will wait until 08:00 to make the final decisions with updated weather. Basically we must fire the shots today because the wind is rising rapidly. The south end of the line will be okay all day. Our present plan is to abandon the two northern shot points IS10 and 11.

Many of the crew are tired. We reminded them that safety is our biggest concern. The blasters have gone to prepare for the day. John Shimeld who was up late last night is busy trying to update all the GPS. Strain is beginning to show. Trine will stay at Alert. I will go out on the ice. This is the best we can do.

Three helicopters left Alert full of coolers to place on the ice. We made it as far north as IR099 next to shot

point IS 07. Fog prevented us going further north. The helicopters then headed for the fuel cache to rendezvous and give a chance for the fog to shift. We refueled and waited for the southern most helicopter to finish placing its seismometers. The Twin Otter had brought out more seismometers that we did not need, so we sent them back to camp and asked for empty geophone boxes. After lunch we decided we would shoot as many of the charges as possible. Hopefully as far north as shot point 7. Søren and I went to fire the northern three sites ISO7, 6 and 5. Tim and Dave S were to fire the middle two. Peer's team went to the far south shots.

The only shot without a beacon marking it was shot number 5. We went to the position it was left and began a search. After half an hour we abandoned the search and went to shot 6. Søren got his shooting equipment together fast and fired it within our shooting window. I was impressed with the professional way he fired his first shot. I would like to hire him for future experiments. The fog was closing in at site 6 so we had to leave quickly and shot location 7 was completely out of the question. Søren got the present position of the shot and calculated the drift for shot 5. Using this information we returned to shot 5 and found it had drifted 2.5 km. Again Søren quickly set up the shooting gear and fired. We flew back to the fuel cache and waited for the other teams to send word they had completed their shoots. Tim's team was already at the cache as well as the Twin Otter waiting to fly coolers home. I explained we were still waiting for shots. The Twin Otter crew waited about two hours. We sent back blasting equipment and coolers we had on board. The afternoon was passing and the weather was continuing to worsen. Both Peer's and Tim shooter boxes failed on them. We had just made the decision to start pick up when we heard the sixth shot had been successfully had been fired.

The rush was now to pick them up in an organized fashion. Tim was to fly as far north as possible, Peer and Dave Snyder to the south. Søren's team was to start near the middle and work north. Unfortunately, the northernmost cooler we could reach was number 58. Therefore we had to fly south again. The coolers without garbage bags were a challenge to find. Fortunately, once one cooler had been located because the coolers had been placed with accurate GPs in a straight line, we could just travel on a course and bearing and pick the rest of them up. It was difficult knowing if we have retrieved all the seismometers in the field because we did not have the cooler box numbers. By 20:00 hours all the helicopters were back. Tomorrow we will determine how many have been missed.

The coolers were opened and Isa played back the data from the shots. The signal to noise was excellent. We have collected significant new data. We celebrated by passing out 'T" shirts.

Monday, April 10, 2006 - overcast, light to heavy snow
The LORITA flying activities are completely shut down. The winds are blowing. I hope the snow is less on the ice that at Alert and at the ice camp they got 2-5 cm of snow.

We retrieved 56 instruments missed coolers at 17 and 57. There are 43 remaining on the ice waiting to be recovered. The tracker site IS07 marks the position of the northern extent of the coolers. We had discussions with the pilots of the best strategy for picking the coolers up. Two helicopters will meet at tracker 7 start a search pattern. It is important not to star pick up until both machines have located the line of the coolers. Once two consecutive coolers are found we can use the same techniques we used to find the others. We need enough wind to blow the snow off the garbage bags.

The teams picking up coolers met to discuss overlaps and gaps. Tim and I placed a cooler exactly at the same spot with 01 minute of latitude one hour apart. The drift of the ice accounts for us not seeing the other instrument. Discussions on the requirement for black bags and better communication took place. John

Shimeld is putting all the information from the trackers into a program and predicting the drift of the Taurus. The updated position in the GPS will be labeled (for example IR034B).

We have reporters galore today. They arrived on a DASH 8 to document the start up to the 2007 winter games in Yellowknife. Trine and I did two interviews. One reporter from Global did a television interview (Nathan Van der Klipp) and the other was from the Globe and Mail paper (Katherine Harding). Thomas announced her as if she was the paper being delivered to my door.

Our ftp site with metrological and ice information has been shared with the military metrological technicians. They were pleased to have the additional information. The DASH 8 crew flying in the press and others was also using this resource and calling hourly for updates.

Ken submitted his report on his weather and ice services provided to LORITA. He pointed out that the Radarsat images were the least useful and the most expensive product.

I will contact Bruce Ramsay and ask him to consult with DMI to inquire if they use Radarsat images in any of the products they produce for us.

Jopee and I worked on his report for the Hunters and Trappers. This took most of the afternoon as we tried to tailor the report to his needs. I also gave him a DVD with the pictures he took of the blast and others I have taken.

Tuesday, April 11, 2006 - overcast, snowing -11° to -25°C
The snow continues to fall, we have at least 20 cm and it is -11°C. The snow at the ice camp is about 10 cm. Mike, Greg and Jørgen are fine. I am sure our coolers are buried. I hope the garbage bags with the coolers have not blown away. We need wind now to blow the snow around. The snow is bad for flying: the helicopters will make white out conditions on taking off and landing and the Twin Otter will not be able to see the surface of the ice to determine if they can land.

The morning started with a fire alarm at 07:00. The civilians all mustered in the appointed location with all their outside gear. At the roll call some people were unaccounted for, none from our group; it is difficult to imagine how any one could sleep through the alarm. With the plane load of press in the barracks, it was a full room. After taking less time than most drills, we were back to our quarters and headed off for breakfast.

Thomas, Christian and I talked about Thomas participating in the cruise on the CGGS Louis S St. Laurent in the western Arctic. Christian was supportive. Thomas and he will write emails to GEUS.
Christian, John, Trine and I held a meeting to discuss the options for cooperating on the Oden cruise along the Lomonosov Ridge to the trough between it and the continental margins. John and I must decide if the benefits will match the costs. Christian pointed out the cruise would not drain GSC personnel because it would be manned by their staff. They would have all the required technology of multibeam, seismic reflection, gravity. It would be an opportunity to get seismic reflection across the Marvin Spur and if the ice allowed in the trough between the Lincoln Sea and the shelf near Alert.

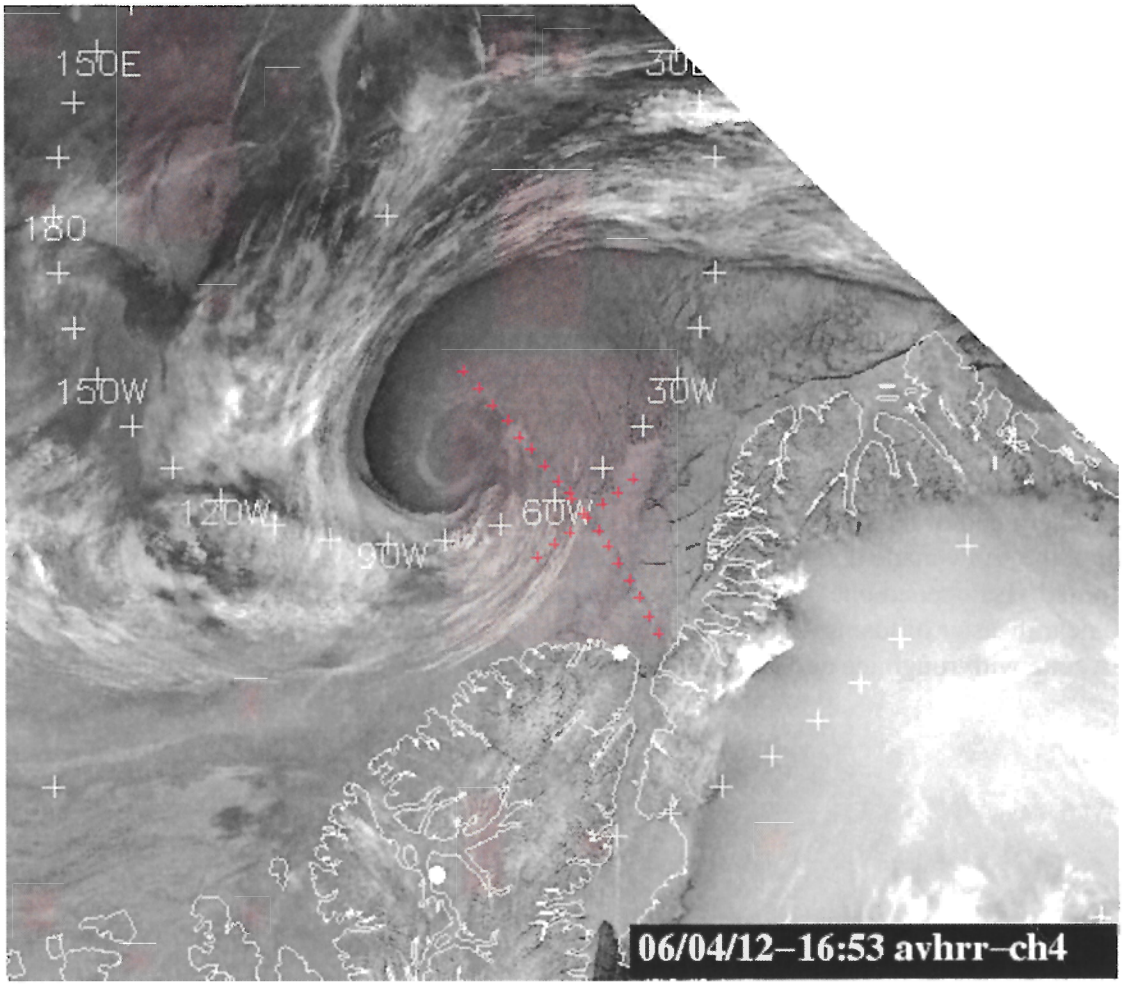
As we wait in Manor House for the weather to improve there is lively conversation, knot tying and Trine is baking bread. After lunch the sun came out and we went for a walk. The snow is about to the top of my mukluks. After supper as a group we went to the Alert sign and took a group picture. There were Danish and Greenlandic flags as well as the large wooden Canadian one as a back drop. The helicopter crew and team logistics also took ensemble photographs.

The weather map in the evening showed two lows covering our work area. Offshore the winds will be high up to 50 knots at the north end of the proposed outer refraction profile.

Wednesday, April 12, 2006 - clear at Alert, snowing,5 m visibility at the ice camp -19°C
The weather conditions over the Arctic Ocean prevent flying. As the information passed by radio to and from the ice camp is minimal, we specifically inquired about how they were getting along. They affirmed that all three of them at the camp are content to stay there. The also updated us on their accomplishments. The seismic reflection system continues to run. They are short a bed for visitors because they used it to drag the runway. Visitors must bring their own.

There is hope that clearing will come from the east. The Twin Otter flight from Resolute may arrive today with the spare parts for the helicopter used by the biologists, parts for our second truck and importantly Bob Schieman to work on the blaster box problems. On the return flight Dave Forsyth, Ken Asmus and Jopee Kiguktak will depart for more southern climes.

Dave Maloley will be talking to Jørgen at the ice camp throughout the day for weather update. The updated weather at 13:00 was still not flyable. If the weather clears at any time in the next 24 hours the helicopters will be sent to recover the coolers with the Taurus recorders. The winds have been significant today up to 24 knots at the camp. Hopefully the winds will make the landing for the helicopters easier by removing the soft snow and revealing the coolers. The satellite images show a classic polar low with the clouds spirally to a point. It is a dynamic system that appears to be slowly moving to the west. The systems seem to be generated near Svalbard where there is a great deal of open water (see below).

The 

rapid

movement of the ice is making it difficult for John to produce a prediction for the position of the ice trackers due to the delay in getting the positions from the camp. The northern most ice tracker reached a speed of greater than 1 km an hour. As the winds drop it rapidly reduced in speed. The only sensible strategy is to fly to tracker 7 and to the fuel cache and navigate from those points to the coolers. We continue to discuss ands refine our plans for picking up the coolers. The latest is for the Twin Otter to fly to the fuel cache get a position send it back for John to update his ice motion prediction program. The Twin Otter will then fly to the predicted locations of the coolers. It will have two observers on board picked for their ability to spot the coolers. They will fly low and slow in the square pattern used for search and rescue. The helicopters will be mustered from Alert after the Twin Otter leaves.

Isa and Thomas produced the first record sections. The data quality are excellent. We have well developed crustal and mantle arrivals. It will be easy to develop a well constrained earth model from the data we are collecting.

We have put together a plan for the Outer Refraction (OR) line. The Taurus seismometers will be placed starting at inner line 7 shot now called OS04. We have 5 of the eleven shots preloaded if we have not lost them in the rapidly moving ice. At any rate the charges are still in line along the ridge.

Because Easter Weekend is coming up and we are planning to work we must remind every one that meal hours change and ensure that air crews get properly fed.

Thursday, April 13, 2006 - clear and sunny at Alert (-14° to 24°C) and the ice camp
We awoke to sun streaming through the windows. The weather report from the ice camp was positive as well. Today we will attempt to recover the cooler boxes with the Taurus inside and bring supplies to the ice camp. The ice tracker buoys indicate that the drift has slowed to 100 m an hour.

Zubov's rule indicates that the ice moves at 10% of the wind speed and at direct of 30° to the right due to Coreollis affect. It will be interesting to confirm this rule of thumb with the wind and ice direction data we have. Meanwhile John Shimeld has been calculating the location the coolers have drifted to based on information from the ice trackers.

The Twin Otter set off at 08:45 for the fuel cache with two observers Tim and Peer. It was quickly found, a beacon was set up and the search for cooler at 117 began. Søren and Trine picked it up. It was 50 m from the predicted position. We had not expected to recover this isolated instrument. They then flew low and slow along the predicted path of the drift of the remaining 42 Taurus. The southern end of the line had a lot of open water. It was lucky we had already recovered the instruments from this mobile ice zone.

The Twin Otter spotters quite quickly sighted two more coolers in the mid section of those left on the ice. On the northern end of the line it was relatively easy to find the coolers; in contrast, at the southern termination the snow made it significantly more difficult. At the end of the day 41 of the 43 coolers had been returned. Isa opened one box and found the temperature of the Taurus still at 0°C. We have recovered from the near disaster of losing 43 of 100 deployed seismometers. The two that could not be recovered were in a zone with rough ice and are believed to be covered in snow (cooler buried in snow see below).

The Twin Otter from Resolute Bay arrived with the engine for helicopter flown by the wildlife biologists. It also brought Kelly Bentham our photographer, Bob Schieman's tool box and AA batteries for the GPS.

John Shimeld, Christian, Dave Snyder, Thomas and I spent some time trying to refine the strategy for the Outer Refraction line. If shots 7, 8, 9, 10 and 11 are still in place we have decided that they are usable for this line. To ensure overlap and reversal of the southern section we have increased the instrument spacing to 1.4 km and shifted the Taurus south so that there is only one offset shot. Open water at the south will probably mean that the southernmost shots cannot be preloaded.

Bob has found the problem with the blasting boxes he designed. GPS positions in northern latitudes (80°N) produce more significant digits than those near Ottawa at 45°N. He has to reprogram the boxes to accept more significant digits. The manual did not explain this idiosyncrasy. Now that he has his tool box he will be able to actually reprogram them.

Bruce Ramsay emailed me to report that Canadian Ice Services (CIS) and DMI have agreed to reduce the Radarsat images to one a week. He will phone Jacob Verhoef to ensure that all contractual issues are addressed. I also contacted Iris Hardy as she requested by email to give her a name for the project in her data base (LORITA 2006). I took the opportunity to remind her that the seismic data to be stored in the database was to be protected.

At John Shimeld's request, I tested the batteries on the 4 CarteNav beacons. They were all delivering 3.6 V. Then I took them outside and turned them all on. One did not operate properly but Tim showed me how to centre the batteries on their mounts and that fixed the problem.

Jon Biggar and Arne Olesen are out in the third helicopter collecting bathymetry and gravity for the first time. They completed all the locations we had positions for. The water depth variety form 200 to 325 m. Both types of measurements were taken at every other Taurus location.

We got the weather and after all the helicopters returned by 21:00, we had a planning meeting. After considerable searching today by Ron and John B. announced that they found all of the previously loaded holes. Care was taken to dig them out and marked them with additional garbage bags. We want to load the four shots at the northern end of the line. We must wait for the weather report tomorrow morning.

Friday, April 14, 2006 - sunny and clear at Alert, -20° to -26°C, low cloud to the east at the ice camp

The initial weather report at 07:00 was positive for the northern end of the line. However, by 07:30 the clouds had shifted to the west making it unfeasible to attempt it. Although there was cloud cover at southern end, we hoped it would pass. There was confusion getting ready for the day of loading the holes. The delayed departure and plan changes exacerbated the pressure of getting the aircraft loaded. Check lists should be implemented. The Twin Otter crew unloaded the charges at the shot holes but not the primacord. When the loaders noticed this over sight the aircraft had to be called back.

Eventually, the Twin Otter left two flags near the last know position of the missing Taurus so that any of our fleet of aircraft cruising over the area could scan the region for them. Meanwhile back in the laboratory Isa, Thomas and Dave Snyder were busy formatting the flash cards in the Taurus so that are uniquely identified with each machine. The process of getting the Taurus ready for the second deployment is more time consuming than the first deployment when this step had already been done before shipping. By lunch time 40 Taurus were secured in their cooler boxes and taped against air links ready to be deployed. The shots from the Taurus recovered last night, all 40 of them, are ready for Thomas to organize into record sections now.

Bob Schieman was continuing to work on the problem with the LED displays on the blaster boxes failing. He tried warming them up in several ways. Eventually, using the hand warmers that came in the pockets of our Snow Geese parkas, solved the problem. Jim had many hot packs left behind by a photographer. More testing will be done to check to see how long they will last.

Kelly Bentham arrived last night unpacked his photographic equipment and has been pointing his digital and video cameras in all directions. His enthusiasm is infectious.

By 14:00 all the helicopters were forced back due to the low cloud along the southern end of the line. It is frustrating the weather is great at Alert and the ice camp. We are waiting to see if the conditions improve to try to get out again. All the AVHR data that were downloaded shows low cloud sitting over the part of the line we need to get to. More highs are showing up on the map but the low that caused our storm has stopped to the west of us. By 16:00 Dave Maloley indicated it was too late to fly for the remains of the day due to the impact on the pilot's duty day.

Ron, Kelly, Doug and Leslie went out the Fielden Peninsula at 2200 ft to establish an FM repeater to increase communications between the helicopters. The helicopters will have to fly up to 2000 ft to communicate with Dave and each other but this is substantially better than no communications.

Trine, Dave, Jim and I had our regular evening meeting. We discussed problems with the trucks. The one that is lent to us from the GAW (Global Atmospheric Watch) lab will be repaired tomorrow. This truck can be driven by any one. They were hoping a scientist would volunteer for this task. With four general duties personnel being paid for by the project I think not. Scientific staff driving the truck when needed will be fine but not as a regular service. The plan for tomorrow is of course weather dependant; hopeful we will be able to fly to either the south or north end of the line and load the shots.

Christian would like help down loading the weather maps. I have volunteered to do this job after he leaves and learn the task in the meantime.

Saturday, April 15, 2006 - sunny and clear at Alert, -20° to -30°C good visibility at the camp
Every one at breakfast between 07:00 and 08:00 waiting patiently for the weather: good at Alert and at the camp. Low cloud in the south is delaying the helicopters take off until the next satellite image indicates

whether the low cloud is breaking up. We are prepared to drill and load holes, put out the beacons and then deploy boxes at the south end. There are 40 boxed ready and more will be needed but there is no point until flying begins. Isa has asked for red surveyors tape to be put on the top of the boxes and the handles lifted as an additional aid to finding the boxes.

The low cloud is still inhibiting the flying. A Hawker Sidley 748 is arriving from Resolute today. It will circle the southern end of the lines to check on weather conditions for us. The aircraft is bringing in Andy Heiberg University of Washington, Polar Science Centre for his regular program at the Pole.

The plans are for the Twin Otter to fly camp with food and supplies and leave John Shimeld as a replacement for Mike Gorveatt. Then fly on to the northern fuel cash and leave two oil drums. Trine is planning to join the trip as well.

After Saturday brunch the weather was deemed suitable for flying and the three teams of drillers, explosive transport and loaders left. A small shuffle took place as a last minute suggestion to put coolers on one of the helicopters resulted in annoying the pilot and quickly resorting to the original plan. There are too many busy minds not paying attention to the airport controller Dave Maloley.

Meanwhile in the Spinnaker lab, Isa and team were busy preparing the Taurus in their cooler boxes. Carefully testing of all Taurus and battery pack indicated a few with low batteries. New battery packs were promptly substituted. As the boxes were being taped up a new aid to recovery was added; orange surveyors tape was tied to the handles. On deployment the handles would be raised and the trailing ribbons hopefully will not be buried in the snow. We loaded the Twin Otter when it came in with 60 coolers and 60 geophones to be carried to the camp. Kelly is busy photographing all the activities.

Andy Heiberg and Jamie Morrison, who I had worked with in 1979 on the Fram ice camps north of Greenland, arrived at mid afternoon on the 748. They are involved in a physical oceanographic program that is collecting data near the North Pole. The Russians set up the camp and build the runway for them. Poor weather brought them to Alert. They inquired if they could have access to our weather information. I also had a chance to talk to Andy at supper time. I learned Allen Gill who was with Wally Hebert when they walked unassisted to the Pole (probably the first to ever do this) had had a stroke and was living in Scotland.

I was looking for some one to relieve Greg Middleton at the ice camp. Morten Solvesten says he would be interested in staying at the camp and perhaps getting additional soundings.

After lunch I asked Bob if he wanted to hike down to the Spinnaker building with me. He was adamant he did not want to walk. I was puzzled until he explained a wolf had trotted up to within10 feet of him. After a pause he decided it would be okay to walk with me because I would be excellent bait.

By working until 23:00 for the last helicopter, the southern shots were loaded and 70 coolers were on the ice. There are still communication problems even though the FM repeater was set up. The pilots can now communicate with each other so long as they are in the air. The range on the repeater is variable varying from 70 to 130 miles. There is a suspicion that the problem is caused by two channel 18s one used in the US and the other internationally.

Sunday, April 16, 2006 - sunny and clear at Alert -17° to -24°C, good visibility at the camp initially
At breakfast in the Manor common room we had visitors from other projects getting weather products and

enjoying the breakfast that Dorothy provides. The weather map shows a major high reaching from Greenland to the Pole. Unfortunately, cloud is still moving quickly over our line. In the Arctic you can have "dirty highs". The Twin Otter will be sent out with fuel to the northern cache and will also give an accurate update on the clouds. Andy Heiberg's group is rather discouraged by the amount of fog they saw on the satellite pictures. They have about two weeks to run their program and are pessimistic at this stage.

By 12:15 the satellite maps had been consulted numerous times and the ice camp called for updates on their situations. The conditions at the camp worsened. A flight with the Twin Otter to the northern fuel cache will be attempted. After the long day yesterday many are getting extra sleep and it is rather quiet in Manor House.

Jim and Gabriel, the Twin Otter pilots, managed to get two flights from the camp to the northern fuel cache one with fuel and the other with explosives. We are ready to move swiftly with the line with 70 instruments deployed (the earliest since Saturday), 7 shots loaded and the explosives at the cache for the northernmost holes.

We are planning to move 39 of the coolers to the northern fuel cache and 38 to the camp. One blaster box will be placed at camp in case we have shots and instruments in place. The opportunity to blow the northern shots cannot be missed.

As Trine and I walked back to the main facility after our meeting with Dave and Jim in the Spinnaker building, there were snow dogs, segments of a rainbow on either side of the sun.

Monday, April 17, 2006 - sunny and clear at Alert -32°C, moderate visibility at the camp
The weather report from Christian was not optimistic. Although we still have a regional high there are clouds along the line and the possibility of snow. The visibility at the camp is still moderate. The Twin Otter is taking Mike and Morton to the camp along with fuel. They will report the actual weather and an update of the days plans will be given at 09:30. The weather forecast always defaults to sunny this is not accurate or useful. Eight of the CarteNav beacons are reporting slow drift of a few tens of meters per hour. Our Twin Otter caching fuel near the end of our line and the 748 making trips to the Pole over flew the refraction line. They reported reasonable conditions for the helicopters to fly except for a band of low cloud out at 75 miles. By 13:00 hours the conditions seemed reasonable to muster the pilots and to load the 4 northern most charges. By 14:30 the fleet of helicopters were in the air. Unfortunately, an hour later they were returning to base with the beacon from the southern fuel cache. Gerard flew into the fog bank for about 10 miles before the visibility was reduced to less than a quarter mile. If they can ever get over the fog bank, they will leave the helicopters at the ice camp. We purchased generators so that it would be possible for the helicopters to be left at the ice camp.

Isa has been looking at the temperature statistics on the boxes and Taurus that were left out the longest. We have at least 5 days, i.e. Thursday, April 20 before we will have to pick them up and redeploy.

News from the Alert community, from the biologists who are doing are regional survey of the caribou and musk ox herds and who we share a helicopter mechanic with, is that they saw their first baby musk ox of the season. On the walk from the Spinnaker building to our barracks, sun dogs made a nearly completed circle around the sun. Trine recorded the sun dogs on four shots and successfully merged them.

John Shimeld returned alone from the ice camp. I had expected Greg to return to Alert for a break from his routine but he did not want to. He is highly committed to the reflection equipment and did not want to be

stranded in Alert and not be able to fly back to the ice camp for several days. This could mean the compressor would not be cared for properly.

John was rather pleased with the seismic reflection set up that he saw for the first time. Of particular note was the special mat that the compressor sits, it completely dampens any vibrations. John adjusted the depth of the airgun to improve the signal and found that the airgun's optimum depth was 2 m below the base of the ice. He could not get the EPC recorder to work on a 1 sec sweep, so he eventually gave up and put it back on .5 sec. He returned with a complete copy of the data set and was ready to plot and do preliminary processing on it. At the extremely slowly rate the camp is moving, the shot spacing is every 9 m.

I have been compiling suggestions for improvements to the working plan for the program. Here is the list:
1. solar panels for the cooler boxes
2. homing device for the coolers (Goose chasers)
3. custom built red insulated boxes
4. same Stihl drill as John B. see below
5. a dedicated mechanical technician
6. anti-static mats to protect the computers from static electricity
7. garbage bags that resist the cold
8. communication improvements
9. helicopters radios must work

Requirements for drilling efficiently from John B: i.e. Stihl B121 auger with grease not oil in gear box
a) spark plugs with hotter rating
b) Swedish Mora 10 inch with sharp bits
c) small diameter drill 2 inch Kovac (CREEL) electrical or gas driven (meter in 30 sec); it takes more time to change extensions
d) Aluminum flights are much lighter and preferable
e) Milwaukee power head with lithium-ion batteries
f) better extended handles difficult to lift otherwise

* remember a strainer with a suitable size mesh standard household about 8 inch in diameter
* an axe to cut the edge of the hole to make a trough to slide the explosives into the hole
* clipboards print with laser to prevent running ink
* need special grinders to keep the bits sharp- need at least 4 se

Tuesday, April 18, 2006 - sunny and clear at Alert -32°C, moderate visibility at the camp
The weather report from the camp indicates that south end of the line is clear. Unfortunately, to the North there is heavy low cloud. The weather predictions, highs and lows and satellite images have been carefully monitored. There is an indication that the cloud cover is moving north. The decision is to send every one back to bed.

At the morning meeting John Shimeld described the successful seismic reflection activities at the ice camp. He circulated the drift track of the ice camp along 30 km in a 5 km radius as well as copies of the good quality seismic reflection profiled he had processed. Other issues brought forward by Kelly included that he has a computer ready to receive pictures from the scientific party. We had a discussion led by Kelly where we all agreed that all digital images were the properties of the Canadian and Danish governments. Another concern was that the staff have to move into a smaller number of rooms as Box Top approaches and they were reminded of this.

Mid-afternoon we set out to camp with three helicopters and the Twin Otter. There were significant regions of clouds; fortunately the helicopters found a route around them. We were able to put out the recorders near camp quickly but the ones to the north of shot point 7 were abandoned due to fog. With all aircraft back at camp we decided to try and fire shots. This meant reorganizing the teams and pressing Jørgen Skafte into being an instrument deployer. The chain of command now made Morten Sølvesten the radio operator.

The Twin Otter and one helicopter flew off. The Twin Otter successfully found a location to land near planned shot 10 and fired it as well as completed the shot at the fuel cache near site 9. From the helicopter Søren was able to fire shot 5 but we could not locate 6 before the weather closed in. The blaster boxes did not work as there are suppose to again. Both blaster boxes 5 and 6 did not fire on their internal GPS. It took four attempts for Søren to fire shot number 5. The time spent playing with the blasting box, the fog, the lack of an updated tracker position meant we had to return to camp before getting shot 6 off. Additional time was used calling on the Iridium phone to camp to check on shot windows. On the second call the battery pack failed. The Sat phone worked well but was programmed for Polar Continental Shelf Project at Resolute Bay where they suggested we should fly back to camp as soon as possible based on the weather from camp.

The flight on the helicopter back into camp was touch and go. The visibility was dropping rapidly and it was only the roughness of the ice that allowed the pilot Bill to find the horizon. Whenever we were about to cross a pan he banked and to find a region of broken ice that provided a horizon.

All the aircraft were back at camp by about 23:00, unloading and repacking the Twin Otter for 12 passengers including all the helicopter pilots and staff took about half an hour. The helicopters were left at the ice camp. We were back about 00:30. The cloud cover flying to Alert was the heaviest I have seen this season.

Wednesday, April 19, 2006 - sunny at Alert -32°C, limited visibility at camp, dropping to zero
The satellite pictures this morning illustrated the thick low cloud over most of our line with the camp and only a small region near it not completed socked in. This is the last day our seismometers our guaranteed to work before the cold makes them useless.

Dave Snyder is going through the box numbers to determine which of the instruments left at the camp but not deployed have been out the longest. They will be returned to Alert so that they came be opened a few at a time on a regular basis to determine if there is any point in shooting to the recorders on the ice.

John Shimeld is processing the seismic reflection data from camp. Preliminary analysis shows only small pockets of finely stratified layers. Not a visually exciting record but it does contain information that will be useful for the interpretation of the seismic refraction profile.

Box Top the refueling of Alert starts today and beds are at a premium on the base. This means that many of the scientific staff will have a roommate so there is a fair amount of activity as people move their luggage from one side of the hall to the other. Others were previously billeted with the pilots and have a longer distance to lug their belongings along the hallways and up the stairs. We were warned by the Station Warrant Officer (SWO) that staff had been seen carrying open cups in the main link ways. This is a serious offence and could mean that we are tasked with cleaning them.

After lunch the AVHR satellite images were downloaded and they confirmed that the cloud cover extends

over a large area and is moving east to west. There is little chance that even the Twin Otter will fly today. Time is passing and the Taurus in their insulated boxes are nearing the end of their battery life and the ability to record a seismic signal. This lack of activity is hard on the large crew. Perhaps it would be appropriate to ask for volunteers to leave on available flights south such as the helicopter or fixed wing rotation of crew.

Ed Hudson through Bruce Ramsay has requested that their metrological buoy be left at the ice camp. The buoy had been taken apart and the batteries were being charged for deployment further north. Due to the poor weather conditions and limited flights it did not make it on the Twin Otter. Jørgen Skafte will be requested to reassemble it at the camp. It reports the camps position and weather statistics so it will be good to have it back on.

At our regular 18:00 meeting of Trine, Dave, Jim and I went over plans for tomorrow if the weather improves at all. The list consists of Isa going to the ice camp. The purpose of this is for him to evaluate if the 5 coolers that have been their since the initial deployment on Saturday must be picked up now and redeployed. A team of two shooters and one driller in case any windows of opportunity for flying occur. Also there will be helicopter mechanic and pilot to the ice. Kelly will also get an opportunity to take pictures at the camp.

Thursday, April 20, 2006 - heavy overcast at Alert, -13°C at the ice camp, limited visibility and light snow The weather report and observations this morning indicate heavy cloud cover. Flying operations are again suspended. At the morning meeting volunteers were solicited who wished to go south. There is limited work to do until the weather improves and all individuals who stay must be patient. Thomas gave a short power presentation on wide angle seismic reflection/refraction for all those who were confused about the technique.

John, Isa and I discussed the requirements for the GSC to run additional Arctic programs under the auspices of UNCLOS. I am preparing a short document for them to review.

Hourly we call the camp to get updated weather reports and down-load all satellite images, aviation weather and wind reports. The fog is still so thick at Alert that it is illegal for the Twin Otter to take off. John Shimeld is monitoring the motion of the ice trackers. Their speed has increased to over 200 m an hour and they have moved 7 km since deployment. We are constantly re-evaluating our plans. Who will go out on the Twin Otter? Should Kelly be sent to take photos before he goes home? Is there space for Søren Rysgaard and his ice sampling gear? Jørgen Skafte will have the coolers ready to ship back that will tell us if the Taurus have stopped working and we need to pick them and redeploy.

Trine and I discussed long term plans. Isa reported that he had an additional 90 battery packs that could be deployed on a fourth deployment if we have to redo most of the Outer Refraction line. Only one person volunteered to go out on the next flight. Dave Snyder has other commitments so he will go home on the next available flight.

Bill Denomme one of the helicopter pilots showed his home movies of his travels across Ellesmere Island with PCSP last summer. The rugged scenery of Tanqueray and Alexander fiords and Panquirtung were the most inspiring. I asked for a rerun of his pictures of Fort Conger where Thomas and I were in 2001 on the CGGS Louis S. St. Laurent.

The skies at Alert and the satellite photos are indicating a better day tomorrow. We can only hope the

Taurus in the coolers boxes are still active. All will be revealed tomorrow.

Friday, April 21, 2006 - sunny at Alert, -11°C at the ice camp limited
Finally, the sun was shining at both Alert and the camp. The base had a fire drill at 06:30. We had to get permission from the CO to be excused from the drill after we mustered in the Arctic Club. We normally spent up to an hour waiting for the event to finish. The drill caused breakfast to be delayed and it was necessary to plead for special favours to get the pilots fed. The drill also upset our daily routine making it difficult to get all the lose ends that must be put together before 4 aircraft and 10 -12 scientific staff fly off for a day. All the aircraft and people's activities have to be coordinated.

The Twin Otter with a full load of people left Alert for ice camp at 09:00. All three helicopters were stationed their and the pilots had to be flown out as well. While the helicopters were being warmed up, Isa tested the 5 Taurus in coolers that had been out for six days. Miraculously all were still working! This means we can shoot the line. Otherwise we would have to pick up all the instruments refurbish them and start again.

The three helicopters were in the air quickly. Shots began to go off before noon at 11:40 and were completed by 15:15. Pick up of coolers also done by 22:00. Five were left on ice north of shot 7. Although Christian searched several times, they could not be located. We plan to go back tomorrow to attempt to recover them.

At the Spinnaker building the coolers were brought in by all available hands including Dorothy and Lisa. The goal was to be able to open the cooler boxes to get the flash cards out of the Taurus to check on the recording of the data. The tapping to keep drafts out of the coolers was removed, the boxes were opened, the Taurus checked to see if their red lights were flashing, the flash cards removed, inventoried and delivered to Isa. In addition, the 6 freezer packs were removed and replaced with warm ones, the batteries disconnected, labeled as used and replaced. An inventory of the instruments was completed to check if any had been left on the ice. A shot table was made by Isa who played back the last shot on 43 of the recorders before retiring at midnight.

By the end of today the project had collected all the necessary data to make it a success.

Søren Rysgaard and Martin Blicker were able to spend the day at the ice camp. They collected multiple ice cores and accomplished a CTD to the sea floor. They were obviously pleased with their accomplishments today. As well, Kelly Bentham our photographer spent the day at the camp to get video footage. The weather has been preventing many of players from quickly reaching their goals. We all have to be patient and be ready to take advantage of any weather window.

Saturday, April 22, 2006 - sunny at Alert -22°C, -8°C at the ice camp limited
The weather at Alert is bright and sunny; however, offshore where the hydrographers need to collect bathymetry along the refraction lines it is not possible to fly. There are high winds and no contrast. In the last twelve days there have only been six with conditions that are suitable for flying.

John's prediction for the position of the coolers based on the CarteNav ice tracker is found to be within 100 m of the position they were recovered. The direction of drift and its speed is used for the prediction. The overall drift between recovery and pick up has been 16 km.

The morning was spent refurbishing the Taurus in their cooler boxes. To give an example of the labour

involved; there are 6 freezer packs per unit. Therefore we have 900 of them to remove, warm up and replace. The geophones all have to be removed from their storage boxes and the snow and ice thawed from them. By the end of the morning all of the units are now accounted for but 5 at the northernmost end of the line. When the weather improves a search will be made for them.

At lunch hour Dave Maloley told me that the situation at the ice camp is tenuous. There is a lot of open water, high winds gusting to 25 km/hr and snow. Jørgen Skafte, the Ice Camp manager, is reporting lots of fog generated by the open leads. As far as the seismic reflection system is concerned, both John Shimeld and I are in agreement that the system has served its purpose and can be packed up. This will greatly facilitate matters if the camp is abandoned and another must be reestablished to enable the cross line to be run. A smaller simpler two person camp could be readily set up if suitable ice can be found.

At supper time Trine and I called the camp to discuss the packing up of the seismic gear with Mike Gorveatt. Because the seismic system is merely recording a hard bottom with 6 multiples its scientific value is limited. The conditions at the camp with high winds, warm temperatures now -6°C snow and open water are suggestive of long term degradation of the weather. The limited opportunities to fly that we have experienced during the rest of the experiment hints that it may be difficult to get Twin Otters into the camp at a moments notice. Therefore, to protect the seismic reflection system for future use we will pack it up and fly it out. There are 3100 lbs or a Twin Otter and a half load. As the seismic equipment is flown out a flight in the opposite direction will carry the explosives that must be removed from temporary storage at Alert by April 28. This shuttling of supplies will also us to have the charges positioned for the cross line. Another benefit to the termination of the seismic reflection program is that it will give Greg the opportunity to participate in the refraction program so that he will receive training for a future wide angle experiment.

A different topic of discussion was brought up by Christian; he noted that the Outer Refraction line had drifted away from its plan position to the west. However the data collected for the line actually encompasses a broad zone of all the shots and the receivers that are spread over 300 km length and 16 km width. The first three shots were fired significantly to the east of the last 7 due to the ice drift and are close to the position intended. Furthermore we agreed the geological structure is not likely to change dramatically over the distance that the recorders drifted during there six day ride on the sea ice.

The last wind maps for the day indicated winds to 45 knots over Greenland and 25 at the ice camp.

Sunday, April 23, 2006 - light snow at Alert -22°C, at the ice camp -9°C, some wind
The satellite images showed heavy cloud in our area of interest and light snow at the camp. No flying this morning. Dave Maloley will get an update from the ice camp at 11:00 and the situation will be reevaluated to see if it will be possible to send the Twin Otter. At our breakfast meeting after the weather, it was announced that Christian would be departing on the flight with Søren Rysgaard and Martin Blicker later this week. With the air crew exchange on Tuesday, Kelly and Dave Snyder will also be going home.

Thomas was able to make record sections of the Outer Refraction profile last night. The data quality was excellent as on the first line. As we cross the trough and on to the Lomonosov Ridge the arrivals are more complex and time is needed to study. The cross line would of course provide valuable insight into the complex structures that may occur on the other lines. We are in the process of modifying the cross line to take as little flying as possible and still show any variations in crustal structure.

I called Jacob and both Dave Maloley and I spoke to him. First the science accomplishments in reflection and refraction were summarized including the strengthens and weaknesses of the data. The primary purpose

of the call was to up date him on the probabilities of getting a third refraction profile and the risks involved. We described the warm temperatures, the poor flying weather, and the difficulty in getting to the ice camp quickly if required. We mentioned that if we attempted the third line there could be loss of instruments due to our lack ability to fly back to them. He replied the decisions belonged to the people on the project and he would support them.

Trine calculates that of the 18 days the helicopters have been at Alert we flew 8 days and 4 of these were half days. This means only 33% of the time are they available to us due to weather alone. For the Twin Otter we have been able to use it on 66% of the days it has been at Alert.

The plans for the cross line was modified with significant input from Thomas based on examining the character of the arrivals on the first two profiles. There will be 100 Taurus at 1.97 km spacing and 9 shots will be fired. The four that are near the centre of the line will be 175 kg and are closer together. Trine, John, Isa, Christian and others were involved in discussions on how to run the final line as efficiently as possible because we think the window of opportunity will be short.

Thomas and Isa have encountered three minor problems with the Taurus traces on the recent data: on two instruments the last shot was not recorded probably due to the cold affecting the batteries, one flash card cannot be read and two Taurus show the position of Alert (confused GPS). Both Isa and Thomas are trying to rectify these problems.

The Twin Otter made two trips to the ice camp with charges and a working skidoo and returning with the heavy seismic reflection gear. All the seismic reflection gear and the tents they were housed in are back in Alert. Greg cannot return from camp yet as there are no beds in Manor House.

A fluffy white fox was visible from the dining room at supper time. Many of the diners took the opportunity to observe it cantering around and climbing over the garbage containers.

Monday, April 24, 2006 - bright and sunny at Alert -22°C, at the ice camp -7°C
At our regular meeting at 07:45, the weather report from Christian indicated that the only flying weather suitable for helicopters was in the immediate vicinity of Alert. The Twin Otter may fly today to look for landing spots along the cross line and to transfer explosives to camp. With Kelly leaving tomorrow, a final reminder went out that only 13 of the over 30 personnel had contributed shots.

Nelly Koziel was contacted to assist Dave Snyder with his travel arrangements back to Ottawa. With Box Top in full swing it was not possible to get a line out with out assistance from the SHAT (Special High Arctic Telephone) technician. He gave us a different line out than is usually unavailable to us. This saved us a lot of time and was appreciated.

By afternoon there was light snow and limited visibility at Alert, in spite of this the Twin Otter was able to work. Jim flew the aircraft with a load of explosives to the camp and then cleaned up the northern fuel cache. After that he flew along the planned cross line and after searching found a landing strip. Dave Maloley and Jim are slowly putting in place the infrastructure we need to run the cross line. If the weather improves we will be ready to take advantage of it.

At the Spinnaker building Isa and Thomas continues to work with the seismic traces. Thomas is making sure all traces have the same polarity. He has gotten information on the 7.7 magnitude earthquake in Siberia that was recorded while the seismometers were deployed along the Lomonosov Ridge. This additional

information could be useful for understand the Moho beneath the ridge. John Shimeld is busy writing the report on the CarteNav tracker buoy.

Kelly went through the digital pictures submitted by the participants. I got a selection of about fifty to use for developing a power point presentation that I worked during the day. So when I return to work I will be ready for a presentation. Christian made two DVDs for all participants of all the files that have been submitted to Kelly.

By the end of the day the Twin Otter had been to camp with explosives, cleaned up the northern fuel cache, found a runway on the cross line at XS03, left 6 drums of fuel, explosives, a radio beacon and a ice tracker. It returned to Alert with a load from the ice camp.

Tuesday, April 25, 2006 - snowing at Alert and at the camp
The weather report was unfavorable for flying in the vicinity along our line. Therefore Dave Maloley has organized the crew change for this morning; the new crews should be in Alert by this afternoon. I mentioned to all participants this was the last chance for any person to leave through Canada until the end of the project. When will the project be over is the question? The chartered company for the Boeing 737, First Air must be informed today if we expect them to pick us up on May 4. What to do next?

After thought and consultation we have decided that the 737 schedule will be unchanged. If necessary a small group will be left behind to pick up, dispose of and ship the remaining scientific gear. Fifty of the Taurus and their coolers can be prepared for shipping on the charter because they will not be used in the next deployment. All the seismic reflection gear, 13 of the 18 staff could fly out on May 4. The batteries that weigh thousands of pounds can be disposed with the military's. The 100 remaining Taurus could be packed to ship out on a Twin Otter and the cooler boxes with their cables and GPS returned on a south bound Hercules at a later date. We talked to Jim Milne about who would be required from his group to clean up the building and dry out the tents if we go down to a "skeleton" crew. We will not need the number of general duties people in the kitchen for example.

At about 10:00 with the Twin Otter on the ramp to the runway in its final loading stage with all of our pilots (5) the mechanics (2) and two staff members standing beside it, a Hercules C-130 overshot the runway heavy with fuel. It stopped in the snow at the end of the ramp zipping past our Twin Otter and not more than 45 ft from the nearest helicopter CYM. No one was hurt. None of our fleet of aircraft damaged. Dave Maloley described it as an uncontrolled landing. All the emergency vehicles were brought to the runway. The passengers and crew from the aircraft evacuated from the Hercules. Meanwhile our civilians are left on the ramp not far perhaps several 100 ft from the Hercules.

The engine was shut off and the military personnel have begun to dig around it with shovels in order to assess the damage. The Hercules is about (again an estimate) 500 ft from the Spinnaker building where many of us were saying good bye to those who were scheduled to leave. Military photographers arrived to document the scene. It is unlikely that any aircraft will be moving on the Alert runway until the Hercules is secured.

The Twin Otter with its crew and passengers was allowed to take off at about 12:30. It was headed for Eureka to change crews. We have no idea if it will be able to return tonight or whether they will overnight in Eureka.

By 18:00 it was obvious the power would not be restored to the run way lights and our Twin Otter will not

be able to return. The pilots will overnight in Eureka and fly to Alert in the morning. By this time the fuel in the Hercules was pumped down to half and two D6 tractors attached to it. The nose kept popping up so the bystanders including Doug and Christian were enlisted to stand in the cockpit while the aircraft was pulled 200 m. More stories for everyone to tell at home and a generally happy ending to the story.

Dave Maloley called First Air; it can fly to Alert on May 6. Nelly will have to be notified to change all the fights for the Canadians from the 5th to the 7th.

Wednesday, April 26, 2006 - snowing at Alert -11°C and at the camp -6°C
The weather report confirmed that it was snowing and the visibility poor at Alert. The conditions are slightly better at camp. The satellite images indicate cloud cover throughout our area. The pressure is rising at Alert and the winds are increasing at the northern end of the outer refraction line. However, there is a string of lows that start in Norway cross the top of Greenland and continue across the Canadian Arctic. The Twin Otter at Eureka will fly back to Alert when and if the weather improves. The runway was officially reopened last night.

This morning Nelly was contacted to change the connecting flights for 737 out of Edmonton and the hotel bookings. I tried several times to contact Borden Chapman about arrangements for the CCGS Louis S St. Laurent cruise to the western Arctic. Eventually I reached him. He pointed out a bottle neck for Thomas joining the Canadian cruise to the western Arctic was the time it took for foreign nationals to get security clearance.

Only 1 Hercules in 3 was able to land at Alert due to the fog. For Box Top, 11 of the 140 flights are now complete.

Thursday, April 27, 2006 - freezing drizzle, Alert -9°C and at the camp -3°C
The weather at Alert again does not allow flying. At this time the visibility is about a mile while at the camp the visibility is better and the winds are higher. The Twin Otter from Greenland is scheduled to arrive this afternoon providing conditions improve.

Thomas has produced an initial model for the data that we have collected so far. This information will be welcomed by the Managers when we return to our home institutions. Isa has been carefully examining all the information on the Taurus and has discovered that there are times when the seismometers are not recording. This has meant the loss of only two traces. This is not a serious impediment to the data set but a problem that should be traced to its origin and corrected. Nanometrics has been made aware of the fault and are looking into its cause as well.

Trine has been copying the original notes made on deployment and pick up to be used by those processing and interpreting the data. I have been compiling the location of supplementary reflection and refraction profiles and working on a power point presentation for distribution with in the group.

The sun came out and both the Greenlandic and Canadian Twin Otters landed late in the afternoon. The Greenlandic plane took Christian, Søren R. and Martin south. They will be missed. The other aircraft brought us new pilots and mechanics. A Hercules landed as well just after supper. Lots of pictures were taken as the mountains and the sea ice were bathed in light. Unfortunately, the winds are picking up and the window of opportunity for flying is small. Our weather information indicates poor weather for tomorrow.

The weather at the ice camp is still unsuitable for flying, they report wind speeds of up to 25 knots and the

tracker buoys indicate motion of 600 m an hour. Only during the snow storm was there faster movement of up to 1 km per hour. We have been not able to reach the camp for three days by Twin Otter and six days with the helicopters. In fact one of the helicopters has been stranded there for six days. We are concerned about the difficulty of reaching the three individuals at the camp if it was required at any particular time.

Dave M., Jim, Trine and I held at meeting at 18:00 and discussed the safety issue of leaving people at camp. We all agreed due diligence means that should be moved to a safer spot (i.e. Alert). The consequence of this action is that we will not have a reliable weather forecast for the cross line. This action of moving the people off the camp effectively means the cross will not be run.

Friday, April 28, 2006 - clear at Alert and at the camp -3°C, poor visibility
At the morning briefing information suggested that the weather would improve sufficiently for the Twin Otter to reach camp so it can be evacuated. The plan also includes the helicopter pilot of the L4 John traveling on the Twin Otter so that it can be flown back to Alert. As well an attempt will be made to recover 5 Taurus near shot 7. The two helicopters at camp will collect bathymetry along the line weather permitting.

Trine and I compared AVHR images from the early days of our experiment where you could see the ice over large areas with the images from today. There is only a small opening today offer a slight chance of removing the people from camp, pick up instruments, trackers and move the helicopter at camp.

By noon the weather had gotten worse. The Twin Otter made it to camp but the conditions were not promising. The helicopter pilot may try to fly the L4 home but it is impossible to look for the beacons or the trackers. The helicopters at Alert could not leave either due to the fog bank moving in.

Actually the Twin Otter was at the camp until about 18:00. Tim and Søren were busy moving and detonating explosives. Both skidoos at camp broke down under the load of explosives and the soft snow. The temperature was -1.9°C. John the pilot and John S. picked up the trackers at sites 5 and 6. They were all deeply buried in snow and had to be dug out. Next they flew to tracker 7 found it, made 3 attempts to land and eventually made it. The conditions were rapidly getting worse and they had little time to search for the 5 missing Coolers. In order to make it back to camp, the contrast was poor, they had to fly along leads.

At the end of the day the three occupants of the ice camp called "Hans County" by the residents were flown back to Alert. The name is an acronym (Helicopter and Aircraft Navigation Support). It is also refers to the highly publicized disagreement between Canadian and Danish over Hans Island and is in contrast a fine example of their cooperation. Last but not least Mike is from Hants County, Nova Scotia. As they left camp the Twin Otter flew around it. The camp is now an island completely surrounded by water. The camp was on the only ice flow in the area that has not suffered major damage. During the camps existence the seismic reflection system operated for 390 hours. The team did well.

Saturday, April 29, 2006 - clear at Alert -8.8 to -21.4°C
Sunny at Alert, the satellite images show one to two layers of cloud in the region of the camp. We have to wait for more information before plans can be made for the day.

Pat Dennis sent a message that was much appreciated with the ticketing she had managed late on Friday afternoon. Mike, John S, and Greg have tickets or are on stand-by to return home on May 2. Isa and Ron do not have tickets. They have been given telephone numbers of government travel and Nelly for support. When they get to Resolute Bay, Mike Christensen of PCSP will assist them in getting tickets.

About 11:30 the Twin Otter left for Resolute with Isa, Greg, Mike, Ron, John B. and John S. A fond farewell with lots of hand shakes and hugs. The usual milling around, hurry up and waiting took place as the take off was delayed by the departure of a Hercules. Then the Twin Otter was taxied down the runway and took off into the wind overhead as we waved good-bye.

Box Top, the refueling of Alert, is now in full operation with aircraft arriving and departing at all hours of the day. George Stewart who is in charge of this operation is here for several days. He attended our planning meeting in Ottawa in June and his approval was crucial for operating out of Alert. He received a LORITA tee shirt as a token of our appreciation of his support of our project. The CO Mike Hilakers was also given a tee shirt as we heard it was his birthday.

Trine and Jørgen flew to Frankfield Bay to reset the seismograph to a sampling rate appropriate for earthquakes and extract the data from our shots. At Frankfield Bay it was windy. One highlight was seeing musk ox with young in the distance. Trine also found the leather men she had left their on her first visit to the seismometer. Unfortunately, the 4 Gigabyte flask card did not record any data. The state of health information reported a bad board. The instrument was replaced with a new one.

Morten and Arne went out in one of the helicopters to collect bathymetry along the southern end of the refraction line. They reached as far north as seismometer site 81. The skies were blue and the satellite pictures for near noon showed the ice clearly to the cross line. To the north, where the remnants of the camp are, there was cloud cover. I was busy during the day down-loading satellite images and the position of the trackers in case it was possible to fly either to the camp or beyond to the beacons at shot 7 on the Outer Line. Jon Biggar and Thomas Funck were disappointed they did not get to collect bathymetry data on the northern end of the outer refraction line today.

After supper the blasters were carried offshore by a helicopter to destroy the last of the explosives that had been stored in the Alert temporary magazine, 39 charges. We also heard that the Twin Otter with our comrades on it had reached Resolute Bay. There was a concern when they left that the weather in Resolute would be too poor to land and they would have had to stay in Eureka. They are now one destination closer to home. The Twin Otter returned to Alert flown by Paul Rask who was here early in the survey.

Sunday, April 30, 2006 - clear at Alert
At the morning briefing, the status of the weather along the cross line and at camp was not flyable. The situation will be monitored all morning and an updated plan announced around noon. The Hawker Sidley left early to pick up the US team at the Borneo camp. The Russians have left them on the ice. The weather conditions are not promising. The situation is rather worrying. Meanwhile we watch as the clouds are slowly moving northward.

All day the clouds and fog slowly moved north and west. After supper the Twin Otter and with the pilot and mechanic for the helicopter at camp as well as Søren, Doug and Jørgen went out to clean up the camp. On the flight out and the satellite images showed little to no cloud. There is a good chance the helicopter will return to Alert at last.

Meanwhile during the day we discussed and planned a modified cross line. The north-south model was examined for clues as to the minimum length and its position in the trough. The information that finally determined its final location was the position of the fuel and explosives cache. Our theoretical plan is to put out 72 coolers over a length of 100 km (1.4 km spacing) and to fire 6 single hole charges at a distance of 20

km. We will use 2 teams of loaders and shooters with the third helicopter ferrying explosives. Next the coolers will be picked up at the cache having been deposited by the Twin Otter.

The helicopter flew home after 10 days on the ice, the last one with no one at the camp. It is a great relief. During the expedition to camp the last of the explosives were detonated in a surface blast. Two more tents were taken down and the most valuable items returned to Alert. There are several more loads to be brought back before the clean up is complete.

Monday, May 1, 2006 - clear at Alert
The weather was clear and fine except for a fog bank along the coast. While waiting for additional satellite images the flight crews were driven to the Spinnaker building to bring preparations for the days work.

Over the last few days the Twin Otter at Dave Maloley's direction had been placing fuel and explosives at cache about mid-way along the planned profile. This was a critical step is executing this line quickly. By 09:30 the first helicopter LIA piloted by John Innes was set off to test the thickness of fog. We waited patiently for the first half hour and he was able to fly through it. The other two helicopters left as well as the Twin Otter carrying the "coolers: the lucky teams today are Peer and Jørgen - blasters and deployers, Tim and Trine blasters and deployers, Thomas and Ruth ferryers of explosives and deployers.

The line was executed by using two helicopter teams to cut the holes and load the charges while the third carried explosives to them. As usual there were communication problems due to poor radio communications. The L4 (LIA) with the greatest carrying capacity had to fly to the fuel cache near the centre of the line and subsequently to the western end to line. When it arrived at the position of shot hole, there was no helicopter in sight. To find it was necessary to call Dave Maloley at Alert who then contacted PCSP who could use there aircraft tracking system to get an exact position. Then LIA was able to fly 8 km west to deliver the cargo of charges and primacord. They had not been able to find suitable ice near there shot point so they carried on along the direction of the profile. After that slight delay the ferrying and loading of the six single shot holes went smoothly.

All three helicopters met at the fuel cache picked up their coolers and readjusted the numbers to be set out based on the fact that all three were beginning to deploy at the same time. When we returned to the cache again a second refinement was made so that no time would be wasted. The coolers, 72 of them, were deployed in 2 hours and twenty minutes. The shooting teams then had to fly along the line and detonate the charges. This took about an hour and a half.

During the day it was possible to see across the ice in all directions as if looking across a large circular plate. Working on the ice was comfortable with a hat and light jacket. There was no sign of any wind.

The final stage of picking up was the quickest. However, there was the initial search to find the first box. In the four hours the boxes had been out they had drifted 380 m to the south east on the eastern end of the line. It also took a little longer to get set up because we had a new set of pilots who had not practiced this operation before. After the first few coolers had been found a pattern was established and all went according to plan. Pick up a load of coolers deliver them to the cache. The second and last load was delivered to the cache as the Twin Otter arrived to take them home. We then helped load the Twin Otter with coolers, geophones, drills and empty oil drums. To complete this line day it required for instance Thomas getting in and out of the helicopter 64 times, 32 hours of helicopter time while they flew over an accumulated distance of 1000 km. For the first time on this line we managed to get all the seismometers and the trackers back. As well all of the charges have been detonated now.

The helicopters had to refuel and then fly back to Alert. This took about an hour and twenty minutes. We arrived back at the Spinnaker building to a happy group having a "barley sandwich". A new term I picked up from the Royal Newfoundland Helicopter Squadron. The relief and joy that we had in completing this profile is difficult to describe. Thumbs Up! Another description of the line would be to use Dave M. expression the logistics went bingo bango.

Tuesday, May 2, 2006 - clear at Alert -12-21°C, cloudy offshore

The weather offshore does not allow flying this morning. Clearing later in the day is predicted. Since the pilots flew late last night there duty day would not start until noon so no time is actually lost. The notion that we utilized a narrow window of opportunity for running the cross line is being reinforced.

Thomas opened the coolers and removed the flash cards for the cross line. He delivered them to Trine for backing up on her computer before lunch. After lunch Trine was at the Spinnaker lab using Isa computer to do the back up. She completed this in the afternoon and returned the originals to me.

Meanwhile Tim was busy preparing the geophones for packing. Everyone had to be removed from their boxes dried off, pins and caps replaced and the foam dried out. He also supervised Leslie and Doug to get the blaster boxes batteries removed and the tools boxes prepared for shipping. Peer was packing Danish augers and other equipment. Dave Maloley and Doug were packing up the camp equipment including the generators. They also packed the CarteNav beacons and put the Taurus that belonged to the universities on a palette and wrapped the box. This cardboard box has $500,000 worth of instruments in it.

Thomas and I prepared all the 150 cooler boxes for shipping. The geophone cables were dipped in alcohol to replace the water some were sitting in. The Taurus were snugged up in their cases with the bags of stuffing they had been shipped with, they were tapped shut and stacked ready for pallets..

Dave Maloley continued to monitor the weather for the opportunity to send the Twin Otter to camp to bring home the remaining two Twin Otter loads of tents and plywood. The hydrographers Jon Biggar in particular was hoping to do a CTD at the fuel cache because it is over the trough where our water depths are greatest.

Trine and I decided since we had only made it to the site OS07 once during our six weeks, there was small opportunity of ever recovering the missing 5 Taurus. In addition it has drifted 80 km and we no longer have fuel caches near it. It would be safer and save money to release the third helicopter after the repeater beacon for the FM is taken down. This means we will have abandoned 5 Taurus and 1 CarteNav beacon.

Wednesday, May 3, 2006 - clear at Alert -12.7 to 22°C, cloudy offshore

The weather report for the morning showed that the local flying would be excellent. Unfortunately, the cross line is covered in clouds as well the fuel cache that is required by the helicopters is cloud covered. Wait and see.

Last night the diesel truck that is used as our primary means of transportation had gasoline put in it. Now we have no independent transportation for the air crews and scientific staff.

During the morning, Thomas and I finished packing the geophones in there now dry packing foam. The cooler they were put in were taped shut and stacked. Meanwhile Leslie started taking apart the shelves that all the coolers had been stored on. She, Thomas and Jim finished taking the shelves down and stacking them neatly for shipping.

I talked to Isa in Ottawa today about backing up the flashcards. He suggested after Trine's back up it was safest to do nothing but hand carry the cards. He wanted me to subject them to a hand search rather than risk demagnetization by running them through a machine at the Edmonton airport.

Isa had a story to tell about bad weather working in his favor. Once he and the others (John S, John B., Greg, and Ron) arrived in Resolute Bay they discovered that all the flights south were booked for a week. The Tuesday morning, May 2 flight from Resolute south was suppose to stop in Nanasivik to pick up seven passengers, except the weather there was too poor to permit any air craft to land. Therefore enough seats were free to take all the LORITA participants stranded at Resolute southward.

The Twin Otter crew landed at the ice camp twice today. Jørgen and the crew have picked up everything except three drums of fuel, a weather buoy and a locator beacon. These were left at the request of Rene Forsberg. His aerogravity project follows our's and he will clean up the drums when he uses them. Now that the ice camp is an acceptable state for the environmental rules it will be possible for Dave Maloley and his group to leave on the charter flight with the scientific staff, otherwise he would have to wait until the weather allow the aircraft to clean up the remains of the camp.

Helicopter hours flown to date: 240.6 minimums 372 hours.

Thursday, May 4, 2006 - snowing at Alert -12 to 20.5°C, cloudy offshore
The weather report at our morning meeting indicated little hope of flying today. We still have fuel at the eastern fuel cache and the hydrographers are rather disappointed. If the Twin Otter can be flown to the fuel cache the hydrographers will go and get a CTD. I downloaded a position for the tracker at the fuel cache incase it was needed. I also called Nelly and got the hotel reservation number for all Canadians going out on the charter.

Because we no longer have a truck we have reserved a time 18:00 for the military transit to carry as much luggage as possible to the Spinnaker building. During the day the halls outside our rooms filled with metal boxes, cases and duffel bags. At the Spinnaker building Dave M. supervised the loading of the scientific gear on pallets and the weighing of it in preparation for the charter flight.

Friday, May 5, 2006 - snowing at Alert -12 to 20.5°C, cloudy offshore
No flying again today. For the scientific staff there is packing of the hydrographic equipment and helping clean up the Spinnaker building. Dave Maloley will be doing the final preparation of the pallets for the Boeing 737 and organizing with the military to ship the compressor and coolers. If the weather in Resolute is suitable for flying, the Twin Otter may take a load of our equipment there to be shipped south later on the sea lift.

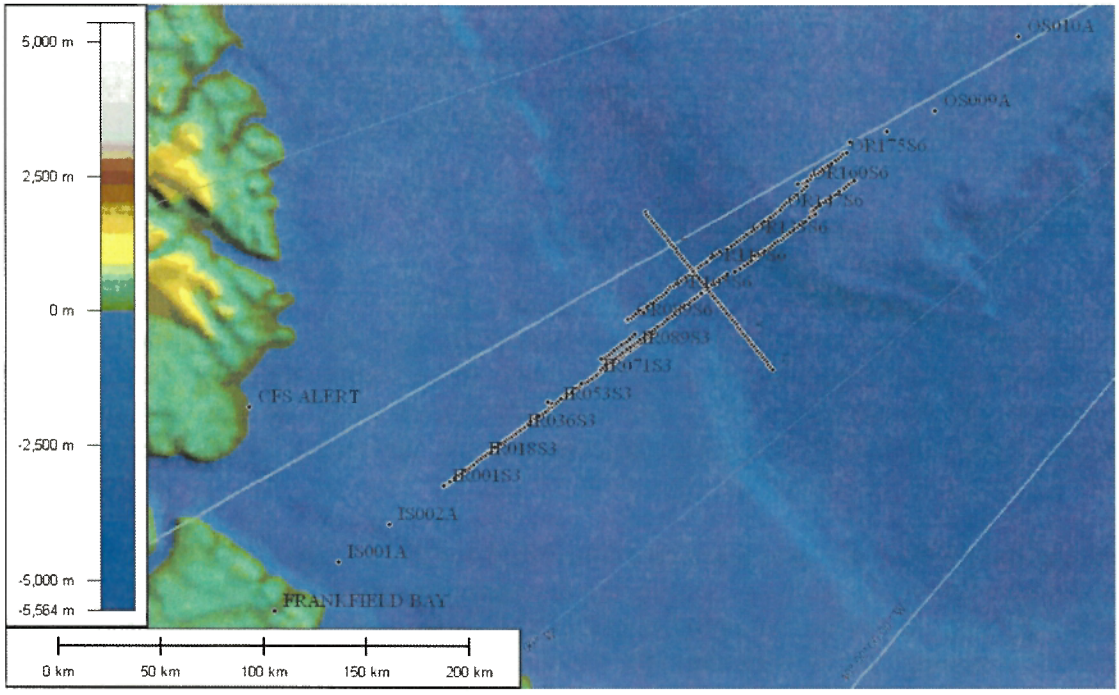
The Spinnaker building was swept and vacuumed. All the remaining scientific gear packed. The pallets were completed and the straps cinched in place. The plans are that 6 military personnel we leave on the aircraft with us tomorrow. We are all to attend the TGIF event this afternoon where Jim will present the base with a plaque with the LORITA logo and signatures of the staff on it. We have two tee shirts that will be given to the base to be drawn for.

After the regular pizza party, the Twin Otter returned from its trip towards Resolute Bay and they had to turn around at Eureka. The weather had improved on the ice so Dave sent them to the eastern fuel cache. They picked up the ice tracker and cleaned up the fuel drums. We will have met all of our environmental conditions to leave the ice as we found it.

Saturday, May 6, 2006 - clear at Alert, clear along our line offshore
For the first time in weeks the offshore, near beacon 7 and the 5 nearby cooler boxes, is clear. Trine enthusiastically is prepared to go and get them. More weather and beacon information is downloaded and it looks possible. Dave Maloley has got the pilots up. The effort to complete this line continues to the last minute.

Trine returned with the tracker and all five coolers!

The figure below shows the lines we completed on LORITA.



This figure illustrates the location of the seismometers and shots as black circles. IS001A is an abbreviation for Inner Shot 1 at time of loading, or IR001S3 inner line receiver 1 for shot 3. The single digits are the locations of the shots on the cross line.

Daily Reports

Trine Dahl-Jensen, Geological Survey of Denmark and Greenland

Lorita-1 - Daily Report No.1 - March 30, 2006

Weather
-30°C, sun, no wind, fog in evening.

What have we done today
In this first report we sum up activities from the start up to and including today.

March 24 * Early group arrives
March 25 * Open DRDC building.
Set up radios for flight control.
March 26 * First Twin Otter (TO) trip out over the ice; choose the fuel cache site (84° 37.19 N 57°10.25 W). Marked a skiway.
* Flew reconnaissance over the inner line and cross line.
March 27 * Twin Otter with 5 drums of fuel to fuel cache. Had drifted 2.4 miles in 24 hours, and new leads open around the site. Site moved to 84° 59.34 N 57° 01.37 W. Two additional Twin Otter trips with 2x6 drums.
* New HF antenna in DRDC building.
March 28 * First Air C-130 charter flight with explosives and cargo. Unloaded.
March 29 * Cargo handling and initial storage setup in DRDC building.
* Twin Otter made check flight to fuel cache with 5 drums of fuel. Site OK.
* First Air 737 charter flight with passengers and cargo.
March 30 * Twin Otter flight with camp gear to fuel cache.
* Lorita start up meeting.
* Alert new people information meeting.
* Twin Otter flight with camp gear to fuel cache.
* Start instrument set up and data download setup.
* Explosives inventory made, explosives inspected and equipment located. Making ready for test shot series.

People movement
March 24 * Arrived in Alert: Jim Milne, Dave Maloley, Jørgen Skafte, Leslie Milne, Dorothy Edwards, Douglas Briscoe, Sean Williams travelled from Ottawa to Alert. Departed Ottawa March 19, arrived in Alert March 24 due to bad weather. Also pilots Paul Rask, John and name unknown.
March 29 * Arrived in Alert: Ruth Jackson, Trine Dahl-Jensen, Isa Asudeh, Thomas Funck, Christian Marcussen, John Shimeld, Dave Snyder, Peer Jørgensen, Ron Verrall ,John Boserup, Dave Forsyth, Søren Bredvig, Tim Cartwright, Greg Middleton, Mike Gorveatt, Ken Asmus, Jopee Kiguktak.

Alert Lorita population: 27
Fuel Cache population: 0

Comments
Ice conditions are bad. On March 23 catabatic winds off Greenland broke the ice and opened a large number of large cracks. There are no Twin Otter landing sites south of the fuel cache site (84 59'N). The

ice is currently freezing up again, but we have decided to start with the cross line where ice conditions are better. File attached to daily message was 200603281227_DMI_Quicklook_NOAA.jpg.

The three helicopters are delayed in transit to Alert due to bad weather further south. Current ETA is Saturday April 1.

Plans for tomorrow - Saturday, April 1, 2006
* Twin Otter loads to fuel cache site.
* We must all be on base at 14:00 hours to attend a welcome party.

Lorita-1 - Daily Report No.2 - March 31, 2006

Weather
-30°C, sun, no wind, fog seawards.

What have we done today
March 30 * One Twin Otter flight with camp gear to fuel cache.
* Data group continue with setup. Computers are running.
* Shooters have discovered a problem with the shot boxes. The GPS unit does not work, and so does not calibrate the internal clock. Speculations are that the cold in transport is the cause for failure, but as all 9 units have the same problem is seems unlikely. Spare parts are being sent from Ottawa in the hope that this is the problem. The shooters are also working on solutions and have some time before the first real shot (estimated earliest in a weeks time).
* Satellite trackers are being tested. One unit is not functioning, and John Shimeld is in communication with Cartenav about troubleshooting. There is a general problem with the data on the website, as the positions of the units seem to revert to a previous position. Cartenav is aware of this problem, which is a software display problem at Cartenav. The simple (no graphics) website they have set up specifically for us is new and this is where the problem is. It is being solved. In the meantime we can access Cartenav's default site which has a lot of graphics on it (slow) but correct positions.

People movement

Nil

Alert Lorita population: 27
Fuel Cache population: 0

Comments
One truck is broken down, leaving us with very little transportation from the main complex to the DRDC building. As the remaining truck is required to have a driver with an approved military drivers license we only have one driver (Jim Milne).

The three helicopters are delayed in transit to Alert due to bad weather further south. Earliest ETA is Sunday April 2 if weather permits. March 31 evening they are in Pond Inlet, with a bad April 1 morning forecast for Resolute Bay.

All newcomers (including 20 Lorita's) have been introduced at the TGIF get-together in Alert's bar. Because of this the Twin Otter had be back early (14:00) so only one trip today.

Media visit to Alert is cancelled.

Plans for tomorrow - Saturday, April 1, 2006
Two or three Twin Otter trips with cargo for the fuel cache site. One trip will be with explosives, including those for the test shot.

Shooters	Shot box and timing problem solving and prepare for test shot probably Sunday.
Data group	Continue setup.
Logistics	Get cargo ready.

Lorita-1 - Daily Report No.3 - April 1, 2006

Weather
-30°C, sun, no wind, fog seawards.

What have we done today
* Three Twin Otter flight with explosives (1)camp gear (2) to fuel cache.
* Shooters tested shot boxes by firing a single detonator; no problem. However, the problem with the shot boxes described yesterday is not solved. Isa Asudeh as talked at length with Bob Schieman in Ottawa (who built the GPS calibration part of the shot boxes) but no explanation for the failure of all units nor a cure has yet been found. Bob is sending spare chips so we can replace and see if that helps. He will also send the original clock to calibrate the internal clock in the shot boxes at home (= Alert) in the mornings before shooting.
* Satellite trackers are now logging correctly on the simple website. One unit is placed at the fuel cache, and is logging the drift of the station; steadily west with approx. 5 km a day for two days now. Cartenav will send spare batteries and the spare instrument to replace the malfunctioning unit.
* Tim has checked over the broken truck, and think he has found the problem. Will double check and then we can get spare parts set up and do a repair. A coupe of skidoos are now operational.

People movement
Nil

Alert Lorita population: 27
Fuel Cache population: 0

Comments
The three helicopters are still delayed in transit to Alert due to bad weather further south. Weather at Resolute Bay has been very bad all day; the helicopters are still in Pond Inlet.

The ice still has very large leads (several km wide) but at being closed by wind drift and it looks like they are beginning to freeze over. The prevailing easterly winds have opened a very wide (10's of km) wide lead along the North Greenland coast. This would have been great for an icebreaker.

Plans for tomorrow - Sunday, April 2, 2006:
TO plan * Flight to fuel cache to set up camp with Jørgen, Greg and Mike (who will stay out) and Ron and Jopee for the day to help. Be ready at the back door at 08:30 hours.
* Flight to fuel cache to do test shot. Tim, Dave F, Peer, Søren, John B. and Christian plus one from the data team. Also 12 blue boxes for testing. Be ready at 12:00 hours at the Spinnaker building.

* Flight to fuel cache while test shot is happening with full load of explosives.

Lorita-1 - Daily Report No.4 - April 2, 2006

Weather
-28°C, slight overcast, no wind, fog seawards.

What have we done today
* First Twin Otter flight to fuel cache site with the fuel cache camp people and Ron and Jopee to help build camp.
* Second flight to fuel cache with explosives.
* Instrument setup and computer network ready.

People movement
Jørgen Skafte, Mike Gorveatt and Greg Middleton from Alert to fuel cache camp.

Alert Lorita population: 24
Fuel Cache population: 3

Comments

The fuel cache camp is now in operation with the three inhabitants. Before the second flight returned 3 tents were up, there was heat in one. Ron identified a suitable location for the test shots not too far from the camp and runway.

The test shot planned for today was postponed due to weather conditions. There was low cloud at the fuel cache, and getting worse. Weather report from camp was for worsening weather. The forecast for tomorrow is not positive.

The three helicopters are still delayed in transit to Alert due to bad weather further south. Weather at Resolute Bay has been very bad all day; the helicopters are still in Pond Inlet.

Plans for tomorrow - Monday, April 3, 2006
TO plan * Flight to fuel cache to do test shot. Tim, Dave F, Peer, Søren, John B. and Christian plus one from the data team (Dave S). Also 12 blue boxes for testing. The weather does not at present (Sunday evening) look promising.

Lorita-1 - Daily Report No.5 - April 3, 2006

Weather
-26°C, slight overcast, no wind.

Location of fuel cache camp
04/01/2006 12:01:23,85.001678,-58.456161
04/02/2006 12:01:23,85.001648,-58.968704
04/03/2006 12:01:24,84.988403,-59.553406

What have we done today

Test shots.
Twin Otter flight to the fuel cache camp with all the blasters (Tim, Dave F, Søren, Peer, Christian), John B and Dave Snyder. Jopee who is the official wildlife observer from Nunavut was also there. It is a requirement from NRCan Department of Fisheries and Oceans that we conduct a test shot and make required measurements of the sound pressure from the large blasts (350 kg). Tim had all the recording equipment from DFO with him. A report will be made and included in the final fieldwork report. In addition, the blasters all have jointly loaded the explosives and have a procedure defined.

The test series conduced were
One charge complete with primacord set of with a cap. All worked fine.

A full charge of two strings of each 10 charges - total of 350 kg of explosives. Also went well. We had 10 recording instruments on site as well as two in Alert (one outside in the snow and one on the lab concrete floor). All recorded normally and the large shot clearly visible. The single charge (17.5 kg) was seen but very faintly. There are some software problems in the process of getting the data off the Taurus instruments and into SEGY with all the correct headers, but the data acquisition itself is OK. The data team is currently addressing the software problem.

People movement
Nil

Alert Lorita population: 24
Fuel Cache population: 3

Comments
The three helicopters made it to Resolute Bay today and the intention is to continue to Alert tomorrow.

We have discussed which line to start with. The ice conditions along the inner line seem to be improving, and on tomorrow's flight to the fuel cache camp we will do a survey along the line position to evaluate. But we are inclined to start with the cross line, although it is not the highest priority. This would give time for the inner line to freeze up more, it would iron out the bugs in our procedures, and as the main drift if the ice is E-W (along the line) we are less pressed for time. Also the fuel cache camp is currently in an OK position for the cross line, and if we have to move it later we can then move it to a good position for the other lines.

Plans for tomorrow - Tuesday, April 4, 2006
TO plan * One flight with supplies for fuel cache camp; ice survey over inner line on the way. Ron and Jopee to join the flight.
* Blasters and drillers (Tim, Dave F, Søren, Peer, Christian) and drillers (Ron and John) please meet with Ruth and Trine in the Manor common room at 14:00 hours to talk over details.

Lorita-1 - Daily Report No.6 - April 4, 2006

Weather
-26°C, slight overcast, no wind (mid afternoon -15°C).

Location of fuel cache camp
04/04/2006 12:01:24,84.986832,-59.928162

What have we done today

* Flight with fuel supply to the fuel cache camp. Ron and Jopee joined the flight and on the way back flew over the inner line to evaluate the ice conditions. There are still open leads, not a problem in as of sites shots & receivers, but they create fog. Today there was hardly any wind, so it was foggy over the line.
* The blasters and drillers and Ruth and Trine met to discuss the details of organizing loading of the charges. The decision was to use three teams, each with a helicopter: the drilling team (Ron, John B and Søren) pick the sites and drill the holes. They also mark the sites and leave a satellite beacon. The ferry team (Christian) ferry explosives, primacord, rope etc. to the sites. Finally the loading team loads the charges and leaves the site ready for blasting. People can rotate once we get started and learn how it works.
* A large number of us visited the earthquake seismic station at Alert (ALE) today.

People movement

Three helicopter pilots plus mechanic.

Alert Lorita population: 27
Fuel Cache population: 3

Comments

The three helicopters (plus a fourth for another project) made it to Alert this evening.

We have decided to start with the cross line and hope for cold weather so the leads on the inner line freezes over.

The movement of the fuel cache camp has slowed down to les than 100 m an hour and turned south. Wind forecast is for the wind to turn to westerly winds.

Plans for tomorrow - Wednesday, April 5, 2006

Twin Otter plan * Preposition explosives and fuel two places on the X line. Will take 2 (or 3) flights.

Helicopters plan * Safety briefing, talk over plans for loading, check how many "lunch boxes" fit in.

Times * TBA, but for most after lunch.

Lorita-1 - Daily Report No.7 - April 5, 2006

Weather

-26°C, fog in the morning, some overcast, no wind (mid afternoon -15°C).

Location of fuel cache camp

04/05/2006 12:00:48,84.975067,-59.896835

What have we done today

* No flights out on the ice today. The weather was foggy at Alert in the early hours, and bad at Camp all day with poor visibility.
* The other Twin Otter arrived yesterday with crew change for pilot and co-pilot; however they are due to leave again on Friday for the longer term replacement crew.
* The helicopter pilots were briefed on plans, and all who at some point will fly on the helicopters were

given a safety briefing on how to behave around the helicopter.
* We tested how many coolers (with recording instruments) fits into the helicopters. 15 instruments (with seismometers) in the Long Rangers; 18 in the L4 - carrying two passengers for deployment.
* Spares for the shot boxes arrived yesterday and were left to warm up over night. The spare shot box displayed the same problem as the others; cannot be a hardware problem but must be a software problem. Tim has rigged the shot boxes so the time can be calibrated in the morning manually from the GPS; then we will use the internal clock during the day for shot timing. Bob Scheimann will travel to Alert (arriving approximately April 12) to troubleshoot and hopefully repair the GPS calibration for the rest of the lines.
* The Fuel Cache Camp now does synoptic weather reports at 00:00 and 12:00 Zulu (08:00 and 20:00) in addition to providing us directly with weather. The automatic icebouy is running; it is to be left when we leave as far north at we can get it on Lorita flights. The "drift" seismic is now online. The drift of the ice at the Fuel Cache Camp has changed - it is now back to the East. Accompanying figure sent with message.
* We have realised (Tim has ..) that the blast phone that recorded the test shot was improperly calibrated, so we will record one of the regular shots with the same setup as the test shot (i.e. hang a blast phone 50 ft down a hole 100 m from the shot site.

People movement
Three helicopter pilots plus mechanic who arrived yesterday are pilots Bill Denomme, Colin Lavalee and engineer Mark Foley. Yesterday, Twin Otter pilot Rodney Fishbrook and co-pilot Mark Vink arrived. Jon Biggar also arrived on the Twin Otter. Today Twin Otter pilot Paul Rask and co-pilot John Kominko left.

Alert Lorita population: 32
Fuel Cache population: 3

Comments
A Wildlife group arrived to survey wildlife numbers on Ellesmere Island. The two "overlapping" Twin Otter at Alert has positioned fuel caches for them. A fourth helicopter arrived together with the three for Lorita. So we had two Twin Otter and four helicopters parked.

The weekly HERC with supplies for Alert Station arrived and left today.

Plans for tomorrow - Thursday, April 6, 2006:
T O plan * Preposition explosives and fuel two places on the X line.
* From Alert to new landing site (X_cache_west) on western part of X line and leave 3x20 charges +ropes, primacord etc. Then to camp to fetch fuel to X_cache_west. Back to camp and fetch fuel for new site (X_cache_east) on eastern part of line X. To Alert for a cargo of fuel/explosives/camp-resupply. At some point during the day the spare cutting head and spare extension for the GSC power head to be the spare system at camp is left at camp.

Helicopter plan Team 1 (Ron, John B Søren B) does the drilling; helicopter VYM pilot Colin.
Team 2 (Christian) ferries explosives from the caches to the drilled holes; helicopter CWR (the L4) pilot Gerad.
Team 3 (Dave F, Peer, Tim) loads the holes; helicopter LIA pilot Bill.

For the flight out of Alert to XS-1 VYM carries Ron, John B (most of Team 1) and one drilling system as there is only room for two passengers with full fuel. Søren joins CWR together with Christian (Team 2) and explosives, rope etc for one shot and goes to XS-1 and Søren stays with Team 1. All satellite trackers go with Team 2 for deployment. Team 3 (Dave, Tim and Peer) goes to XS-1 on LIA, and will during the day

get the GEUS drilling system from Camp with one of the loads of explosives with CWR. The satellite trackers are always with the explosives; so they go with Team 2. If Team 1 gets too far ahead they can stay at a site until team 2 comes with explosives and then load a hole.

All movements and actions are reported back to Dave M. through the pilots. If you have good ideas about change in the way we do things we would love to know them - when you come back home. During the day Dave M must approve all variations on the plan. The pilots get their directions from him.

Lorita-1 - Daily Report No.8 - April 6, 2006

Weather
-26°C in the morning, sunny, no wind (mid afternoon -15°C. Fine sundog halo mid afternoon.

Location of fuel cache camp
04/06/2006 12:00:56,84.968735,-59.652985

What have we done today
No helicopter flights out on the ice today. The weather was beautiful at Alert, but no-fly weather at camp. It cleared at noon, and Twin Otter went out with a load of fuel to the Fuel Cache Camp. Ruth joined the flight to see the drift seismic system. It was nearly running (not operational April 5 as noted in Daily Report No.7), but not quite operational. The airgun system was up and test fired, and the hydrophone needed to be placed. Leaving Ruth at camp, the Twin Otter went out on the western end of the X line to look for a landing site; they did land at one spot but decided against it due to poor ice. The Twin Otter returned to camp, picked up Ruth and returned to Alert.

Helicopter flight to Frankfield Bay in Greenland to ensure the earthquake seismic station there is operational. The data logger was off on arrival (as expected), but booted correctly when power cycled. There was no parameter file in the RAM, and acquisition was off. Full charge on the batteries. The flashcards were changed to 2x4GB cards, and the sample rate set to 100 samples per second (for the Lorita shots). The STS-2 was slightly out of centering (one channel was 9.9V, the other two below 2V). After one mass-centering all were below 1V. The GPS was locked before we left the site, acquisition turned on. Trine has not yet had time to look at the data on the flashcards.

The Greenland Air Twin Otter arrived as scheduled close to 16:30. The pilots will stay overnight and return tomorrow morning.

People movement
Morten Sølvsten, Arne Olesen, Søren Rysgaard and Martin Blicker came by Greenland Air Twin.

Alert Lorita population (including aircrew): 33 + 3 overnighting Air Greenland crew
Fuel Cache population: 3

Comments
As the weather is now good on the inner line and the forecast for tomorrow good, the ice not looking good on the X line, and the inner line is the highest priority - and time is running - we have decided to start tomorrow loading charges on the inner line.

Plans for tomorrow - Friday April 7, 2006

Friday we will start loading charges on the inner line. We will start from the north and work south with three teams:
* Team 1 (Ron, John B Søren B) does the drilling; helicopter CWR pilot Colin.
* Team 2 (Christian) ferries explosives from the caches to the drilled holes; helicopter LIA (the L4) pilot Gerard.
* Team 3 (Dave F, Peer, Tim) loads the holes; helicopter VYM pilot Bill.

Twin Otter plan * Morning flight to Fuel Cache Camp with camp supplies, rope and 2 people from Team 1 and 2 people from team 3. Teams please arrange who is going with the Twin Otter. At camp the teams will be "re-united" and start finding sites, drilling, ferrying explosives and loading the charges.
* Returning from camp the Twin Otter will look for a Twin Otter landing site on the southern part of the inner line where we hope to establish a fuel and explosives cache.

Helicopter plan * For the flight out of Alert to camp one from Team 1 and one from team 2 join the helicopters; the four others go on the Twin Otter. Christian (Team 2) tales a full load of explosives, rope, etc. for one shot and goes to camp. All satellite trackers go with Team 2 for deployment. The satellite trackers are always with the explosives; so they go with Team 2. If Team 1 gets too far ahead they can stay at a site until team 2 comes with explosives and then load a hole. Dave M will advise from Alert.

Team 1 brings their preferred drilling system; Team 3 take another system as backup. There is also a spare system at camp.

All movements and actions are reported back to Dave M. through the pilots. If you have good ideas about change in the way we do things we would love to know them - when you come back home. During the day, Dave M must approve all variations on the plan. The pilots get their directions from him.

Lorita-1 - Daily Report No.9 - April 7, 2006

Weather
-26°C in the morning, sunny, no wind (mid afternoon -14°C).

Location of fuel cache camp
04/07/2006 12:01:01,84.966354,-59.691910

What have we done today
Loaded IS6-11.

We worked with three teams:
Team 1 (Ron, John B Søren B) does the drilling; helicopter CWR pilot Colin.
Team 2 (Christian) ferries explosives from the caches to the drilled holes; helicopter LIA (the L4) pilot Gerard.
Team 3 (Dave F, Peer, Tim) loads the holes; helicopter VYM pilot Bill.

In the morning, the three helicopters with full fuel and one from their team and for Team 2 also 20 charges took off for all to rendezvous at the Fuel Cache Camp. The Twin Otter with the remaining team members, their cargo, camp supplies and fuel also meet at Fuel Cache Camp. Here the teams reunited and started working from site IS11. Team 1 had left two extensions for the drilling system back at Alert and when they met ice thicker than 3 m had to fetch the spare drilling system at the Fuel Cache Camp. The extensions

were sent out from Alert during the day with the Twin Otter. The system worked well.

The Twin Otter returned from the Fuel Cache Camp along the inner line in order to search for a landing strip for fuel and explosives cache. They succeeded (southern fuel cache) just north of IS4. The then did two trips from Alert to this new cache with fuel and explosives. TO returned after 18:00; the helicopters a bit later; with team 1 and 2 at 19:15 at team 3 at 20:45.

The replacement aircrew for the TO arrived late afternoon (Jim Huffy and Gabriel Lluberas) from Resolute Bay.

People movement
Jim Haffey and Gabriel (TO aircrew) to Alert.

Alert Lorita population (including aircrew): 35
Fuel Cache population: 3

Comments
On parts of the inner line there are stretches of very thin ice, where a helicopter cannot land.

Plans for tomorrow - Saturday, April 8, 2006
Saturday we will continue and load the remaining 5 shots (IS5,4,3,2,1) on the inner line. If weather and time permits, we will start deploying coolers.

For the loading
* Team 1 (Ron, John B Søren B) does the drilling; helicopter CWR pilot Colin.
* Team 2 (Christian) ferries explosives from the caches to the drilled holes; helicopter LIA (the L4) pilot Gerard.
* Team 3 (Dave F, Peer, Tim) loads the holes; helicopter VYM pilot Bill.

Plans for tomorrow - Saturday, April 8, 2006
TO plan * At the cache close to IS4 are 60 charges; 30 more are needed. Team 2 will bring 20 charges along in the morning; the TO will bring the remaining 10. Following that the TO will start building supplies at Fuel Cache Camp for the northern line.

Helicopter plan * Each Team goes out in the morning with their team on designated helicopters. The cargo each team needs for the day should be placed in the Spinnaker building – we will set up "staging areas" for each helicopter & the TO. Doug will them take out to the helicopters; the pilots need to inform their team when they want you out at the helicopters.

Deploying coolers * If time and weather permits we will start deploying the coolers wit instruments. The TO will rendezvous with the helicopters at ?the southern fuel cache? John S will go out with the TO; and Dave F and Ron goes back to Alert with the TO. The deployment teams should be two to each helicopter.

All movements and actions are reported back to Dave M. through the pilots.

Lorita-1 - Daily Report No.10 - April 8, 2006

Weather

-29°C in the morning, sunny, no wind.

Location of fuel cache camp
As of today we have midnight sun.

What have we done today
* Loaded IS1-6, deployed IS1-66.

* We worked again with three teams:
* Team 1 (Ron, John B Søren B) does the drilling; helicopter CWR pilot Colin.
* Team 2 (Christian) ferries explosives from the caches to the drilled holes; helicopter LIA (the L4) pilot Gerard.
* Team 3 (Dave F, Peer, Tim) loads the holes; helicopter VYM pilot Bill.

The three teams took off from Alert to start from IS5 and work south, using the southern fuel cache. All worked well, ending at IS1 mid-afternoon. All three helicopters then made a rendezvous at the southern fuel cache where the TO brought 66 coolers (with instruments) and 7 boxes of each 10 seismometers. Due to bad communications we at Alert thought LIA and VYM where an hour later than CWR, so only Ruth went along, and joined Søren on CWR. Ron and John B came back to Alert, only to take off immediately with the TO along with John S to the south cache along with a load of fuel for the cache. This meant that Christian ended deploying alone until picking Tim up with the next load. John S and John B them deployed with VYM. Last helicopter home at around 21.00 hours. Long day.

One TO took Morten, Arne and Jon B to the camp to test the echo sounders. They are now ready to start when we can free a helicopter for them.

We had two TO's working for us today, as the TO supposed to work for the wildlife crew also flew for Lorita. This because the helicopter flying for the wildlife team has a technical problem and is not flying. This meant we during the day could stock the fuel cache camp well with both Fuel and explosives to get ready for the outer line.

Søren Rysgaard and Martin have set up a small lab in a corner of the Spinnaker building and took their first core in Dumbell Bay by Skidoo from camp. They are satisfied that all works well. Dave M. has a list of weights for their equipment and they now wait for space out to the fuel cache camp for a day.

Fuel cache camp has the drift seismic operational now.

People movement
Jim Haffey and Gabriel Lluberas (TO aircrew) to Alert.

Alert Lorita population (including aircrew): 35
Fuel Cache population: 3

Comments
We have bad communication. Only one helicopter (LIA) has a HF radio good enough to reach camp, so when LIA is in the air Gerard relays info back to Alert, as does the TO when in the air. The alternative, to use the Iridium phones, is troubled by it being quite difficult to phone to Alert, and we are still waiting for an antenna extension for the Iridium in the comm. room where Dave M keeps track of things. The aircraft

relay messages for each other and can also phone in to Resolute Bay.

Plans for tomorrow - Saturday, April 9, 2006
Sunday we will finish deploying coolers, do the blasting and if time permits start recovering coolers.

The teams for the day are:
* Team 1 (Tim and Thomas); helicopter LIA (the L4) pilot Gerard.
* Team 2 (Søren and Ruth); helicopter CWR pilot Colin.
* Team 3 (Peer and Trine); helicopter VYM pilot Bill.

Deploying instruments and blasting:
* Team 1 loads a full load of coolers (14) and 2 seismo boxes and goes to IR 149 and starts to deploy south. Refuel and reload with coolers and restock with seismometers at fuel cache camp. Responsible for IR115-149. When done refuel and go to IS 11 for blasting when it is confirmed that all is deployed. Shots IS11,10,9. Shooting windows 00 and 30.
* Team 2 loads a full load of coolers (12) and 2 seismo boxes, tops up fuel at the southern fuel cache and starts deploying from IR91. Refuel and reload with coolers at southern fuel cache (Team 2 and 3 share a box of seismos at the cache). Responsible for IR91- 114. When done refuel at camp and go to IS 8 for blasting when it is confirmed that all is deployed. Shots IS 8,7,65. Shooting windows 10 and 40.
* Team 3 loads a full load of coolers (12) and 2 seismo boxes, tops up fuel at the southern fuel cache and starts deploying from IR67. Refuel and reload with coolers at southern fuel cache (Team 2 and 3 share a box of seismos at the cache). Responsible for IR67-90. When done refuel at southern cache and go to IS 4 for blasting when it is confirmed that all is deployed. Shots IS 4,3,2,1. Shooting windows 20 and 50.

If time permits we start picking up coolers. Weather might deteriorate from the north, so Team 1 and 2 must start from the north. Team 1 IR149-115 (close to IS9). Team 2 IR114-91. Team 3 IR 1-12 or 24 or .....

All movements and actions are reported back to Dave M. through the pilots.

Lorita-1 - Daily Report No.11 - April 9, 2006

Weather
-29°C in the morning, sunny, wind picked up a bit in the evening.

Location of fuel cache camp

What have we done today
Deployed IS66-99, blasted IS1-6, recovered IR1-57.

We worked with three teams:
* Team 1 (Tim and Thomas); helicopter LIA (the L4) pilot Gerard.
* Team 2 (Søren and Ruth); helicopter CWR pilot Colin.
* Team 3 (Peer and Dave Snyder); helicopter VYM pilot Bill.

John S spent a large part of the night on position calculations so all had the best updated position of shots (easy from the beacons) and receiver positions (by interpolation) which is more complex.

From the morning we knew that the weather in the northern part was going to be not too good. We attempted to deploy instruments all the way to IR149, but IR99 (just south of IS7) was on the edge of the cloud and fog bank and we could go no further. The TO had already taken the coolers out to the southern cache when the message about the northern limit reached us, and was on the ground in the process of unloading - and shut down. We could not get hold of them from Alert so the pilots unloaded all, and took off only to circle and land and reload. Two of the helicopters had at that time returned and could help load.

The weather started to move south and the wind picked up, so combined with the forecast we decided to blast as far north as possible on IR1-99. IS6 was the furthest north we got, and all shots IS1-6 went off well. Due to the poor communication we have while out on the ice each blasting team had dedicated shot times; i.e. Team 1 00 and 30 min each hour, team 2 10 and 40min, and team 3, 20 and 50 min. Despite that it costs 30 min sometimes it ensures no shots go at the same time. Several of the shot boxes died of cold; this is a new problem with then that is not known from earlier use. Bob (who did the GPS modifications to them) will hopefully be here Tuesday and call help troubleshoot.

After blasting we stated picking up - IR57 was at this time the furthest north we were able to go due to low clouds and fog.

A few hours after the first load of coolers were back in Alert, Isa had data off 25 of the Taurus instruments and we could see that we have data in hand. Good signal to noise ratio and very clear signals. This called for a small celebration and the Lorita logo T-shirts were broken out of storage.

Trine checked the Frankfield Bay data. It was active until Julian day 310 with good data.

People movement
Ron and Mark(TO aircrew) to Eureka.

Alert Lorita population (including aircrew): 33
Fuel Cache population: 3

Comments
Lessons learned today - Make plans that make the aircraft as independent of each other as possible. The shot boxes must be kept as warm as possible during the day. The black garbage bags with snow are very important during recovery, in particular if we have poor definition. A few coolers were deployed without, and they were hard to see. All found however. A list of locations and cooler number correlation (i.e. IR55 has cooler no. 147) is very important, as the locations move with the drifting ice and it is not obvious which station you have found.

Plans for tomorrow - Monday, April 11, 2006
Monday we will pick up the coolers at IR58-99 so all coolers get back home. Weather permitting - forecast not 100% positive. We will use two helicopters, so Morten/Jon B/Arne can go out.

The teams for the day are:
* Team 1 (Ron and John B); helicopter LIA (the L4) pilot Gerard.
* Team 2 (Søren and Trine); helicopter CWR pilot Colin.
* Team 3 (2? of Morten/John B/Arne); helicopter VYM pilot Bill.

The data team will start the download and backup process from the instruments recovered so far.

Lorita-1 - Daily Report No.12 - April 10, 2006

Weather
-20°C, snow , light wind.

Location of fuel cache camp

What have we done today
Today has been a weather day - no flying.
In the Spinnaker building download and back up of data from the stations brought home is continuing.

People movement
Nil

Alert Lorita population (including aircrew): 33
Fuel Cache population: 3

Comments
Today we had 16 cm of new snow.

The Arctic Games Canada visited - 28 in all came on a Dash 8. They lit the torch to carry around Arctic Canada in preparation for the games in 2007. They arrived Sunday evening and were due to leave Monday 10 evening, but the weather forced them to stay an additional night.

In the Arctic Canada Games group are 10 journalists, and several in the Lorita group have given interviews on the project.

Plans for tomorrow - Tuesday, April 11, 2006
Weather forecast is not good, but if flyable we will pick up the instruments on the ice.

Tuesday we will pick up the coolers at IR58-99 so all coolers get back home. Weather permitting - forecast not 100% positive. We will use two helicopters, so Morten/Jon B/Arne can go out.

The teams for the day are:
* Team 1 (Ron and John B); helicopter LIA (the L4) pilot Gerard.
* Team 2 (Søren and Trine); helicopter CWR pilot Colin.
* Team 3 (2? of Morten/John B/Arne); helicopter VYM pilot Bill.

The data team will continue the download and backup process from the instruments recovered so far.

Lorita-1 - Daily Report No.13 - April 11, 2006

Weather
-10°C, snow, light wind. Clearing in the late afternoon.

Location of fuel cache camp

What have we done today
Today has been a weather day - no flying.

Isa has been working on the data files; we now have segy file but not sorted by offset yet.

John S has developed scripts that predict the current position of each receiver from the satellite trackers. He also calculates the predicted distance and bearing from the last know position as well as from the nearest beacon.

Additional interviews to the journalist at Alert for Canada Winter Games - the group finally got off late morning.
We have taken a Lorita group photo.

People movement
Nil

Alert Lorita population (including aircrew): 33
Fuel Cache population: 3

Comments
In all we got 20 cm of new snow. As the wind has been very light, it is not good for the helicopters with all the very fluffy snow.

Plans for tomorrow - Tuesday, April 11, 2006
Weather update at 7:45. The forecast reasonably good, and weather permitting we will pick up the coolers at IR58-99 so all coolers get back home. One helicopter for the hydrographers.

The teams for the day are:
* Team 1 (Ron and John B); helicopter LIA (the L4) pilot Gerard.
* Team 2 (Søren and Trine); helicopter CWR pilot Colin.
* Team 3 (2? of Morten/John B/Arne); helicopter VYM pilot Bill.

Team 1 starts with IS17, where a cooler was skipped during pickup.

Team 2 goes to IS7 where there is a satellite beacon to pick up the line. John S will provide both teams with predicted positions and further info to help find the coolers; a recovery checklist is prepared and Trine will see to copies are made.

Team 3 will get coordinates from Isa on the positions of the IR locations for gravity and bathymetry recovered so far.

Lorita-1 - Daily Report No.14 - April 12, 2006

Weather
-10°C, snow ,wind up to 20 kt. Clearing in the late afternoon.

Location of fuel cache camp
12 UTC 84.9 N 60.5 W

What have we done today

* Today has been a weather day - no flying.

* We now have real reduced time sections of the data; this helps in planning the next line.

People movement

* Arriving from Resolute Bay by TO: Bob Schieman.

* Leaving Alert by TO: Ken Asmus, Dave Forsyth, Jopee Kiguktak. Jopee will be dropped of at Grise Fiord.

Alert Lorita population (including aircrew): 31
Fuel Cache population: 3

Comments

Today we got the wind. Conditions in the morning at the fuel cache camp were bad; high winds and poor visibility. At 10:00 local they had 24 kt winds and no visibility due to blowing snow. The satellite pictures during the day showed a large low slowly moving west creating winds and cloud cover making it impossible to work. At 17:00 we decided to put any flying off till the morning, even though conditions were improving. Attached to the message was a satellite pictures that showed the low over the area, the channel 2 image also showed the large open water area off Svalbard created by the wind. The NE Greenland Polynia is also clearly visible.

Plans for tomorrow - Tuesday, April 13, 2006

Weather update at 7:45. The forecast is good, and we will pick up the coolers at IR57-99 so all coolers get back home. One helicopter for the hydrographers.

The teams for the day are:

* TO spotters Tim and Peer (ready at 7:45).
* Team 1 (Ron and John B); helicopter LIA (the L4) pilot Gerard. Ready at 8:00.
* Team 2 (Søren and Trine); helicopter CWR pilot Colin. Ready at 8:00.
* Team 3 (2? of Morten/John B/Arne); helicopter VYM pilot Bill.

The will TO start by homing in on the fuel cache, radio the coordinates back so John S can calculate predicted coordinates for the coolers. The will bring a satellite beacon and leave there (Tim!) and new batteries for the homer. They will then search for the cooler line and when found (fingers crossed) radio info back to the helicopters.

Team 1 starts with IS17, where a cooler was skipped during pickup.

Team 2 goes to line with info from the TO. John S will provide both teams with predicted positions and further info to help find the coolers; a recovery checklist is prepared and Trine will see to copies are made.

Team 3 will get coordinates from Isa on the positions of the IR locations for gravity and bathymetry.

Lorita-1 - Daily Report No.15 - April 13, 2006

Weather
-22°C, light wind, sunny. Warmer in the afternoon.

Location of fuel cache camp
12 UTC 84.9 N 60.o W

What have we done today
Picked up coolers IR17, 57, 60, 61, 63-99. Checked shots IS7,8,9,10 and 11 now renamed to OS3,4,5,6,7. Supply flight to Fuel cache camp. Located fuel cache in the northern end of the outer line.

The teams for the day are:
* TO spotters Tim and Peer.
* Team 1 (Ron and John B); helicopter LIA (the L4) pilot Gerard.
* Team 2 (Søren and Trine); helicopter CWR pilot Colin.
* Team 3 (2 of Morten/John B/Arne); helicopter VYM pilot Bill.

The TO left first, went to the fuel cache and radioed back coordinates. They left a satellite tracker and changed batteries on the homer. They then continued along the predicted line and rapidly spotted several coolers. They radioed the locations to team 1 and 2, who rapidly found the line and was from then able to go from location to location on bearing and distance. Coolers on IR57 and 62 were not found despite two searches at each site and must be considered lost. We have had a three day snow & blow, and are pleased we "only" have two instruments still out there. The cooler at IR58 was almost buried, and we think the coolers at IR 58 and 62 are buried. IR17 was easily found, thanks to predicted coordinates John S calculated based on the location of the fuel cache radioed in from the TO.

The TO returned to Alert, went out to the fuel cache camp with supplies and later out again with fuel to search for a fuel cache site close to OS9. They succeeded, which will help us greatly in the coming days.

After leaving coolers at the fuel cache team 2 went north to check the loaded shot sites OS3,4,5,6,7. All were eventually found, although they had to return to the fuel cache camp for updated coordinates. IS 10 and 11 (OS6 and 7) were almost buried but were dug out and remarked.

The hydrographers started out with Arne and Morten, but had to return as Morten's sounds had a problem (which is now solved). Jon B and Arne then continued at measured gravity and bathymetry at 27 sites (every second receiver location from IR1-58). An average site took 12 min. They report that it would not be faster to do only gravity, as they have to dig down to the ice and there is a lot of snow.

People movement
Kelly Bentham by TO from Resolute Bay.

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments

Plans for tomorrow - Friday, April 14, 2006
Weather update at 7:45. The forecast is good, and we will start loading the shots on the northern end of the outer line. The line will be deployed with a spacing of 1.4 km between instruments, and unchanged

distance between shots. The shots OS8, 9 10, 11 will loaded first, as there are explosives in the fuel cache camp already. Shots 7,6,5 and 4 are already ready; left over from the inner line.

The teams for the day are:
* TO John S to Camp to check on the seismic system; otherwise the TO will transport fuel and explosives north on the line.
* Team 1 (Drillers Ron and John B); helicopter CWR pilot Colin. Ready at 8:00.
* Team 2 (Ferry man Christian); helicopter LIA (the L4) pilot Gerard. Ready at 8:00.
* Team 3 (Loaders Tim, Peer and Søren) helicopter VYM pilot Bill. Ready at 8:00.

All three helicopters will rendezvous at the fuel cache camp to refuel, and then start at OS8 and continue north, using a fuel cache established close to or north of OS9.

If there is time after the these 4 shots are loaded, either continue loading on OS1, 2 and 3 which currently has one string loaded and need another loaded. Decision on which option to be relayed from Dave M during the day.

All movements and actions are reported back to Dave M. through the pilots.

Lorita-1 - Daily Report No.16 - April 14, 2006

Weather (6 a.m.)
-26.9°C, light wind, sunny. Warmer in the afternoon.

Location of fuel cache camp
12 UTC 84.9 N 59.9 W

What have we done today
Loaded OS1, drilled OS2. Established FM relay station on the top of "Merv's Peak".

The teams for today are:
* Team 1 (Drillers Ron and John B); helicopter CWR pilot Colin.
* Team 2 (Ferry man Christian); helicopter LIA (the L4) pilot Gerard.
* Team 3 (Loaders Tim, Peer and Søren) helicopter VYM pilot Bill.

We changed the plan in the morning, as a large cloud system was moving in over the northern end of the outer line. Instead we went out to load OS1,2 and add an extra hole with 175 kg at OS3 (leftover IS7).

The TO made two flights to the southern fuel cache with explosives and fuel.

OS 1 was drilled and loaded, and OS 2 drilled, but had to be abandoned as fog and low cloud moved in over the area and made further work impossible. The helicopters returned to Alert, and waited to see if this fairly small area of low clouds would move off. It did not, instead changed direction to move along the line.

All explosives needed for the outer line are out in the southern fuel cache and at the fuel cache camp.

That freed helicopter time to establish a FM repeater station on top of a near by mountain, used before for the same purpose. Ron, Leslie, Doug and photographer Kelly did the work; attached to the original message

was one of Kelly's pictures. This should improve our communication vastly with the helicopters. Unfortunately the TO cannot communicate on these FM frequencies.

In the Spinnaker building sections for the whole inner line are now ready, and coolers ready to be deployed tomorrow.

People movement
Nil

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments

Plans for tomorrow - Saturday, April 15, 2006
The forecast is good, but not crystal clear. So we have two options, to be decided in the morning.
Option 1: We will start loading the shots on the northern end of the outer line. The line will be deployed with a spacing of 1.4 km between instruments, and unchanged distance between shots. The shots OS8, 9 10, 11 will loaded first, as there are explosives in the fuel cache camp already. Shots 7,6,5 and 4 are already ready; left over from the inner line. If time permits, start deploying coolers from the north.

Option 2: We will continue in the southern end of the line with OS 2 and the upgrade of OS3. Then start deploying coolers at 1.4 km interval.

In both cases the teams need equipment both for drilling/ferrying/loading and for deployment. The loading team brings the satellite beacons and leaves them at the shot site. There are deployment/recovery sheets available for book keeping. John S had the excellent idea of writing the station no. (for example OR112) on the duck tape on the coolers when deployed to ensure the recovery team knows which station they are at if they do not have the cooler no. So bring a black marker and do so please.

The teams for the day are:
* TO John S to camp to check on the seismic system and relieve Mike for a day or so; otherwise the TO will transport fuel north on the line.
* Team 1 (Drillers Ron and John B); helicopter CWR pilot Colin.
* Team 2 (Ferry man Søren); helicopter LIA (the L4) pilot Gerard.
* Team 3 (Loaders Tim, Peer and Doug) helicopter VYM pilot Bill.

All teams to be ready shortly after the morning meeting. First "taxi ride" is priority pilots.

All movements and actions are reported back to Dave M. through the pilots.

Lorita-1 - Daily Report No.17 - April 15, 2006

Weather (6 a.m.)
-24°C, calm, overcast morning, later sunny.

Location of fuel cache camp
12 UTC 84.9 N 59.9 W

What have we done today
Loaded OS2 and 3, deployed OR75-126; 160-177. Replaced Mike from the fuel cache camp for a day.

The teams for today are:
* Team 1 (Drillers Ron and John B); helicopter CWR pilot Colin.
* Team 2 (Ferry man Søren); helicopter LIA (the L4) pilot Gerard.
* Team 3 (Loaders Tim, Peer and Doug) helicopter VYM pilot Bill.

The departure was delayed until 11:30 due to cloud cover and fog over the southern part of the outer line - the northern end was covered by low clouds.
The TO went to the fuel cache camp with 24 coolers which were left the southern fuel cache, camp supplies, fuel and John S and Trine. John S stayed in camp for the night, allowing Mike to go back into Alert. Trine was there between TO flights. The TO was back late afternoon with 60 coolers for deployment.

Team 1 went straight for OS 3 leaving it to Team 3 to re-drill the holes at OS 2 from yesterday. OS 2 was loaded; OS3 had an extra string added so it became a 350 kg hole.
Then Team 1 and 2 each picked up a load of coolers and deployed then OR 75-98.

Team 3 went to the fuel cache camp and waited for the TO with coolers. The three teams then deployed a load of coolers each and returned late to Alert (last in around 23:00).

John S had a look at the seismic acquisition at the fuel cache camp - all running well. The airgun freezes up now and then and is replaced and thawed out.

People movement
John S. to fuel cache camp to Alert. Mike from Alert to fuel cache camp.

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments

Plans for tomorrow - Sunday, April 16, 2006
Weather and plan update at morning meeting at 10:00. Ready time will be given at the meeting at 10:00.

The teams for today are:
* Team 1 (Drillers Ron and John B); helicopter CWR pilot Colin.
* Team 2 (Ferry man Christian and Søren on the trip out from Alert and for deployment); helicopter LIA (the L4) pilot Gerard.
* Team 3 (Loaders Tim, Peer and Søren during loading) helicopter VYM pilot Bill.

First "taxi ride" is priority pilots.

TO will go to the northern fuel cache with fuel in the morning, back to camp to pick up 60 charges for OS 9,10,11 and leave them at the northern fuel cache. Back to Alert to pick up and remaining coolers, Mike and Morten plus his echo sounder to camp, then more fuel north. John S and Greg will return on the TO, leaving Morten at camp to relieve Greg.

Helicopters:
* First job is to drill and load OS 8,9,10,11, then if time deploy coolers.

Team 1 goes to OS 8 to drill, then on to 9,10,11. They will finish first and should take 12 coolers and seismometers from camp and deploy them at OR137-148. Then back to camp, load 12 coolers and wait for the other two teams before heading out to deploy.

Team 2 takes Søren and a maximum of 10 coolers (7 available Saturday evening, hopefully 3 more before departure) and deploy them at OR 127-136. Then continue to camp; Søren rejoins Team 3 here; to pick up explosives, etc. for OS 8 and then continue ferrying explosives to 9,10,11. After this to camp to load 15 coolers and wait for the two other teams before heading out to deploy. Søren joins Team 2 again here.

Team 3 goes by the southern fuel cache to pick up the satellite tracker left there and then on to OS8 to load, then on to OS 9,10,11. Then back to camp, load 12 coolers and wait for the other two teams before heading out to deploy. Søren leaves Team 3 here. Brings a shot box just in case there is time to get 1 or 2 of the northernmost shots of.

Please relay plan made at the deployment "pow wow" at camp to Dave M.

The remaining coolers should all be ready to go out at noon, if possible 10 from the morning. 7 are already ready to go.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Deployed Saturday: 70 coolers (IR 75-126; 160-177).
* In camp: 14
* On LIA in the morning: (7) -10
* On TO at noon: (58) - 53

Lorita-1 - Daily Report No.18 - April 16, 2006

Weather (6 a.m.)
-27°C , calm, overcast morning, evening sunny.

Location of fuel cache camp
12 UTC 84.9 N 59.8 W

What have we done today
The TO took a load of fuel to the northern fuel cache, then fetched explosives etc. for OS 9 ,10 11 from fuel cache camp to northern fuel cache and a load of fuel to northern fuel cache from fuel cache camp.

The helicopters did not fly today due to low cloud over most of the outer line.

People movement
Nil

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments
The weather forecasts and analysis tell us the weather is good with a high pressure ridge, but reality as seen locally a Alert and fuel cache camp and on satellite images show a lot of cloud cover. Jim M calls is a "dirty high".

Plans for tomorrow - Monday, April 17, 2006
Weather and plan update at morning meeting at 7:45. Ready time if weather OK at 8:00. First "taxi ride" is priority pilots.

The days job is to drill and load OS8,9,10,11 and then deploy coolers. Northernmost position is OR221.

First TO trip will be to the northern cache with fuel and will bring Mike and Morten to camp. Greg and John S will come back to Alert. Mike to bring a shot box to camp and keep it warm for the day in case it is needed.

Second TO trip with 24 coolers to go to camp and 39 to the northern fuel cache. Ruth and Thomas to go to relieve John B and Ron for deployment. The TO will wait for the helicopters before returning to Alert. Ron and John and the drilling equipment goes back to Alert with the TO.

Third TO trip with fuel to camp or northern cache as needed.

For the drilling:
* Team 1 (Drillers Ron and John B); helicopter CWR pilot Colin.
* Team 2 (Ferry man Christian); helicopter LIA (the L4) pilot Gerard.
* Team 3 (Loaders Tim, Peer and Søren) helicopter VYM pilot Bill.

Helicopters:
* First job is to drill and load OS 8,9,10,11

Team 1 goes camp to pickup drilling equipment left there Saturday and then to OS 8 to drill, then on to 9,10,11. When finished to northern fuel cache load 12 coolers and wait for the other two teams.

Team 2 to camp to pick up explosives, etc. for OS 8 and then continue ferrying explosives to 9,10,11 which are at the northern fuel cache. After this to northern fuel cache to load 15 coolers and wait for the two other teams.

Team 3 goes by the southern fuel cache to pick up the satellite tracker left there and then on to OS8 to load, then on to OS 9,10,11. When finished to northern fuel cache load 12 coolers and wait for the other two teams.

For deployment:
* Team 1 (Ruth and Søren); helicopter CWR pilot Colin.
* Team 2 (Christian and Peer); helicopter LIA (the L4) pilot Gerard.
* Team 3 (Tim and Thomas) helicopter VYM pilot Bill.

After meeting at the northern fuel cache:
* Team 1 deploys from OR194-183 (12 coolers).
* Team 2 deploys from OR221-207 (15 coolers).
* Team 3 from OR206-195 (12 coolers).

Then to camp to pick up coolers and wait for each other to confirm plans.
* Team 1 deploys from OR138-127 (12 coolers).
* Team 2 deploys from OR151-159 and OR178-183 (14 coolers) and brings shot box just in case (and to bring home).
* Team 3 deploys OR150-139 (12 coolers).

If time, Team 2 has time when all is deployed blast with priority OS11 and 10.

Please relay plan made at the deployment "pow wow's" at to Dave M.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Deployed Saturday: 70 coolers (IR 75-126; 160-177).
* In camp: 14
* On second TO trip : 39 for northern cache + 24 for camp.

Lorita-1 - Daily Report No.19 - April 17, 2006
Weather (6 a.m.)
-31°C, calm, fog clearing late afternoon.

Location of fuel cache camp
12 UTC 84.9 N 59.9 W

What have we done today
The TO took a load of fuel to the northern fuel cache, then another load split between the fuel cache camp and the northern fuel cache. Just as valuable, the TO pilots reported weather conditions along the route to our current working are (map was attached to original message). At 13:00 the report seemed to improve and the helicopters took off at 14:00, only to return 110 nm out due to increasing fog and bad flying conditions.

People movement
Nil

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments
We got several visual weather reports today; another project flew to the Russian camp near the pole and back and reported on weather for us, as did the TO on both flights today.

The fog prevented us from working on the seismic line, but created clear sundogs (picture was attached to original message).

The Wildlife Survey Group here reported a sighting of a newborn musk ox today; so spring is arriving.

Plans for tomorrow - Tuesday, April 18, 2006
Weather and plan update at morning meeting at 7:45. Ready time if weather OK at 8:00. First "taxi ride" is priority pilots.

The days job is to drill and load OS8,9,10,11 and then deploy coolers. Northernmost position is OR221.

TO trip with 10 coolers to go to camp (14 already there from Saturday) and 53 to the northern fuel cache. Ruth and Thomas to go to relieve John B and Ron for deployment. The TO will wait for the helicopters before returning to Alert. Ron and John and the drilling equipment goes back to Alert with the TO. At the end of the day the helicopters may stay at camp, in which case the TO will pick all non-camp people up and take back to Alert.

For the drilling:
* Team 1 (Drillers Ron and John B); helicopter CWR pilot Colin.
* Team 2 (Ferry man Christian); helicopter LIA (the L4) pilot Gerard.
* Team 3 (Loaders Tim, Peer and Søren) helicopter VYM pilot Bill.

Helicopters:
* First job is to drill and load OS 8,9,10,11.

Team 1 goes camp to pickup drilling equipment left there Saturday and then to OS 8 to drill, then on to 9,10,11. When finished to northern fuel cache load 12 coolers and wait for the other two teams.
Team 2 to Camp to pick up explosives, etc. for OS 8 and then continue ferrying explosives (from the northern fuel cache) to 9,10,11. After this to northern fuel cache to load 15 coolers and wait for the two other teams.

Team 3 goes by the southern fuel cache to pick up the satellite tracker left there and then on to OS8 to load, then on to OS 9,10,11. When finished to northern fuel cache load 12 coolers and wait for the other two teams.

For deployment:
* Team 1 (Ruth and Søren); helicopter CWR pilot Colin.
* Team 2 (Christian and Peer); helicopter LIA (the L4) pilot Gerard.
* Team 3 (Tim and Thomas) helicopter VYM pilot Bill.

After meeting at the northern fuel cache:
* Team 1 deploys from OR194-183 (12 coolers).
* Team 2 deploys from OR221-207 (15 coolers).
* Team 3 from OR206-195 (12 coolers).

Team 2 returns to northern fuel cache and picks up coolers and deploys from OR151-159 and OR178-182 (14 coolers).

Team 1 and 3 to camp to pick up coolers and wait for each other to confirm plans.

Team 1 deploys from OR138-127 (12 coolers).

Team 3 deploys OR150-139 (12 coolers). Team 2 and brings shot box from camp just in case (and to bring home).

If time, Team 2 has time when all is deployed blast with priority OS11 and 10.

Please relay plan made at the deployment "pow wow's" at to Dave M.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Deployed Saturday: 70 coolers (IR 75-126; 160-177).
* In camp: 14
* On second TO trip : 53 for northern cache + 10 for camp

Messages:
We currently only have one truck running, and only Jim allowed to drive. Please try to stick to mealtime transports as much as possible (walking is an option).

Lorita-1 - Daily Report No.20 - April 18, 2006

Weather (6 a.m.)
-31°C , light wind, sunny.

Location of fuel cache camp

What have we done today
Deployed coolers OR127-159 and 178-184. Blasted OS5, OS9 (moved to the northern fuel cache) and OS10.

For deployment:
* Team 1 (Thomas and John B); helicopter CWR pilot Colin.
* Team 2 (Christian and Jørgen); helicopter LIA (the L4) pilot Gerard.
* Team 3 (Ruth and Søren) helicopter VYM pilot Bill.

For blasting:
* On TO Tim and Peer and Ron.
* Team 3 Ruth and Søren, helicopter VYM pilot Bill.

The day did not get underway until 12:30 as the weather was bad on the northern end of the line with low clouds and fog over the line. It cleared somewhat and the helicopters left for camp, the TO following shortly after with coolers, Thomas and Ruth. The teams deployed coolers in the gap OR127-159 and further north from OR178-184 were weather prohibited the helicopters from going further.

The TO then picked up Tim and Peer and drilling equipment and went to the northern fuel cache (just south of OS9) drilled and loaded. They then continued north and found a landing strip close to OS10, drilled, loaded and blasted (21:00). Then back to OS 9 and blast (21:50). At this time the weather at camp was so the TO could not land, so they fuelled plenty for safety but were able to land at camp to bring all home. The

helicopters stayed at camp as there was fog around Alert requiring a long detour. The southern fuel cache was probably also in fog.

CWR and LIA went to Camp to wait.

Team 1 on VYM went to OS5 and blasted (20:40). They then proceeded to OS6 but were unable to find it due to bad visibility. They went to camp.

All home on the TO at 19/4 00:40.

People movement
Nil

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments
John S has been out in the fuel cache camp to check out the "drift seismic". It has been in operation for 11 days and has covered a distance of 30 km total on a quite round about route (map was attached to original message). Greg set everything up and it has run with very few glitches since. The air gun freezes up every now and again and is replaced and thawed out. The compressor and generator are placed on a high tech foam that decouples them from the ice - John S reports that he could not see the vibrations in the records. The data itself looks fine, although the plotter only plots the first 0.5 sec of data there is geology there. The ice produces a reverberation at approx 15 Hz which we estimate can be processed out.

Plans for tomorrow - Wednesday, April 19, 2006
Weather and plan update at morning meeting at 10:00.

The days job is to drill and load OS8, and shoot OS 1,2,3,4,6 and 7. Then start pick up.

All helicopters are in camp. To go to camp by TO Gerard, Bill, Colin and items for the helicopters. Also the teams: Tim, Peer, Søren, John, Trine and John S. This might mean two trips. First priority is pilots and helicopter items, then John, Tim and Peer, then the remaining passengers.

The teams for the day are:
* Team 1 (John B and Tim); helicopter CWR pilot Colin. Blast at 20 and 50.
* Team 2 (Peer and John S); helicopter LIA (the L4) pilot Gerard. Blast at 00 and 30.
* Team 3 (Søren and Trine) helicopter VYM pilot Bill. Blast at 10 and 40.

If weather is really good, deploy 37 coolers from 185-221 and then if weather decent:
* Team 1 goes to OS8 and drills and waits for Team 2.
* Team 2 (John S stays in camp) picks up explosives form camp and goes to OS 8 to load and blast. Then back to camp.

Team 1 goes to OS6 to blast, then to OS 4. Team 2 goes to OS7 to blast. Team 3 goes from camp to OS1 and blasts, then to OS 2 and 3.

When all blasting done:

* Team 1 picks up OR154-143 and OR142-131(if possible take 13 each time and end at 129), leave coolers at camp.
* Team 2 picks up OR184-170 and OR169-155, leave coolers at camp.
* Team 3 picks up OR75-86 and OR87-98, leave coolers and southern cache.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Deployed Tuesday: 110 coolers (IR 75-184).
* In camp: 37

Lorita-1 - Daily Report No.21 - April 19, 2006

Weather (6 a.m.)
-24°C, overcast, fog.

Location of fuel cache camp

What have we done today
No flying today; cap was in zero visibility all day; Alert in low cloud and fog offshore.

Dave S has made an overview of "age" of the coolers; how long time since they were started, and how long they have been out in the cold. As we have 6 of the "oldest" generation in camp - in the cold - we can use this information to see if the batteries are still alive tomorrow so we can blast if possible.

People movement
Nil
Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments
Plans for tomorrow - Thursday, April 20, 2006
Weather and plan update at morning meeting at 7:45.

The days job is check the status of a number of coolers which have been out in the cold but are still at camp; if OK then to drill and load OS8 (possibly by TO), and shoot OS 1,2,3,4,6 and 7. Then start pick up. Weather permitting of course.

All helicopters are in camp.

To go to camp by TO: 2 helicopter engineers, 1 pilot and items for the helicopters. Also Isa to check on the coolers, Tim, John B, Søren and Kelly. Second flight remaining of the teams: Peer, Trine and Christian.

First is to check the status of coolers 115, 120,123,134,135 and 137 which should all be in camp. They were taped April 14 and went out to amp April 15. If three of the six are OK we will proceed shooting.

The teams for the day are:
* Team 1 (John B and Tim); helicopter CWR pilot Colin. Blast at 00 and 30.

* Team 2 (Peer and Christian); helicopter LIA (the L4) pilot Gerard. Blast at 20 and 50.
* Team 3 (Søren and Trine) helicopter VYM pilot Bill. Blast at 10 and 40.

If weather decent: Team 1 goes to OS8, drills and waits for Team 2. Team 2 (John S stays in camp) picks up explosives form camp and goes to OS 8 to load and blast. This could also be done by TO if weather is not great. Then back to Camp and Team 1 goes to OS6 to blast, then to OS 4. Team 2 goes to OS7 to blast, then to OR184 to wait for pickup time. Team 3 goes from camp to OS1 and blasts, then to OS 2 and 3.

When all blasting done:
* Team 1 picks up OR111-122 and OR123-134 and OR148-154, leave coolers at camp.
* Team 2 picks up OR184-170 and OR169-155, and OR135-147 leave coolers at camp.
* Team 3 picks up OR75-86 and OR87-98 and OR99-110 leave coolers at southern cache.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Deployed Tuesday: 110 coolers (OR 75-182).
* In camp: 39

Lorita-1 - Daily Report No.22 - April 20, 2006

Weather (6 a.m.)
-19°C, overcast, fog, clearing in the evening.

Location of fuel cache camp
84.9N 60.5W

What have we done today
No flying today; camp was good in the morning, but bad in the late afternoon. Alert in low visibility and fog all day, clearing n the evening.

People movement
Nil

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments
Included in (only original message) today's report two PowerPoint files with two different satellite channels - both infrared. In the last images the ice starts to show as the clouds clear. Channel 3 show the low clouds and fog in dark. The red crosses show the originally planned lines. There is a large area of low clouds over most of the area, slowly clearing from east. Note also the fog patch over Alert (marked wit a white dot).

Plans for tomorrow - Friday, April 21, 2006
Weather and plan update at morning meeting at 7:45. If OK we will attempt to leave early so be ready at 8:00.

The days job is check the status of a number of coolers which have been out in the cold but are still at camp; if OK then to drill and load OS8 (possibly by TO), and shoot OS 1,2,3,4,6 and 7. Then start pick up. Weather permitting of course.

All helicopters are in camp:
To go to camp by TO: 2 helicopter engineers, 3 pilot and items for the helicopters. Isa to check on the coolers, and the teams Tim, Søren, Peer, John B, Trine and Christian.

Second TO flight with fuel, Kelly, Søren R and Martin and their equipment for CTD and ice coring.

Third TO flight as needed.

First is to check the status of coolers 115, 120,123,134,135 and 137 which should all be in camp. They were taped April 14 and went out to camp April 15. If three of the six are OK we will proceed shooting.

The teams for the day are:
* Team 1 (John B and Tim); helicopter CWR pilot Colin. Blast at 00 and 30.
* Team 2 (Peer and Christian); helicopter LIA (the L4) pilot Gerard. Blast at 20 and 50.
* Team 3 (Søren and Trine) helicopter VYM pilot Bill. Blast at 10 and 40.

If weather decent:
* Team 1 goes to OS8, drills and waits for Team 2.
* Team 2 (John S stays in camp) picks up explosives form camp and goes to OS 8 to load and blast. This could also be done by TO if weather is not great. Then back to Camp and
* Team 1 goes to OS6 to blast, then to OS 4.
* Team 2 goes to OS7 to blast, then to OR184 to wait for pickup time.
* Team 3 goes from camp to OS1 and blasts, then to OS 2 and 3.

When all blasting done:
* Team 1 picks up OR111-122 and OR123-134 and OR148-154, leave coolers at camp.
* Team 2 picks up OR184-170 and OR169-155, and OR135-147 leave coolers at camp.
* Team 3 picks up OR75-86 and OR87-98 and OR99-110 leave coolers at southern cache.

All movements and actions are reported back to Dave M. through the pilots.
Cooler budget:
* Deployed Tuesday: 110 coolers (OR 75-182).
* In camp: 39

Lorita-1 - Daily Report No.23 - April 21, 2006

Weather (6 a.m.)
-19°C, sunny.

Location of fuel cache camp
84.9N 60.5W

What have we done today
Blasted OS1,2,3,4,6,7, loaded and blasted OS8. Picked up OR75-177.

Team 1 (John B and Tim); helicopter CWR pilot Colin. Blast at 00 and 30.
Team 2 (Peer and Christian); helicopter LIA (the L4) pilot Gerard. Blast at 20 and 50.
Team 3 (Søren and Trine) helicopter VYM pilot Bill. Blast at 10 and 40.

The weather this morning was fine, so all got off to an early start (8:30)despite a plane crash exercise the station did at 6:30. A very full TO with 12 passengers (3 helicopter pilots, 2 engineers, Isa and the teams) got off to the fuel cache camp, where we rapidly found that all the 6 coolers that had been out in the cold with the coolers on line all were still active. Thus decision to go ahead and blast.

Team 1 and 2 joined forces and went to drill, load and blast OS8 at a location 14 nm north of OS7. Team 2 then went to OS 7 to blast, while Team 1 went to OS6 and then OS4. Team 3 went to OS3, the 2 and 1.

At 15:5 the last blast was completed and we started recovery. Team 2 went to OR182 but searched in vain for the 5 northernmost location; they were deployed together separate from OR177 and south. After refuelling, Team 1 picked up the line at OR177 and recovered south. Team 2 continued further south while Team 3 went to the southernmost location (OR75) and recovered north. All cooler except OR178-182 were recovered. The satellite tracker at OS7 was left in place to aid in finding the missing coolers.

LIA was left at the fuel cache camp and Team 2 and the pilot returned to Alert by TO. CWY and VYM returned to Alert.

Søren Rysgaard and Martin Blicher was on the second flight to the camp and spent the day doing a deep CTD (to bottom), taking water samples down through the water column and drilling ice cores in several different floes.

Kelly was in camp all day taking pictures and filming.

The TO went to camp 3 times today; third time to bring people back. All back between 22:30 and 00:00.

People movement
Nil

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3
Comments

Plans for tomorrow - Saturday, April 22, 2006
Weather and plan update at morning meeting at 8:30.

We will start late due to late return to Alert Friday. CWY and VYM will work with the B&G team. Team 1 (Morten and Arne) will leave first to do the data points on the northern part at the inner line, while Jon B and John S will leave later with new locations from the outer line.

The TO will go to camp with Gerard and Dave S so LIA can search for the OR178-182. Before departure, John S, Christian (who searched Friday) and Dave S (who will search today) will talk though available information. Dave S will also bring back satellite tracker at OS7 left there to aid in finding OR178-182.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182).
* In camp: 1??
* In Spinnaker: 139 (+2?)

We have three coolers unaccounted for at present. One is thought to be in camp; it was one of the 6 test coolers in camp this morning. Two additional coolers were not ticked off as returned to Spinnaker but both noted as recovered by the team. A check will be done tomorrow morning and camp asked to check for the one thought to be there.

Lorita-1 - Daily Report No.24 - April 22, 2006

Weather (Alert 6 a.m.)
-22°C, sunny.

Location of fuel cache camp
85.0N 62.1W

What have we done today
No flying today. Bad visibility and low clouds have covered the area north of IS6, thus the entire area the B&G people have not yet covered. The fuel cache camp have had decreasing weather all day; at 17:00 20-25 kt, snow and -6C. Very warm weather.

Data download is complete, and sections for the outer line are now printed. The quality of the data is fine.

The coolers are being prepared for the next deployment; the icepacks have been thawed out and warmed and new batteries fitted.

People movement
Nil

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments
We have decided to shut down the "drift seismics" at camp. Mike and Greg will start packing down and as soon as weather allows we will start pulling the seismic equipment out and shuttling explosives out to store in camp.

Plans for tomorrow - Sunday, April 23, 2006
Weather and plan update at morning meeting at 7:45.

CWY and VYM will work with the B&G team. The two teams will be Morten and Arne and Jon B and John S.

The TO will go to camp with Gerard and Dave S so LIA can search for the OR178-182. Dave S will also

bring back satellite tracker at OS7 left there to aid in finding OR178-182. The TO will start pulling the seismic equipment out from the fuel cache camp and ferrying explosives to the fuel cache camp.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182).
* In camp: 0
* In Spinnaker: 142

The thee coolers unaccounted for yesterday are all located (in the Spinnaker building).

Lorita-1 - Daily Report No.25 - April 23, 2006

Weather (Alert 6 a.m.)
-12°C, snow.

Location of fuel cache camp
85.0N 63.0W

What have we done today
No helicopter flying today.

The TO has made two trips to the fuel cache camp to fetch out the drift seismic equipment and to ferry explosives out.

People movement
Nil

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments
Attached to the original message were two maps of the recorded shots and receivers. Not all receivers active at the same time; black for the inner line shots (IS1,2,3,4,5,6) white OS5,9,10 and red for OS1,2,3,4,6,7,8. One shows bathymetry (IBCAO) the other the DMI quicklook NOAA image from the day shots OS1,2,3,4,6,7,8 (on red receivers) were recorded. The outer receivers were on the white position on April 19, and had drifted to the red positions on April 21. The shear zone in the ice has seen to a differential movement of the receiver line during the 2 days, approximately 16 km in the northern part of the outer line.
Plans for tomorrow - Monday, April 24, 2006
Weather and plan update at morning meeting at 7:45. Weather permitting the B&G team will work with 2 helicopters.

CWY and VYM will work with the B&G team. The two teams will be Morten & Arne and Jon B & John S.

The TO will go to Camp with Gerard and Dave S so LIA can search for the OR178-182. Dave S will also bring back satellite tracker at OS7 left there to aid in finding OR178-182. The TO will continue pulling the seismic equipment out from the fuel cache camp and ferrying explosives to the Fuel cache camp. The TO

will also look for fuel cache sites along the cross line

Cooler budget:
* Still deployed: 5 coolers (OR 178-182).
* In camp: 0
* In Spinnaker: 142

Lorita-1 - Daily Report No.26 - April 24, 2006

Weather (Alert 6 a.m.)
-19°C, sunny in the morning, later snow.

Location of fuel cache camp

What have we done today
No helicopter flying to day due to weather.

The TO has made two trips today: the fuel cache camp is now empty of seismic equipment as are the tents used for the seismic. The northern fuel cache is emptied and a new landing strip found close to XS3 on the cross line. Six drums of fuel and a load of explosives are now left there (and a sat tracker).

People movement
Nil

Alert Lorita population (including aircrew): 32
Fuel Cache population: 3

Comments

Plans for tomorrow - Tuesday, April 25, 2006
Weather and plan update at morning meeting at 7:45. Weather permitting the B&G team will work with 2 helicopters.

CWY and VYM will work with the B&G team. The two teams will be Morten and Arne and Jon B and John S.

The TO will go to camp with Gerard and Dave S so LIA can search for the OR178-182. Dave S will also bring back satellite trackers left out there to aid in finding OR178-182. The TO will continue ferrying explosives to the caches.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182)
* In camp: 0
* In Spinnaker: 142

Lorita-1 - Daily Report No.27 - April 25, 2006

Weather (Alert 6 a.m.)
-22°C, snow.

Location of fuel cache camp

What have we done today
No helicopter flying to day due to weather.

We now have explosives and fuel in place in the fuel caches to start the cross line when weather permits.

The TO went to Eureka today to do a crew change for both TO and helicopter crews, and is staying overnight.

People movement
By TO to Eureka (and on to Resolute): TO crew (Jim Haffey, Gabriel, Kevin) helicopter crew (Bill, Gerard, Colin, Mark, Jason) Dave S. and Kelly.

Alert Lorita population (including aircrew): 22
Fuel Cache population: 3

Comments
BoxTop started yesterday, and the 11th Herc flight from Thule overshot the runway on landing just before 10 a.m. The TO was allowed to take off until approximately 1½ hour later, but the airfield was then closed until 22:00. The Herc was dug free and pulled back on to the runway at 18:00. The TO was not able to return to Alert today as the airfield was closed.

Plans for tomorrow - Wednesday, April 26, 2006
Weather and plan update at morning meeting at 7:45.

The TO from Eureka with the new aircrew will not arrive until approximately 10 a.m.

Following that.

If we have a short weather window the B&G teams will go out. If we have a outlook to a couple of days of decent weather we will start the cross line.

The TO will go to camp with new pilot and John Shimeld so LIA can search for the OR178-182. John S will also bring back satellite trackers (at OS5,6,7) left out there to aid in finding OR178-182.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182)
* In camp: 0
* In Spinnaker: 142

Lorita-1 - Daily Report No.28 - April 26, 2006

Weather (Alert 6 a.m.)

-13°C, snow, low cloud, wind 13 km/h.

Location of fuel cache camp
84.9N 64.4W

What have we done today
No flying to day due to weather.

The TO was not able to return from Eureka today with the crew change due to poor weather at Alert.

People movement
Nil

Alert Lorita population (including aircrew): 22
Fuel Cache population: 3

Comments

Plans for tomorrow - Thursday, April 27, 2006
Weather and plan update at morning meeting at 7:45.

The TO from Eureka with the new aircrew will not arrive until earliest 10 a.m.

Following that:

If we have a short weather window the B&G teams will go out. If we have a outlook to a couple of days of decent weather we will start the cross line

The TO will go to camp with new pilot and John Shimeld so LIA can search for the OR178-182. John S will also bring back satellite trackers (at OS5,6,7) left out there to aid in finding OR178-182.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182)
* In camp: 0
* In Spinnaker: 142

Lorita-1 - Daily Report No.29 - April 27, 2006

Weather (Alert 6 a.m.)
-8°C, freezing drizzle, visibility 0.8 nm, wind 9 kn NNW, clearing at noon.

Location of fuel cache camp
84.9N 65.3W

What have we done today
No helicopter flying today due to poor weather.

The TO has returned to Alert from Eureka with the new aircrew.

The Greenlandair TO arrived, picked up Søren R, Martin and Christian and returned after 45 min to Greenland.

People movement
By TO to Greenland: Søren Rysgaard, Martin Blicher, Christian Marcussen.

By TO to Alert: Steve King, Rory McNicols, Brad Belan, Gerry Nutall, John Innes, James Barry, Keith Bauld.

Alert Lorita population (including aircrew): 26
Fuel Cache population: 3

Comments

Plans for tomorrow - Friday, 28 April, 2006
Weather and plan update at morning meeting at 7:45.

Jørgen, Mike and Greg will be pulled out of the Fuel cache camp as soon as weather allows.

The TO will go the camp with a helicopter pilot (who flies the L4?) and John S to search with LIA for the five coolers still deployed (OR178-182) and the three satellite trackers (at OS5,6,7) still out there. Peer, Tim, Søren, and John B. will also go to detonate all explosives at camp, including the 39 charges currently at Alert.

The 60 charges at the XR fuel cache act as a fall back cache for 6 single hole charges should the weather shift and the weather allow shooting the cross line.

CWY and VYM will work with the B&G team. The two teams will be Morten and Arne and Jon B and Thomas.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182)
* In camp: 0
* In Spinnaker: 142

Explosives budget:
* Alert: 39 charges
* Camp: 150 charges
* XS eastern cache: 60 charges

Lorita-1 - Daily Report No.30 - April 28, 2006

Weather (Alert 6 a.m.)

Location of fuel cache camp

84.9N 66.7W

What have we done today
TO flight to fuel cache camp with Søren, Tim, John S, John I (helicopter pilot). Tim and Søren blasted 55 charges; it was difficult to move the charges around on the ice due as the contrast was very bad. Two skidoos were damaged. John I and John S went out with LIA and picked the satellite trackers at OS5 and 6. They also found the tracker at OS7, but had to turn back due to low visibility and no contrast before finding any of the coolers. The tracker at OS 7 was left in place so we can try again.

People movement
Jørgen Skafte, Greg Middleton, Mike Gorveatt from fuel cache camp to Alert.

Alert Lorita population (including aircrew): 29
Fuel Cache population: 0

Comments
The weather window today was quite small, and got smaller during the afternoon. It was not possible to fly the L4 helicopter home from camp, so it is still sitting out there.

Plans for tomorrow - Saturday, April 29, 2006
Weather and plan update at morning meeting at 7:45.

The TO will go the camp with Jørgen and Doug to pack up camp; John I and Peer to search with LIA for the five coolers still deployed (OR178-182) and the satellite tracker at OS7 still out there.

Tim and Søren will also go to detonate all explosives at camp, including the 39 charges currently at Alert. Before LIA leaves camp they should sling the explosives to a suitable place for blasting close to camp.

If possible the TO will home several loads during the day.

The 60 charges at the XR fuel cache act as a fall back cache for 6 single hole charges should the weather shift and allow shooting the cross line.

CWY and VYM will work with the B&G team. The two teams will be Morten and Arne and Jon B and Thomas.

To go to Resolute Bay and on home tomorrow: Isa, John S, Mike, Greg, John B, Ron.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182)
* In camp: 0
* In Spinnaker: 142

Explosives budget:
* Alert: 39 charges
* Camp: 95 charges

* XS eastern cache: 60 charges

All movements and actions are reported back to Dave M. through the pilots.

Lorita-1 - Daily Report No.31 - April 29, 2006

Weather (Alert 6 a.m.)
-13°C, sunny, light wind.

Location of fuel cache camp
Unpopulated

What have we done today
The TO pilots did another crew change (Steve and Rory were a short time fill in crew) and took 6 people from the Lorita group out through Eureka. The TO was back at 15:00 with the new TO pilots Paul Rask and Trevise Goetzinger.

Early afternoon the weather started to clear in the southern part of the NS line, and Jim in CWR went with Morten and Arne to acquire bathymetry and gravity. They acquired stations OR58-81 and shot points IS4, OS1,2. They also took a measurement at the southern fuel cache (83 24.86N -56 56.83W) and were back at 21:45. Two sites were in open water, but on the return flight it was possible to find a landing site. At one site it was not possible to get a signal through the ice.

After lunch Gerry in VYM took Jørgen and Trine went to Frankfield Bay to collect data from the earthquake site acquired during Lorita blasts and service the station for the coming year. It turned out that a board fault (the probable cause) in the data logger had prevented more than one RAM dump, meaning no data was recorded during Lorita.

Following this VYM took the blasters Søren, Tim and Peer went out some miles from Alert with the 39 charges in store at Alert and detonated them.

People movement
Greg Middleton, Mike Gorveatt, Ron Verral, John Boserup, Isa Asudeh, John Shimeld by TO to Eureka and on to Resolute Bay to go home.

Steve King and Rory McNicols from Alert to Resolute.

Paul Rask and Trevise Goetzinger from Resolute to Alert.

Alert Lorita population (including aircrew): 23
Fuel Cache population: 0

Comments
The weather this morning was quite bad and overcast over the entire area. It cleared from south in late morning.

This morning we noted that a large lead is opening in the Nares Strait. Three satellite pictures from morning 28/4, morning 29/4 and evening 30/4 clearly show it growing. This might be the ice bridge breaking - no worry for us as we do not (and do not need to) have instruments on the ice in the inner part of

the Lincoln Sea. Trine took a picture of the lead when visiting Frankfield Bay - attached to the original message.

Plans for tomorrow - Sunday, April 30, 2006
Weather and plan update at morning meeting at 7:45.

The TO will go the camp with Jørgen and Doug to pack up camp; John I and Peer to search with LIA for the five coolers still deployed (OR178-182) and the satellite tracker at OS7 still out there.

Tim and Søren will also go to detonate all explosives at camp. Before LIA leaves camp they should sling the explosives to a suitable place for blasting close (but not too close to the runway) to camp.

If possible the TO will home several loads during the day.

The 60 charges at the XR fuel cache act as a fall back cache for 6 single hole charges should the weather shift and allow shooting the crosslink.

CWY and VYM will work with the B&G team. The two teams will be Morten and Arne and Jon B and Thomas.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182)
* In camp: 0
* In Spinnaker: 142

Explosives budget:
* Alert: 0 charges
* Camp: 95 charges
* XS eastern cache: 60 charges

Lorita-1 - Daily Report No.32 - April 30, 2006

Weather (Alert 6 a.m.)
-17°C, sunny, calm.

Location of fuel cache camp
Unpopulated

What have we done today
The TO went to camp with John Innes, Søren, Jørgen and Doug to fetch LIA, detonate the 95 charges left in camp and bring back camp equipment.

People movement
Nil

Alert Lorita population (including aircrew): 23

Fuel Cache population: 0

Comments
The weather this morning was quite bad with fog and overcast from south of the cross line and north. It cleared slowly northward, allowing us to fly to camp with take off at 18.00.
Plans for tomorrow - Monday, May 1, 2006
Weather and plan update at morning meeting at 7:45.

If weather permits we will load, deploy, shoot and recover the cross line with 72 coolers on a 100 km line and 6 single hole shots on the line spaced 20 km apart.

Three teams:
* VYM (pilot Gerry) drill and load, then deploy, blast and recover: Peer and Jørgen.
* CWR (pilot Jim) drill and load, then deploy, blast and recover: Tim and Trine.
* LIA (pilot John) ferry explosives, en deploy and recover: Thomas, later also Ruth.

All three helicopters will go to X line cache, each bringing approx 8-10?? coolers.

VYM and CWR will drill and load, with LIA ferrying explosives. All 6 XS sites with one hole 10 charges - there are 60 charges at X line cache.

CWR does XS1,3,5
VYM XS2,4,6

The TO will bring Ruth and the remaining coolers out to the X line cache so start deployment when loading is done. All three helicopters meet/talk before starting deployments.

Deploying:
* LIA will deploy 41-72
* CWR will deploy 21-40
* VYM will deploy XR1-20

Blasting:
* CWR (Tim) will blast XS4,5,6 shot times: 00, 20, 40
* VYM (Peer) will blast XS1,2,3 shot times: 10, 30, 50

Recovery:
* LIA will recover 41-72
* CWR will recover 21-40
* VYM will recover XR1-20

If weather does not permit the cross line, CWY and VYM will work with the B&G team. The two teams will be Morten and Arne and Jon B and Thomas.

All movements and actions are reported back to Dave M. through the pilots.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182)

* In camp: 0
* In Spinnaker: 142

Explosives budget:
* Alert: 0 charges
* Camp: 0 charges
* XS eastern cache: 60 charges

Lorita-1 - Daily Report No.33 - May 1, 2006

Weather (Alert 6 a.m.)
-18°C, sunny, calm.

Location of fuel cache camp
Unpopulated

What have we done today
Loaded XS1,2,3,4,5,6; deployed XR1-17; blasted XS1,2,3,4,5,6; recovered XR1-72.

The weather was good this morning with only a few fog patches, and we acquired a pared down version of the cross line. The 72 receivers were placed along a 100 km long line, and 6 single hole shots were spread evenly along it.

First two teams (Peer and Jørgen and Tim and Trine) loaded the 6 shots with the third team (Thomas and Ruth) ferrying explosives out. Then the three teams deployed the receivers. The blasting teams them blasted three shots each, and finally each team picked up the receivers they had deployed earlier. A fog patch in the western end of the line made the pickup of the XR1-5 tricky but all were found. With a start at 9:00 the last helicopter was home at 23:30.

People movement
Nil

Alert Lorita population (including aircrew): 23
Fuel Cache population: 0

Comments
This was a good day.

Plans for tomorrow - Tuesday, May 2, 2006
Weather and plan update at morning meeting at 12:30.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182)
* In camp: 0
* In Spinnaker: 142

Explosives budget:
* Alert: 0 charges

* Camp: 0 charges
* XS eastern cache: 0 charges

Lorita-1 - Daily Report No.34 - May 2, 2006

Weather (Alert 6 a.m.)
-17°C, sunny, light wind.
Location of fuel cache camp
Unpopulated

What have we done today
No flying today due to fog and low cloud over the working area - the B&G team are waiting to get out.

All flashcards from the 72 instruments used on the cross line have been extracted and backup made.

Packing has started on the seismic equipment in preparation for the 737 flight to Edmonton Saturday, May 6.

People movement
May 1, Søren Bredvig from Alert to Thule by BOXTOP Herc.

Alert Lorita population (including aircrew): 22
Fuel Cache population: 0

Comments

Plans for tomorrow - Wednesday, May 3, 2006
Weather and plan update at morning meeting at 7:45.

Bathymetry and gravity will work in two teams; Morten and Arne and Jon B and Thomas.

If weather is really fine up the 5 missing coolers we will make a final attempt to recover them and the satellite tracker close by.

Cooler budget:
* Still deployed: 5 coolers (OR 178-182)
* In camp: 0
* In Spinnaker: 142

Explosives budget:
* Alert: 0 charges
* Camp: 0 charges
* XS eastern cache: 0 charges

Lorita-1 - Daily Report No.35 - May 3, 2006

Weather (Alert 6 a.m.)
-17°C, sunny, calm.

Location of fuel cache camp
Unpopulated

What have we done today
No helicopter flying today due to fog and low cloud over the working area. The TO made two trips in the afternoon to the fuel cache camp site. All equipment is now back in Alert, and at the site is left 3 sealed drums of fuel for Rene Forsberg, a flag and the runway markers. Rene will clear the site when finished in the area.

Packing has continued in preparation for the 737 flight to Edmonton Saturday, May 6.

People movement
Nil

Alert Lorita population (including aircrew): 22
Fuel Cache population: 0

Comments

Plans for tomorrow - Thursday, May 4, 2006
Weather and plan update at morning meeting at 7:45.

Bathymetry and gravity will work in two teams; Morten and Arne and Jon B and Thomas.

Packing equipment. Please have all cargo ready and marked by Friday morning for Dave M.

Cooler budget:
* 147 packed on pallets

Lorita-1 - Daily Report No.36 - May 4, 2006

Weather (Alert 6 a.m.)
-16°C, snow, light wind.

Location of fuel cache camp
Unpopulated

What have we done today
No flying today due to snow, fog and low cloud.

Packing has continued in preparation for the 737 flight to Edmonton Saturday, May 6.

People movement
Nil

Alert Lorita population (including aircrew): 22
Fuel Cache population: 0

Comments

Plans for tomorrow - Friday, May 5, 2006
Weather and plan update at morning meeting at 7:45.

Bathymetry and gravity will work in two teams; Morten and Arne and Jon B and Thomas.

Clearing the fuel cache on the cross line by TO.

Taking down the mast on Merv's Peak by helicopter.
Packing equipment.

Cooler budget:
* 142 packed on pallets

Lorita-1 Daily Report No.37 - May 5, 2006

Weather (Alert 6 a.m.)
-16°C, light snow, wind.

Location of fuel cache camp
Unpopulated

What have we done today
No helicopter flying today due to snow, fog and low cloud. The TO was due to Resolute today, but had to turn back in Eureka. On return the TO went to the fuel cache on the cross line and emptied it for fuel and the satellite tracker.

Packing is (almost) complete for the 737 flight to Edmonton Saturday, May 6.

People movement
Nil

Alert Lorita population (including aircrew): 22
Fuel Cache population: 0

Comments

Plans for tomorrow - Saturday, May 6, 2006
737 flight to Edmonton. ETA (Plan A) 17:00 with departure 18:00.
Updates will be noted here.

Lorita-1 - Daily Report No.38 - May 6, 2006

Weather (Alert 6 a.m.)
-16°C, sunny, calm.

Location of fuel cache camp
Unpopulated

What have we done today
VYM with pilot Gerry and Trine went to search for the five coolers on OR177-182 and the satellite tracker at OS7. All found. Refuelled at camp and left 2 full drums of fuel (sealed) and one empty drum. A homing beacon was left there (125 MHz).

Taken down the FM repeater on Merv's Peak - pilot John Innes with Jim M, Sean and Dorothy.

737 flight to Edmonton at 18:10

People movement
Ruth, Trine, Thomas, Tim, Peer, Morten, Arne, Jon B, Dorothy, Doug, Jørgen by 737 to Edmonton. Jim B with LIA to Eureka to another project. Paul, Trevise and Brad by TO to Resolute Bay on another project. Gerry with VYM and John Innes with CWR to wait in Alert for next project.

Alert Lorita population (including aircrew): 3 (Jim M, Leslie and Sean)
Fuel Cache population: 0

Comments
With the perfect irony typical to life in general we today had the best flying condition over our entire working area we had for weeks. This gave us the option to recover the five lost coolers with the northernmost 7.5 km of the North South line, the five Tauruses and the satellite tracker left to leave us the chance to find them.

This is the last daily report from Lorita-1.

Plans for tomorrow - Sunday, May 7, 2006
Go home.

Data Report

Thomas Funck, Geological Survey of Denmark and Greenland

Isa Asudeh created the raw SEGY files from the stores he downloaded from the flash cards in the Taurus instruments. This report describes the processing following the creation of the raw data files. For this purpose, a SUN workstation (SunBlade 150) was used together with the seismic software package Seismic Unix (SU, release 34) and Generic Mapping Tools (GMT, version 4.0).

Inner line

The raw data files for the first deployment were stored in two directories, one for the first 56 instruments that were recovered (DVD/inner-line/raw-segy/part1) and 41 instruments that were deployed after the snowstorm passed through (DVD/inner-line/raw-segy/Part2).

The raw files in these directories are named
combined_20060409_180000.sgy for shot IS 4
combined_20060409_181000.sgy for shot IS 6
combined_20060409_190000.sgy for shot IS 3
combined_20060409_191000.sgy for shot IS 5
combined_20060409_192000.sgy for shot IS 1
combined_20060409_200000.sgy for shot IS 2

It turned out that trace 16 in the raw files for the second part did not have the receiver location written to the header due to a bad GPS signal. The receiver location for these two shots and that instrument were extracted from the raw file of IS 3 and the resulting output files are called
combined20060409_1910-posadd.sgy for shot IS 5
combined20060409_1920-posadd.sgy for shot IS 1
and used for all subsequent processing. These files are stored in the same directory as the raw-data.

The raw SEGY files were sorted after the receiver latitude in descending order. The receiver positions (gx and gy) were dumped to a file and shot-receiver offsets were calculated using the GMT process "project". The offsets were then added to the SEGY files together with the receiver positions (sx, sy). Shot and receiver locations in the header fields sx, sy, gx, gx are written in geographical coordinates with a scaling factor of 10 000.

The shot positions were taken from the beacon position closest to the shot time in case of shots IS 3 and 4. For the other shots, GPS waypoints were taken just prior to the shot.

82.487142	N	56.231821	W	Shot IS1	Fired at 2006-04-09 19:20 UTC
82.766678	N	56.358237	W	Shot IS2	Fired at 2006-04-09 20:00 UTC
83.062134	N	56.446777	W	Shot IS3	Fired at 2006-04-09 19:00 UTC
83.346954	N	56.594986	W	Shot IS4	Fired at 2006-04-09 18:00 UTC
83.665392	N	56.857670	W	Shot IS5	Fired at 2006-04-09 19:10 UTC
83.933876	N	56.914535	W	Shot IS6	Fired at 2006-04-09 18:10 UTC

The resulting SEGY files have a record length of 57 seconds, a sampling rate of 100 Hz, consist of 97 traces (receivers IR57 and IR 62 were not recovered), are named shot-is[001-006].sgy and are stored in DVD/inner-line/final-segy/. The instrument serial number is written to the SEGY header into the header

word "tracf" (corresponding to "trace number within field record"). Station and shot numbers are not added to the SEGY headers.
Some of the traces had a reverse polarity. In case of the first deployment (inner line), this was the case for traces 60 and 76. The polarity of these traces were changed and the resulting files are named shot-is[001-006]-pol.sgy and are stored in DVD/inner-line/final-segy/

Outer line
The raw SEGY files for the outer line are stored in two directories (DVD/outer-line/raw-segy/part[1-2]).

The raw files in these directories are named
combined_20060419_004700.sgy for shot OS 5
combined_20060419_010000.sgy for shot OS 10
combined_20060419_015000.sgy for shot OS 9
combined_20060421_154000.sgy for shot OS 3
combined_20060421_161000.sgy for shot OS 2
combined_20060421_162000.sgy for shot OS 8
combined_20060421_165000.sgy for shot OS 7
combined_20060421_171100.sgy for shot OS 1
combined_20060421_173000.sgy for shot OS 6
combined_20060421_191500.sgy for shot OS 4

Five instruments at the northern end of the line were not recovered. This comprises stations OR 178 through OR 182.

Two instruments had problems with recording the GPS positions. Instead of recording the actual positions, the position of Alert (62.3 W, 82.5 N) was written into the trace headers of the raw files. These two traces were excluded from the subsequent processing. The data were from
Station OR 156 (Cooler box 155, Taurus Serial Number 477)
Station OR 172 (Cooler box 237, Taurus Serial Number 242)

During the shots on April 21, 2006, Isa had deployed four instruments at the ice camp for test purposes. These stations are included in the raw SEGY files but were excluded from the subsequent processing. This includes cooler boxes 123, 124, 135, and 137 (Taurus Serial Numbers 419, 421, 381, and 454, respectively).

Isa had problems with reading the flash card from station OR 128 (cooler box 171, Taurus Serial Number 528). This station is therefore not included in the SEGY files.

During the last shot OS4, two Taurus seismometers did not record for unknown technical reasons. Isa checked the state-of-health file but could not find anything conspicuous. Hence, there are two traces less in the record of OS4 compared to the other shots. The missing stations are
Station OR 119 (Cooler box 243, Taurus Serial Number 216)
Station OR 168 (Cooler box 233, Taurus Serial Number 268)

The raw SEGY files were sorted after the receiver latitude in descending order. The receiver positions (gx and gy) were dumped to a file and shot-receiver offsets were calculated using the GMT process "project". The offsets were then added to the SEGY files together with the receiver positions (sx, sy). Shot and receiver locations in the header fields sx, sy, gx, gx are written in geographical coordinates with a scaling factor of 10 000.

For the purpose of calculating shot-receiver distances (offsets), shot positions (sx, sy) were used from a file that was provided by John Shimeld, who extracted the last waypoint prior to each shot from the handheld GPS receivers that were provided to each shooting team. However, shot positions were taken up to half an hour prior to the shot time and it is unknown if the position was taken from the actual site of the explosives or of the shot box. Hence, some post processing might be necessary to verify the shot positions. The shot positions are

56.951839 W 83.652748 N Shot OS1 Fired at 2006-04-21 17:11 UTC
57.276713 W 83.956904 N Shot OS2 Fired at 2006-04-21 16:10 UTC
57.993619 W 84.227171 N Shot OS3 Fired at 2006-04-21 15:40 UTC
58.342814 W 84.513775 N Shot OS4 Fired at 2006-04-21 19:15 UTC
57.530572 W 84.776401 N Shot OS5 Fired at 2006-04-19 00:47 UTC
59.490388 W 85.107256 N Shot OS6 Fired at 2006-04-21 17:30 UTC
60.050325 W 85.404848 N Shot OS7 Fired at 2006-04-21 16:50 UTC
59.522121 W 85.568831 N Shot OS8 Fired at 2006-04-21 16:20 UTC
59.157278 W 85.797167 N Shot OS9 Fired at 2006-04-19 01:50 UTC
60.620370 W 86.283670 N Shot OS10 Fired at 2006-04-19 01:00 UTC

The resulting SEGY files have a record length of 57 seconds, a sampling rate of 100 Hz, consist of 105 traces (for shot OS4 only 103 traces), are named shot-os[001-010].sgy and are stored in DVD/outer-line/final-segy/. The instrument serial number is written to the SEGY header into the header word "tracf" (corresponding to "trace number within field record"). Station and shot numbers are not added to the SEGY headers.

Some of the traces had a reverse polarity. This was the case for traces 46 and 81 (for shot OS4 on traces 45 and 79) in the final SEGY files. These two traces correspond to
Station OR 130 (Cooler box 150, Taurus Serial Number 471, geophone# 290)
Station OR 94 (Cooler box 110, Taurus Serial Number 456, geophone# 106)

The polarity of these traces were changed and the resulting files are named shot-os[001-010]-pol.sgy and are stored in DVD/outer-line/final-segy/

Earthquake (Mw=7.7)
While the seismometers were deployed along the outer line, an earthquake in Russia was recorded on the stations. Details of the earthquake are specified below.

Magnitude 7.7 Mw
Date 20 April 2006
Time 23:05:05 UTC
Longitude 167.100 E
Latitude 61.092 N
Depth 43 km

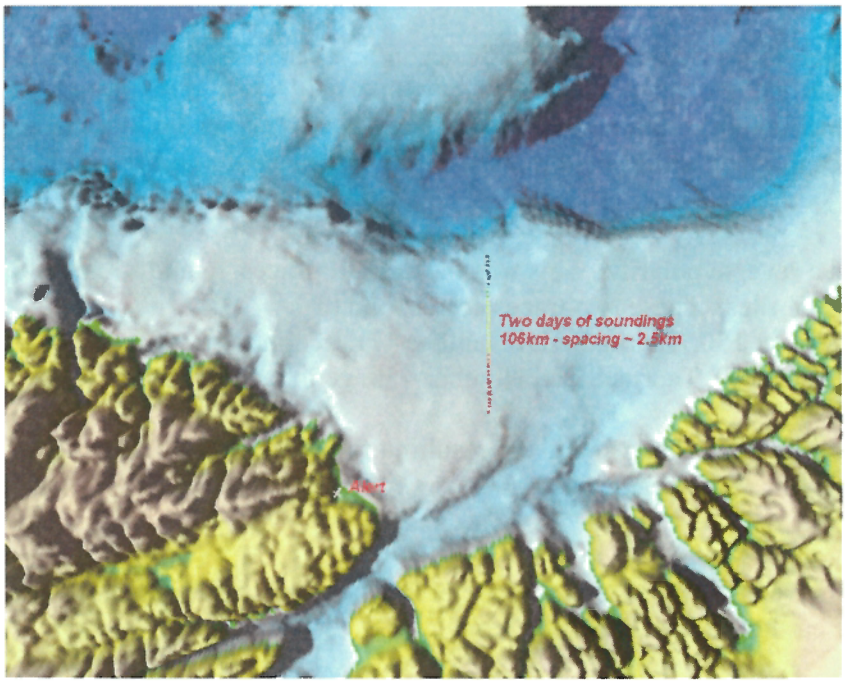
The SEGY file with the recordings on the LORITA line starts at 20 April 2006 23:31:00 UTC. The processing (calculation of offsets, polarity change) was carried out analog to the processing of the shots on the outer line. All files are stored in DVD/earthquake/.

Hydrography and Gravity Report

Arne Olesen Morten Sølvsten and Jon Biggar

Objectives

The bathymetry and gravity information collected is to augmented/ground-truthed the seismic operations and further to be combined and refine the historical information and bathymetry data model for the UNCLOS claim. The bathymetry and gravity team consisted of Arne Vestergaard Olesen (Danish National Space Center), Morten Sølvsten (Royal Danish Administration of Navigation and Hydrography) and Jon Biggar (Canadian Hydrographic Service).
General working schedule was to follow the seismic program stages using two helicopters at the pre determined points from the results of seismic receiver and shot locations. The bathymetry and gravity program was 100% successful but did not complete the data collection because of weather conditions which plagued all aspects of the project.



IBCAO model overlayed with singlebeam bathymetry collected April 2006

Method

This multi-disciplinary effort involved the collection of bathymetry and gravity at each given location. The procedure was to acquire a depth measurement where ice conditions are crucial to the success and then continue with a gravity measurement. Normally in the Arctic conditions, an echo sounder transducer cannot be placed directly in contact with the water. This means that sound wave must travel through the ice into the water, echo off the bottom, return to through the

ice back to the transducer. At each boundary some of the sound is reflected and lost. The best reflector is the air /ice interface and thus creates the largest acoustic impedance. The method to minimize the impedance is to adhere/bond the sounder transducer to the ice surface using a thin layer food grade gear oil. Multiple echo sounder transducers using different frequencies were used depending on water depth. The depths were collected at a fixed velocity of 1500 ms/sec and then corrected to an average true velocity derived from the CTD casts. (See figure 2) Because of the difficultly knowing the nature of the ice conditions, an estimate of ice thickness was recorded and divided by two and applied to the measured depth as a positive correction. The assumption made is speed of sound travels at a speed of approximately 2250m/sec through the ice column. The gravity meters utilized were ice dampened La Coste & Romberg gravity meters. The whole process under ideal conditions was expected to take 5 to 10 minutes per location.

Events

Initial tests of equipment in the ice camp.

On April 8th, one day was spent at the ice camp testing the echo sounders and various transducer configurations. A permanent hole used for seismic operations (air gun) was used for initial testing before trying them on the first year ice. After the initial tests it was concluded that the equipment was working properly, only Morten had a problem with his 15 kHz transducer which was sorted out the day after the initial test. The depths recorded were in the 750 metre range.

On April 17th, Morten Sølvsten spent two days at the ice camp sounding locally with the snowmobile.

Data Collection

The B&G team was able to collect data only on two opportunities because of weather conditions. The first day of collection on the 13th April, the team consisted of Jon Biggar and Arne Vestergaard Olesen in helicopter VYM. The departure was delayed due to an installation problem. Bathymetry and gravity measurements were achieved on every second receiver location from IR001ST3 through to IR056ST3, a total of 30 locations. (See figure 1) We were able achieve 4 measurements/locations per hour, including time spent for refueling the helicopter twice. The second day of collection was on April 29th after a late start due to weather. The team consisted of Morten Sølvsten and Arne Vestergaard Olesen in helicopter CWR. Every second point from IR058ST3 through to IR081ST10 plus shot points IS04, OS01, OS02 were completed. Total of 17 points were done before we had to return to Alert because of low visibility/contrast. (See figure 1)

The ice conditions were in most cases multiyear with snow thickness up to 60 cm. This hampered production because of the time involved in finding good stable ice surface for sounding and gravity readings. The echo soundings in shallow water generally were faster than the gravity readings if the air /ice interface is to a minimum. The B&G team doesn't expect to be able to do the readings much faster than it was done on the 13th April unless the snow cover becomes considerable thinner further north.

One of the lessons learned has been to physically walk around on the ice after the helicopter has landed in order to find good ice if a sounding is not achievable at the initial location. Good ice in this sense means a hard smooth surface which in some instances was very hard to find because of the snow cover. One way to find hard ice was found to hammer the shovel into the ice surface and feel the response. This is faster than actually removing the snow when there is ½ m of hardened snow or more.

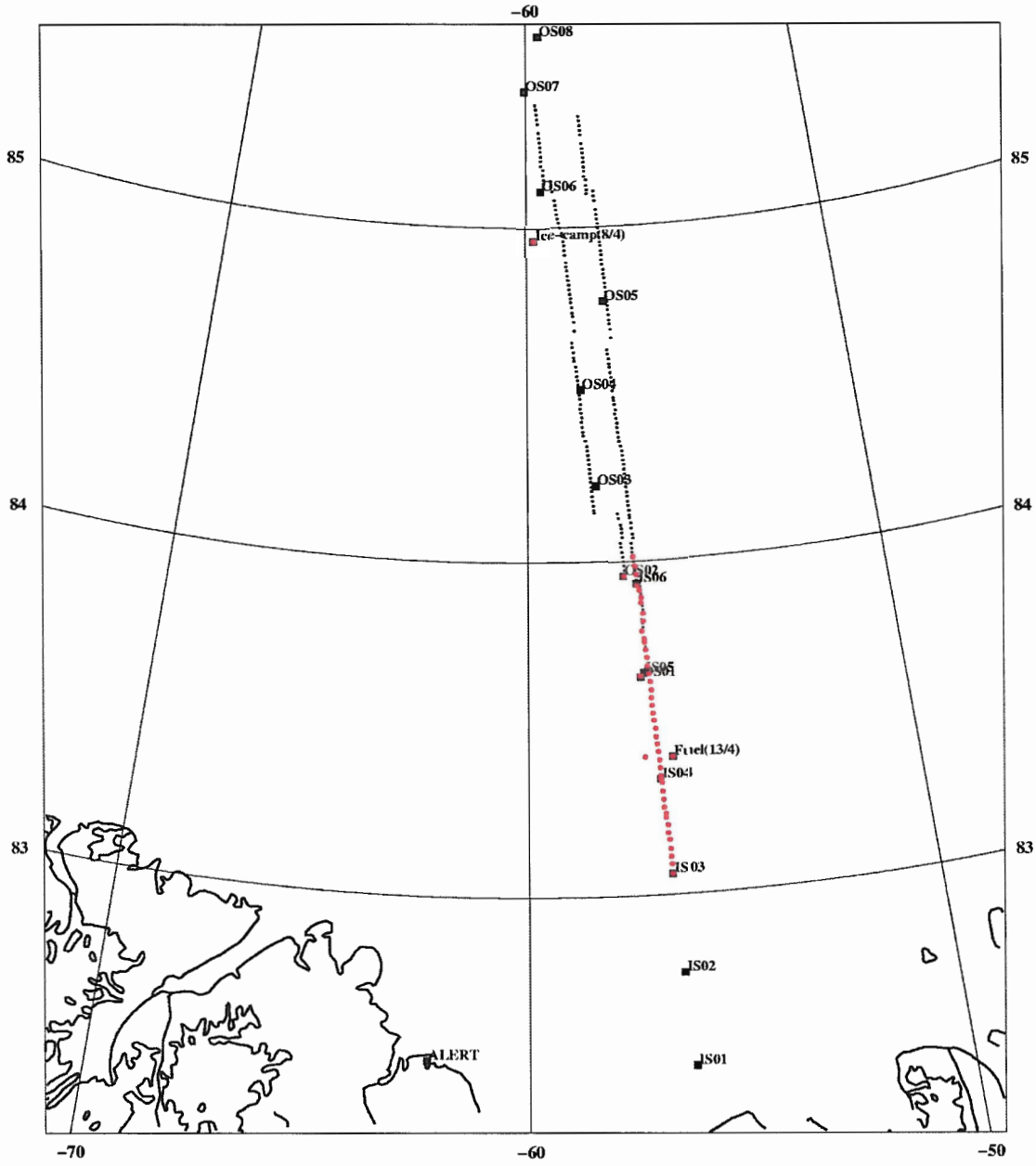
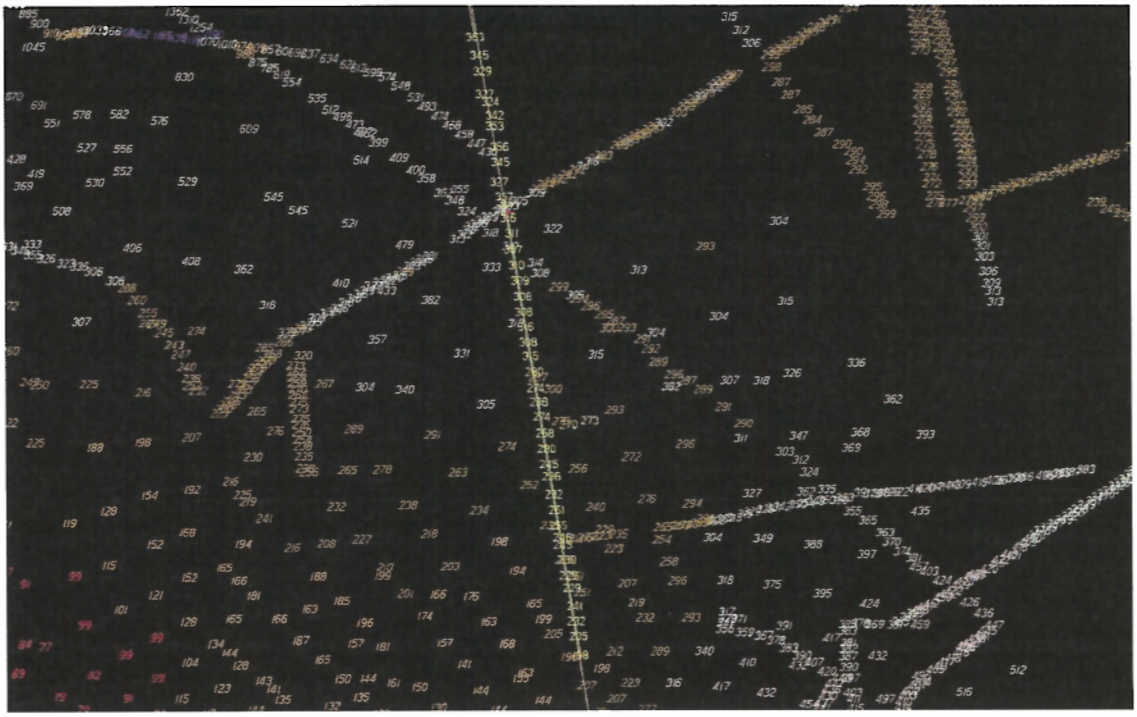


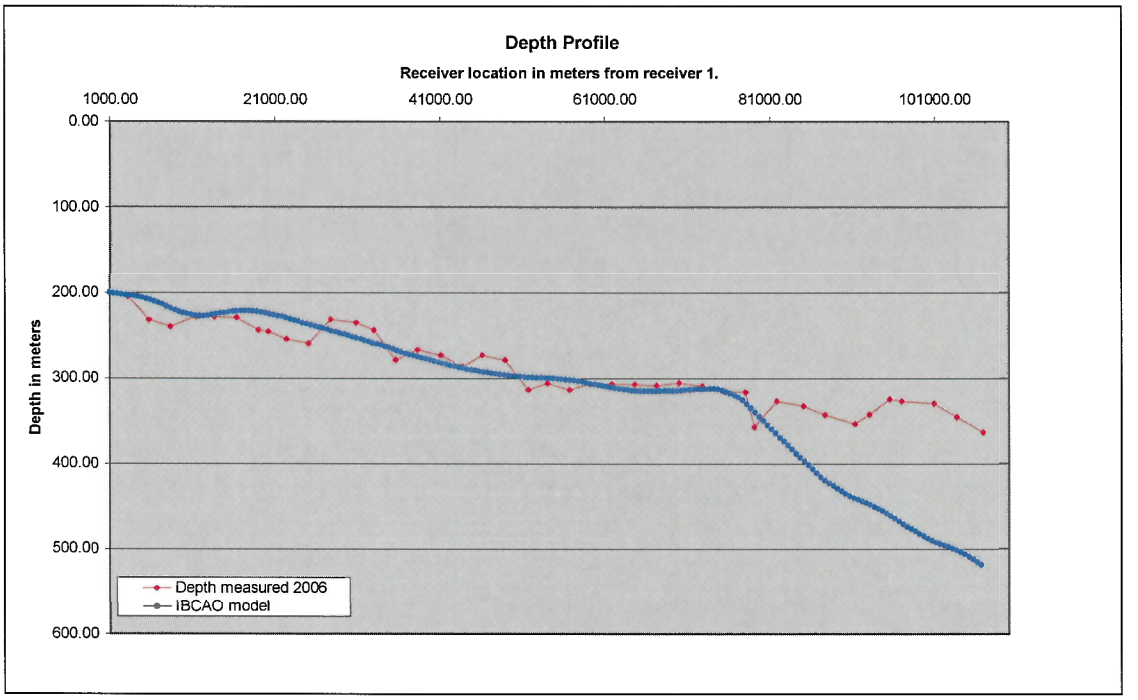
Figure 1. *Location of seismic geophones (black) and B&G measurements (red). (to be updated with x-line and hopefully more readings)*

Historical Data (April 2006 soundings in yellow)



Comparison of IBCAO model with the acquired depth measurements

As it may be seen from a comparison between the acquired depth measurements and a profile taken from the IBCAO DTM the inner part of the line matches up reasonably. But on the outer end we see a depth difference of approximately 150m. This means that the continental shelf reaches out further than the IBCAO model shows. The historical data show the same tendency. We do believe that this is not caused by inaccurate depth measurements but is rather a question of the position accuracy in the historical data.

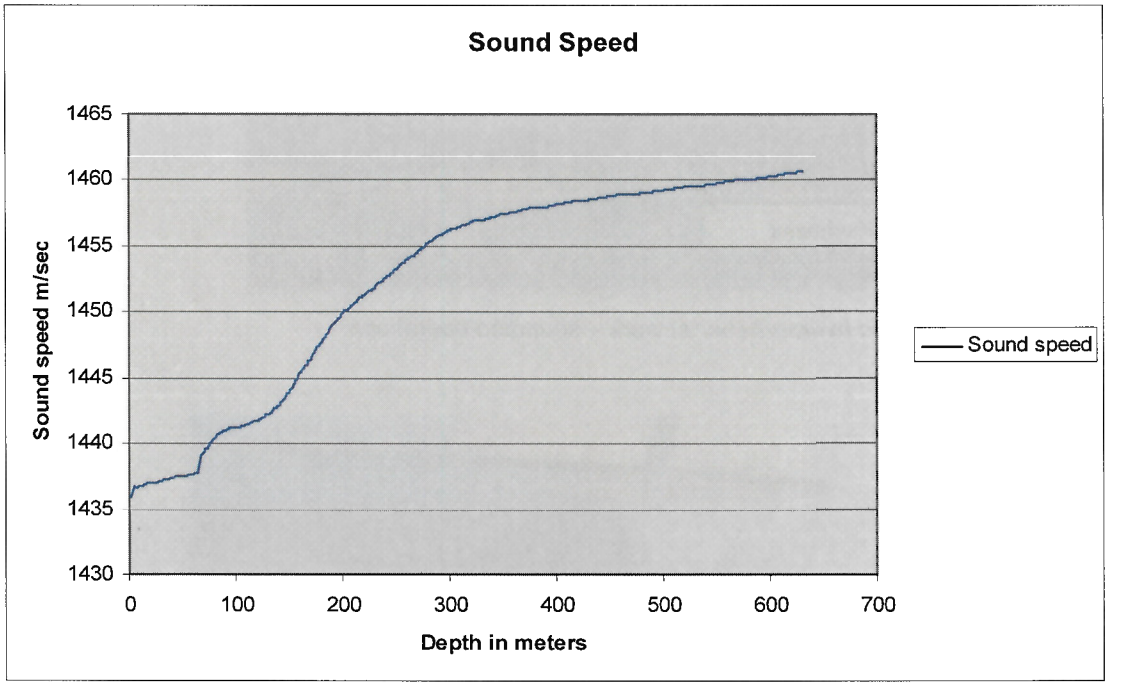

Depth Profile
Receiver location in meters from receiver 1.
1000.00
21000.00
41000.00
61000.00
81000.00
101000.00
0.00
100.00
200.00
300.00
400.00
500.00
600.00
Depth in meters
Depth measured 2006
IBCAO model

Arctic hydrographer at work – sounding operations

Gravity data collection

Ice camp testing - Reson NS420DS echo sounder and Knudsen 320A echo sounder

Figure 2- CTD water column profiles
Profiles of conductivity and temperature versus depth (CTD) were taken at the ice camp and the intersection of the two seismic lines.



Ice camp profile – average velocity 1452.5 m/sec

Equipment inventory

The gravity instrumentation consisted of three LaCoste & Romberg G-meters: G-932 (GSC), G-867 (DNSC) and G-466 (DNSC). G-932 and G-867 are equipped with an ice-damping option.

4 Knudsen 320A (Arctic) Echo sounders
2 Knudsen 320M (Marine) Echo sounders
2 – Gifft 12Khz transducers
1 – Sensor Technology transducer - 24 KHz
1 – Sperry SR9042 transducer - 24 KHz
2 – Edo 9042 transducer – 24 KHz
1 – Edo Western (2 kwatt) transducer - 24 KHz
1 – Airmar transducer – 24 KHz
1 Reson NS420DS modified Echo sounder*
1 – Reson TC2135 15Khz transducer*
1 – Reson TC2144 24Khz transducer*

CARTENAV ETS-1500 Satellite beacons

John Shimeld, Geological Survey of Canada (Atlantic)

Beacon Specifications

To monitor the geographic position of explosives on the sea ice during the field program, eleven ETS-1500 satellite beacons (serial numbers GSCA02 through 11) were purchased from Cartenav Solutions Incorporated of Halifax, Nova Scotia. Cartenav also manufactured a twelfth beacon (GSCA01) for testing and development.

The beacons each contain a global positioning satellite (GPS) receiver, an Iridium satellite communications transceiver, and a microprocessor, which are all powered by 8 Saft 3.6 volt lithium 'D' cells. All components are rated for operating temperatures between -40 and +30°C. By switching the Iridium transceiver on only briefly (< 1 minute) once an hour, the ETS-1500 units have an estimated battery life of 40 to 60 days at -40°C.

The components are housed inside a small orange box (34 x 30 x 15.5 cm) connected with 1.8 m long cables to a combined GPS antenna/Iridium transceiver which is mounted on a 1" diameter aluminum pole (Figure 1). The mass of each beacon including batteries, antenna, and pole is 6 kg.

Figure 1: **Cartenav ETS-1500 satellite beacon installed at the test site, 30 m south of the Spinnaker building.**

Once per hour, the beacons obtain GPS fixes and communicate information about their geographic positions and state of health, via the Iridium satellite network, to a Cartenav

computer. Each beacon reports: serial number, time (UTC), latitude, longitude, linear distance moved since last report, total operating time since (seconds), time elapsed during Iridium transmission (seconds), and time elapsed during GPS fix (seconds). During the field program, Lorita participants and supporting personnel were able to access these data through two separate World-Wide Web interfaces:

1) https://www.sattrax.net/etuser (username: gsca password: iceflow).
2) http://www.cartenav.com/icetracker/icetracker.php (no password protection)

The first website is the main interface provided by Cartenav for commercial applications, but the graphical content of the site makes access very slow from CFS Alert because of the low bandwidth Internet connection. At our request, Cartenav designed the second website which has a text-only interface. The total time required to download the beacon data to Alert was generally less than 30 seconds.

The following is a sample of the data obtained from the text-only web site:

```
asset,time,lat,lon,distance,totalOn,deltaOn,gpsOn
GSCA02,04/14/2006 16:00:18,83.656876,-56.667526,0.013,006923,056,008
GSCA02,04/14/2006 17:00:36,83.656921,-56.664536,0.037,006947,024,006
GSCA02,04/14/2006 18:00:42,83.657242,-56.661499,0.052,006971,024,010
asset,time,lat,lon,distance,totalOn,deltaOn,gpsOn
GSCA04,04/14/2006 00:01:12,83.414093,-56.228500,0.156,009551,024,008
GSCA04,04/14/2006 01:01:35,83.412369,-56.232925,0.201,009575,024,030
GSCA04,04/14/2006 02:01:12,83.410599,-56.236923,0.205,009631,056,006
GSCA04,04/14/2006 03:01:18,83.409134,-56.241730,0.175,009655,024,010
GSCA04,04/14/2006 04:01:18,83.408508,-56.244781,0.080,009679,024,010
GSCA04,04/14/2006 05:01:18,83.408707,-56.245743,0.025,009721,042,010

Etc …
```

Pre-deployment testing

On March 30th, shortly after arrival at Alert, the satellite beacons were unpacked, the batteries were tested and installed, and each unit was turned on. The beacons were placed at a test site, 30 metres south of the Spinnaker building at CFS Alert, and allowed to operate continuously while preparations were underway for the ice camp and the first refraction line.

During this test all beacons except one functioned properly. The faulty unit, GSCA12, indicated a normal start-up sequence (power-up, GPS lock, sleep mode) but did not make the Iridium transmissions. After removing the batteries, the unit was inspected for loose connectors and the CPU chip was reseated. However the problem persisted and, after consultation with a Cartenav technician, we decided to ship GSCA12 back to the Cartenav office in exchange for GSCA01 (which had remained at the Cartenav offices). We also used the opportunity to order a spare set of Saft batteries.

GSCA12 arrived back in Halifax on April 12, where the fault was discovered to be a loose connection with the Iridium transceiver. The shipment of GSCA01 and spare batteries did not arrive at CFS Alert, despite efforts on both ends to track down the shipping error. As a result, we were forced to operate with ten beacons rather than the originally intended eleven. This posed no problem since, due to weather constraints, there were never more than ten shot holes loaded with

explosives along any of the refraction lines.

Processing of the Data

Data from the ETS-1500 beacons were essential for locating the receiver packages after deployment. The data were used to update a list and a map of beacon positions on an hourly basis, to interpolate geographic coordinates for (potentially) up to 150 receiver stations, and to generate waypoints for loading to GPS receivers at 07:15 each morning before the helicopter teams departed at 08:00. These tasks were accomplished by creating two computer programs. Both were written using a scripting language called Perl which comes with all standard Unix and Linux distributions, and which can also be installed under the Windows and Apple operating systems.

The first program, *summarize.pl*, scans the Cartenav data file and produces a table of the last reported beacon positions together with the associated station number, the speed over ground, the course over ground, and the local time. An output file containing the beacon/station positions over time is generated in GPS Exchange format, which can be loaded directly into many geographic information systems (e.g. Global Mapper) and plotted on a map. This format was also very useful for uploading the positions as waypoints to GPS receivers using a software package called GPS Utility.

The second program is called predict_positions.pl. It reads the ETS-1500 data file and computes motion vectors for each beacon. Then it reads a second file assigning each receiver station to two beacons, and calculates a motion vector for the receiver station by using the distance-weighted average of the vectors for the two assigned beacons. To use the vector from just one beacon, that beacon name is listed twice. This is useful, for example, if two beacons are separated by a shear zone and the user wishes to use the vector of just the closest beacon to interpolate station positions.

Descriptions of these programs and instructions on their use may be obtained by invoking them from the command line with no arguments (e.g., by typing summarize.pl at the prompt). Program listings, with detailed comments and synopses of how to use the programs, are provided in Appendix a. Examples of the output from each program are listed below.

Example output from *summarize.pl*:

```
         SUMMARY OF SATELLITE TRACKER AND STATION POSITIONS

Current local time: Mon Apr 24 19:07:11 2006


STN    TRKR       LAST_KNOWN_POS     SOG(m/hr) COG DATE   TIME (local)
CACHE GSCA02   83 23.39 -56 23.65        3     60 Apr 23 16:00
OS005 GSCA06   84 48.24 -60 32.10      235    242 Apr 23 18:00
OS006 GSCA10   85  6.74 -61 19.98      177    239 Apr 23 16:00
OS007 GSCA11   85 24.35 -62  6.57      187    238 Apr 23 18:00
STNDB GSCA05   82 30.66 -62 19.71        4    201 Apr 23 17:00
```

Example output from *interpolate.pl*:

```
STATION: OR075
  Last known coordinates: 83 56.78, -56 49.62 (15-APR-06 16:05:02)
  Predicted coordinates:  83 57.38, -57 13.57 (21-APR-06 11:00:43)
  Predicted distance from last known position: 4.809 km (2.6 nm)
  Predicted bearing from last known position: 283.6 degrees

    Nearest tracker: GSCA07/OS002A (21-APR-06 11:00:43)
    ... coordinates: 83 57.35, -57 16.31
    ... speed over ground:  0.126 km/hr (0.068 knots)
    ... course over ground: 321.1 degrees
    ... distance to predicted station position: 0.537 km (0.3 nm)
    ... bearing to predicted station position: 85.0 degrees


STATION: OR076
  Last known coordinates: 83 57.69, -56 50.51 (15-APR-06 16:12:28)
  Predicted coordinates:  83 58.26, -57 16.09 (21-APR-06 11:00:43)
  Predicted distance from last known position: 5.098 km (2.8 nm)
  Predicted bearing from last known position: 282.3 degrees

    Nearest tracker: GSCA07/OS002A (21-APR-06 11:00:43)
    ... coordinates: 83 57.35, -57 16.31
    ... speed over ground:  0.126 km/hr (0.068 knots)
    ... course over ground: 321.1 degrees
    ... distance to predicted station position: 1.681 km (0.9 nm)
    ... bearing to predicted station position: 1.4 degrees
```

Results during the field program

A satellite beacon was deployed at every shot hole location so that the position of every explosive charge would always be known, and so that the positions of the receiver packages could be interpolated between the shot holes. The beacons performed as intended and proved to be essential to the field program. For example, 70 receiver packages were deployed along the outer line on April 15th, but then poor weather prevented further deployments until April 18th. In the interim, the satellite beacons enabled tracking of the sea ice as it drifted 2.5 km to the southwest; no reconnaissance flights were necessary when the weather cleared on the 18th to determine how far the line had drifted, and therefore helicopter crews set out at the first possible moment to finish deployment of the remaining 38 receiver packages. The teams were also able to deploy explosives at 4 shot holes and detonate two shots that day.

Again the weather deteriorated, forcing another delay until April 21st. As soon as weather conditions allowed on the 21st, explosives were deployed at 5 additional shot hole locations and all shots were detonated. Using geographic positions calculated with interpolate.pl and the ETS-1500 data, the helicopter teams successfully recovered 103 of the 108 deployed receiver packages, even though they had drifted an average of 14 km northwestward, between the 18th and the 21st, at speeds ranging between 30 and 600 m/hr (Figure 2). The last five receiver packages were successfully recovered, after yet another weather delay, on May 6th.

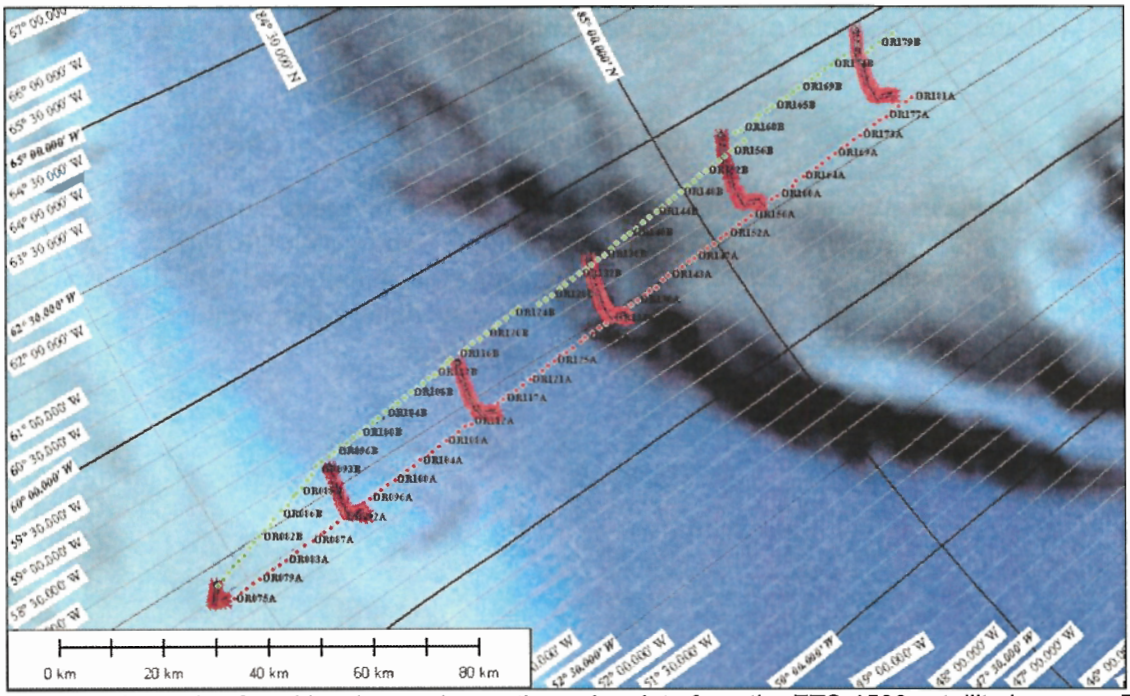


Figure 2: Example of tracking the sea ice motion using data from the ETS-1500 satellite beacons. The red dots indicate the deployed positions of the receiver packages on April 18th; the red stars indicate the drift of the satellite beacons at each shot hole location through time; the green dots indicate the interpolated positions of the receiver stations on April 21st. This information was used to successfully recover 103 of the 108 deployed receivers. The final 5 receivers were recovered May 6th.

Operational issues

At times there were delays of 1-2 hours in the reported positions of some of the beacons. Since the delays typically occurred with only 2-3 beacons out of 10, and since the delays were not systematically associated with any one particular beacon, it appears that the cause was related to Iridium transmission errors, perhaps due to atmospheric conditions. In the event that a beacon is unable to establish an Iridium connection, it is programmed to resend at the next transmission time. As a result, a position fix was available from every beacon for every hour that is was activated during the field program.

In addition to transmission error delays, there was also generally a lag between the time for which an interpolated receiver position was generated and the time at which the recovery team could actually be at the site. For example, predicted positions were generated at 07:00 each morning but, by the time the helicopter had flown to the first receiver position, several hours may have elapsed. This, combined with the transmission delays, meant that the total time lag was usually 3-6 hours.

To cope with the time lag, the recovery teams were able to use the last known position, speed over ground, and course over ground of the beacon nearest to their target receiver and extrapolate a new position. If they were still unable to find the line of receivers, the recovery teams would attempt communication back to Alert to obtain the latest positions. In general, these strategies worked well and, out of at total of 255 receiver deployments, only 2 receivers were lost.

Conclusions

The ETS-1500 satellite beacons were an essential component of the field program. They met all the design specifications and allowed hourly tracking of the shot hole locations on the drifting sea ice. Not only did this help to satisfy safety and environmental issues, it also saved valuable operational time by removing the need for reconnaissance flights immediately after weather delays, and it most certainly reduced the number of lost receiver packages.

APPENDIX a: PROGRAM LISTINGS FOR PROCESSING DATA FROM THE CARTENAV ETS-1500 SATELLITE BEACONS

summarize.pl

```
#!/usr/bin/perl
#
# Script to summarize Cartenav gps tracker position data
#
# John Shimeld, April 2006
#
#########################################################################

sub Info {
print STDERR << 'eom';

NAME
 summarize.pl

SYNOPSIS
 summarize.pl <beacon_file> <beacon_station_table>

DESCRIPTION
 This script reads a Cartenav .csv file to produce a summary
 of the last known position for each GPS beacon and its associated
 station number. For each beacon, a speed over ground and bearing are
 also calculated. The positions of the beacons are printed to a
        file (beacon_file.gpx) in GPS Exchange format.

        NOTE 1: the Cartenav data are reported in Zulu time (UTC) but
              this script converts to local time at CFS Alert (UTC-4).

EXAMPLE
 summarize.pl icetracker-latest.csv bcn2stn.lst

FILE FORMATS
        Beacon_file should have the same format as the following
        example, which was obtained from the Cartenav web site
        (www.cartenav.com/icetracker/icetracker.php):

        asset,time,lat,lon,distance,totalOn,deltaOn,gpsOn
        GSCA01,03/31/2006 00:00:18,44.647507,-63.571640,0.008,020104,038,012
        GSCA01,03/31/2006 01:00:31,44.647415,-63.571701,0.011,020128,024,024
        asset,time,lat,lon,distance,totalOn,deltaOn,gpsOn
        GSCA02,04/01/2006 00:00:49,82.510910,-62.329666,0.003,001755,045,010
        GSCA02,04/01/2006 01:00:48,82.510880,-62.329330,0.006,001804,049,010

        etc.


        Beacon_station_table is a file containing one beacon serial
        number per line with the associated station name, as in the
        following example:

        GSCA02 CACHE-SOUTH
        GSCA03 STNDBY
        GSCA04 STNDBY
        GSCA05 STNDBY
        GSCA06 OS005A
        GSCA07 OS002A
        GSCA08 OS004A
        GSCA09 OS003A
        GSCA10 OS006A
```

```
        GSCA11 OS007A

AUTHOR
        John Shimeld, April 2006

eom
exit(1);
}


use POSIX;
use Time::Local;

die(&Info) if ($ARGV[0] eq '-h');
die(&Info) unless ($#ARGV == 1);


# Input files
$trkr_file = shift;
$t2s_file = shift;

# Output file
($out_file, $tmp) = split /\./, $trkr_file;
$out_file = $out_file . '.gpx';
print "$out_file\n";

# Build tracker to station hashes
open (T2S, "<$t2s_file") or die ("Error: $t2s_file does not exist.\n");
while (<T2S>) {
  ($tracker, $stn) = split;
  $STN{$tracker} = $stn;
}
close (T2S);

# open file containing satellite tracker positions and scan
# to obtain penultimate and last geographic coordinates for each tracker
open (TRKRFILE, "<$trkr_file") or die ("Error: $trkr_file does not exist.\n");
while (<TRKRFILE>) {
  next if /^asset/;
  chomp;

  # read tracker name and position
  @F = split /\,/;
  $trkr = $F[0];
  $lat = $F[2];
  $lon = $F[3];
  $lat_deg = int($lat);
  $lon_deg = int($lon);
  $lat_min = ($lat - $lat_deg) * 60;
  $lon_min = (abs($lon) - abs($lon_deg)) * 60;

  # parse out the date and time information
  # NOTE: these are assumed to be UTC
  $date_time = $F[1];
  ($date,$time) = split /\s+/, $date_time;
  ($month,$day,$year) = split /\//, $date;
  ($hour,$min,$sec) = split /:/, $time;

  # calculate epoch seconds and convert to CFS Alert local time
  $es = timelocal($sec,$min,$hour,$day,$month-1,$year);
  $es = $es - 4*60*60;

  # make a new date stamp for pretty output
  $month = (localtime($es))[4];
  $day = (localtime($es))[3];
  $hour = (localtime($es))[2];
  $minute = (localtime($es))[1];
  $day = sprintf("%02d", $day);
  $hour = sprintf("%02d", $hour);
  $minute = sprintf("%02d", $minute);
  $stamp = (Jan,Feb,Mar,Apr,May,Jun,Jul,Aug,Sep,Oct,Nov,Dec)[$month] .
           ' ' . $day . ' ' . $hour . ':' . $min;


  # add data to hash of hashes structure
  $stn = $STN{$trkr};
```

```
  $TRKR{$stn}{name} = $trkr;
  push @{ $TRKR{$stn}{epoch_sec} }, $es;
  push @{ $TRKR{$stn}{datestamp} }, $stamp;
  push @{ $TRKR{$stn}{lat} }, $lat;
  push @{ $TRKR{$stn}{lon} }, $lon;
  push @{ $TRKR{$stn}{lat_deg} }, $lat_deg;
  push @{ $TRKR{$stn}{lat_min} }, $lat_min;
  push @{ $TRKR{$stn}{lon_deg} }, $lon_deg;
  push @{ $TRKR{$stn}{lon_min} }, $lon_min;
}

# print header line to screen
print "\n\n         SUMMARY OF SATELLITE TRACKER AND STATION POSITIONS\n\n";
$curr_time = localtime;
print "Current local time: $curr_time\n\n\n";
print "STN   TRKR       LAST_KNOWN_POS    SOG(m/hr) COG DATE   TIME (local)\n";

# print header line to output file
open (GPX,">$out_file");
$gpx_hdr =
'<?xml version="1.0" encoding="ISO-8859-1" standalone="yes"?>
 <gpx
 version="1.1"
 creator="John Shimeld"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns="http://www.topografix.com/GPX/1/1"
 xsi:schemaLocation="http://www.topografix.com/GPX/1/1 /GPX/1/1/gpx.xsd">
<metadata> </metadata>';

print GPX "$gpx_hdr";

foreach $stn (sort keys %TRKR) {

  # Calculate distance and course over ground of last reported ice motion
  $lat_pen = $TRKR{$stn}{lat}[-2];
  $lat_end = $TRKR{$stn}{lat}[-1];
  $lon_pen = $TRKR{$stn}{lon}[-2];
  $lon_end = $TRKR{$stn}{lon}[-1];
  ($dist,$cog) = dist_cog( $TRKR{$stn}{lat}[-2],
                           $TRKR{$stn}{lon}[-2],
                           $TRKR{$stn}{lat}[-1],
                           $TRKR{$stn}{lon}[-1]
                         );

  # Calculate latest known station sog
  $dt = $TRKR{$stn}{epoch_sec}[-1] - $TRKR{$stn}{epoch_sec}[-2];
  $sog = $dist/$dt * 60*60;

  # Output stations to .gpx file
  for $i (0 .. $#{$TRKR{$stn}{lat}}) {
    print GPX "<wpt lat=\"$TRKR{$stn}{lat}[$i]\" lon=\"$TRKR{$stn}{lon}[$i]\">\n";
    print GPX " <name>$stn ($TRKR{$stn}{datestamp}[$i])</name>)\n";
    print GPX " <desc>$TRKR{$stn}{name} ($TRKR{$stn}{datestamp}[$i])</desc>\n";
    print GPX " <sym>Beacon</sym>\n";
    print GPX "</wpt>\n";
  }

  # Output station summary to screen
  $~ = STATION;
  write;


format STATION =
^<<<< ^<<<<<   @# @#.## @## @#.##   @####    @## ^<<<<<<<<<<<<<<<
$stn, $TRKR{$stn}{name}, $TRKR{$stn}{lat_deg}[-1], $TRKR{$stn}{lat_min}[-1],
$TRKR{$stn}{lon_deg}[-1], $TRKR{$stn}{lon_min}[-1], $sog, $cog, $TRKR{$stn}{datestamp}[-1]
.
}

close (TRKRFILE);
close (GPX);

sub dist_cog {

  my $pi = 3.14159265358979323846;
  my $d2r = $pi/180;
```

```
  my $qmrad = 6372.795478;

  my $lat1 = shift(@_);
  my $lon1 = shift(@_);
  my $lat2 = shift(@_);
  my $lon2 = shift(@_);

  my $a = (90-$lat2) * $d2r;
  my $b = (90-$lat1) * $d2r;
  my $cc = ($lon2-$lon1) * $d2r;
  my $c = acos(cos($a)*cos($b) + sin($a)*sin($b)*cos($cc));
  my $A = acos((cos($a) - cos($c)*cos($b))/(sin($c)*sin($b)));
  if (sin($cc) < 0) {
    $A = 2*$pi - $A;
  }
  my $dist = $qmrad*$c*1000;
  $A = $A/$d2r;
  return ($dist, $A);
}
```

interpolate.pl

```
#!/usr/bin/perl

sub Info {
print STDERR << 'eom';

NAME
 interpolate.pl

SYNOPSIS
 interpolate.pl <beacon_file> <station_file> <beacon_station_table>

DESCRIPTION
        This script reads a Cartenav .csv file (beacon_file) to calculate
        motion vectors for each beacon listed in the file. For each station
        listed in station_file, a geographic position, speed over ground,
        and course over ground are interpolated using the distance-weighted
        average of the motion vectors of two specified beacons. The results
        are output to STDOUT and also written to a GPS Exchange formatted
        file called interp_stn_pos.gpx. The translation from beacon serial
        number (e.g. GSCA05) to station name (e.g. OS005) is specified
        in beacon_station_table.

        NOTE 1: the Cartenav data are reported in Zulu time (UTC) but
              this script converts to local time at CFS Alert (UTC-4).

EXAMPLE
 interpolate.pl beacons.csv stations.lst bcn2stn.lst

FILE FORMATS
        Beacon_file should have the same format as the following
        example, which was obtained from the Cartenav web site
        (www.cartenav.com/icetracker/icetracker.php):

        asset,time,lat,lon,distance,totalOn,deltaOn,gpsOn
        GSCA01,03/31/2006 00:00:18,44.647507,-63.571640,0.008,020104,038,012
        GSCA01,03/31/2006 01:00:31,44.647415,-63.571701,0.011,020128,024,024
        asset,time,lat,lon,distance,totalOn,deltaOn,gpsOn
        GSCA02,04/01/2006 00:00:49,82.510910,-62.329666,0.003,001755,045,010
        GSCA02,04/01/2006 01:00:48,82.510880,-62.329330,0.006,001804,049,010

        etc.

        Station_file contains a listing of all stations for which
        interpolated positions are desired. Each line of the file
        must contain the station name and, with respect to deployment,
        the latitude, longitude, date, and time. The last two columns
        specifiy two beacons which are to be used for the interpolation.
        If the same beacon is specified twice, then the motion of just
        that beacon will be applied to calculate the station motion
        vector. An example station_file follows:

        OR075 +83.946286 -056.826984 15-APR-06 16:05:02 gsca07 gsca07
        OR076 +83.961424 -056.841852 15-APR-06 16:12:28 gsca07 gsca07
        OR077 +83.975694 -056.853387 15-APR-06 16:19:06 gsca07 gsca07
        OR078 +83.989127 -056.858660 15-APR-06 16:25:18 gsca07 gsca09
        OR079 +84.003212 -056.869963 15-APR-06 16:32:19 gsca07 gsca09
        OR080 +84.016094 -056.880809 15-APR-06 16:37:56 gsca07 gsca09
        OR081 +84.032709 -056.885740 15-APR-06 16:43:28 gsca07 gsca09


        Beacon_station_table is a file containing one beacon serial
        number per line with the associated station name, as in the
        following example:

        GSCA02 CACHE-SOUTH
        GSCA03 STNDBY
        GSCA04 STNDBY
        GSCA05 STNDBY
        GSCA06 OS005A
        GSCA07 OS002A
        GSCA08 OS004A
        GSCA09 OS003A
        GSCA10 OS006A
```

```
        GSCA11 OS007A

AUTHOR
        John Shimeld, April 2006

eom
exit(1);
}


use POSIX;
use Time::Local;

die(&Info) if ($ARGV[0] eq '-h');
die(&Info) unless ($#ARGV == 2);

# Input files
$trkr_file = shift;
$stn_file = shift;
$t2s_file = shift;

# Output file
$pred_file = 'interp_stn_pos.gpx';

# hashes and parameters
$prediction_version = 'B';

%month2num = (
  'JAN' => '01',
  'FEB' => '02',
  'MAR' => '03',
  'APR' => '04',
  'MAY' => '05',
  'JUN' => '06',
  'JUL' => '07',
  'AUG' => '08',
  'SEP' => '09',
  'OCT' => '10',
  'NOV' => '11',
  'DEC' => '12'
);

# Build tracker to station hashes
open (T2S, "<$t2s_file") or die ("Error: $t2s_file does not exist.\n");
while (<T2S>) {
  ($tracker, $stn) = split;
  $station{$tracker} = $stn;
}
close (T2S);

$gpx_hdr =
'<?xml version="1.0" encoding="ISO-8859-1" standalone="yes"?>
<gpx
 version="1.1"
 creator="John Shimeld"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns="http://www.topografix.com/GPX/1/1"
 xsi:schemaLocation="http://www.topografix.com/GPX/1/1 /GPX/1/1/gpx.xsd">
 <metadata>
 </metadata>';



#--------------------------------------------------------------------
# open tracker file and create a hash of hashes for all the trackers
#--------------------------------------------------------------------
open (TRKR, "<$trkr_file") or die ("Error: $trkr_file does not exist.\n");
while (<TRKR>) {

  next if /^asset/;

  # read tracker name and position
  @F = split /\,/;
  $F[0] = uc $F[0];
  $T{$F[0]}{name} = $F[0];
```

```
  push @{ $T{$F[0]}{lat} }, $F[2];
  push @{ $T{$F[0]}{lon} }, $F[3];
  push @{ $T{$F[0]}{drift} }, $F[4];

  # parse out the date and time information
  # NOTE: these are assumed to be UTC
  $date_time = $F[1];
  ($date,$time) = split /\s+/, $date_time;
  ($month,$day,$year) = split /\//, $date;
  ($hr,$min,$sec) = split /:/, $time;

  # calculate epoch seconds and convert to CFS Alert local time
  $es = timelocal($sec,$min,$hr,$day,$month-1,$year);
  $es = $es - 4*60*60;
  push @{ $T{$F[0]}{es} }, $es;

}
close (TRKR);

#---------------------------------------------------------------------
# calculate last known COG and SOG for each tracker
#---------------------------------------------------------------------
foreach $idx (keys %T) {
  ($drift,$cog) =
      drift_cog(
        $T{$idx}{lat}[-2],
        $T{$idx}{lon}[-2],
        $T{$idx}{lat}[-1],
        $T{$idx}{lon}[-1]
      );
   $sog = $drift/($T{$idx}{es}[-1]-$T{$idx}{es}[-2]) * 60*60;
   $T{$idx}{last_sog} = $sog;
   $T{$idx}{last_cog} = $cog;
}

#---------------------------------------------------------------------
# open output file for predictions and print the GPX header
#---------------------------------------------------------------------
open (PRED,">$pred_file") or die ("Error: can not open $pred_file.\n");
print PRED "$gpx_hdr\n";

#---------------------------------------------------------------------
# MAIN LOOP
# open station file and loop through one station at a time
#---------------------------------------------------------------------
open (STN,"<$stn_file") or die ("Error: $stn_file does not exist.\n");
while (<STN>) {

  # parse data from file
  @F = split;
  $stn = uc $F[0];
  $stn_lat0 = $F[1];
  $stn_lon0 = $F[2];
  $date = $F[3];
  $time = $F[4];  # this is assumed to be local time at Alert (UCT-4)
  $trkr[0] = uc $F[5];
  $trkr[1] = uc $F[6];

  # parse date and determine epoch seconds
  $day = substr($date,0,2);
  $month = $month2num{substr($date,3,3)};
  $year = '20' . substr($date,7,2);
  ($hr,$min,$sec) = split /:/, $time;
  $es = timelocal($sec,$min,$hr,$day,$month-1,$year);

  # Check that we have data for the two nearest trackers
  if ($T{$trkr[0]}{name} eq '') {
    die("Error: no data for $trkr[0] in $trkr_file.\n");
  } elsif ($T{$trkr[1]}{name} eq '') {
    die("Error: no data for $trkr[1] in $trkr_file.\n");
  }

  # Loop through the two nearest trackers to find their positions
  # at the desired time for the station. Note that we have to keep
  # track of the sign of $dt so that we can correctly interpolate
  # the tracker position with respect to the time of station deployment.
```

```
for $i (0 .. 1) {
  $dt_min = 100000;
  $dt_min_idx = 0;
  $dt_min_sign = 1;
  for $j (0 .. $#{ $T{$trkr[$i]}{es} }) {
    $dt = $T{$trkr[$i]}{es}[$j] - $es;
    if (abs($dt) < $dt_min) {
      $dt_min = abs($dt);
      $dt_min_idx = $j;
      $dt_min_sign = -1 if ($dt>0);
    }
  }

  # $t0 is the time index of the tracker position at the
  # time nearest the deployment time of the station. $t1 is the
  # index of for the second nearest.
  $t0[$i] = $dt_min_idx;
  $t1[$i] = $dt_min_idx + $dt_min_sign;
}

# loop through trackers again to determine necessary information
# for the interpolation
for $i (0 .. 1) {

  # determine time between the tracker reports that span the
  # time interval of interest
  $rpt_int =
    abs( $T{$trkr[$i]}{es}[$t0[$i]]-$T{$trkr[$i]}{es}[$t1[$i]] );

  # warn user if we don't have a tracker position within 1.5 hours of
  # the time of station deployment
  #if ($rpt_int > 5400) {
  #  $msg = "\n\nWARNING: no position for $T{$trkr[$i]}{name} within\n";
  #  $msg .= "         1.5 hours of desired time for station $stn.\n";
  #  $msg .= "         int: $rpt_int\n";
  #  print "$msg";
  #}

  # make sure we have at least one tracker position
  # before or at the time of deployment
  $msg = "Error: $trkr_file must contain tracker coordinates\n";
  $msg .= "       for times before and after the station deployment.\n";
  if ($T{$trkr[$i]}{es}[0] > $es) {
    die($msg);
  } elsif ($T{$trkr[$i]}{es}[-1] < $es) {
    die($msg);
  }

  # determine the drift and course over ground for the tracker between
  # reported time and the deployment time
  ($extra_drift[$i],$extra_cog[$i]) =
    drift_cog(
      $T{$trkr[$i]}{lat}[$t0[$i]],
      $T{$trkr[$i]}{lon}[$t0[$i]],
      $T{$trkr[$i]}{lat}[$t1[$i]],
      $T{$trkr[$i]}{lon}[$t1[$i]]
  );
  $extra_drift[$i] = $extra_drift[$i] * $dt_min/$rpt_int;

  # find the coordinates of the two closest trackers at the
  # time of deployment
  ($trkr_lat0[$i],$trkr_lon0[$i]) =
    new_ll(
      $T{$trkr[$i]}{lat}[$t0[$i]],
      $T{$trkr[$i]}{lon}[$t0[$i]],
      $extra_drift[$i],
      $extra_cog
  );

  # find total drift and course over ground for the two closest trackers
  ($trkr_drift[$i],$trkr_cog[$i]) =
    drift_cog(
      $trkr_lat0[$i],
      $trkr_lon0[$i],
      $T{$trkr[$i]}{lat}[-1],
      $T{$trkr[$i]}{lon}[-1]
```

```
    );

  # find distance (and bearing) between each of the trackers
  # (at $t0) and the station
  ($dx[$i],$brg[$i]) =
    drift_cog(
      $trkr_lat0[$i],
      $trkr_lon0[$i],
      $stn_lat0,
      $stn_lon0
  );
} # end of $i loop

# calculate weight for averaging of iceflow vectors
$wt = 1 - $dx[0]/($dx[0]+$dx[1]);

# predict the coodinates of the station in two steps by following
# the weighted average vector course
($stn_lat1,$stn_lon1) =
  new_ll(
    $stn_lat0,
    $stn_lon0,
    $wt*($trkr_drift[0]+$extra_drift[0]),
    $trkr_cog[0]
  );
($stn_lat1,$stn_lon1) =
  new_ll(
    $stn_lat1,
    $stn_lon1,
    (1-$wt)*($trkr_drift[1] + $extra_drift[1]),
    $trkr_cog[1]
  );

# find distance and bearing of station from last known position
($stn_drift,$stn_brg) =
  drift_cog(
    $stn_lat0,
    $stn_lon0,
    $stn_lat1,
    $stn_lon1
  );

# output summary of results to screen
printf "\n\nSTATION: %s\n", $stn;
printf "  Last known coordinates: %s, %s (%s %s)\n",
  ddm($stn_lat0), ddm($stn_lon0), $date, $time;

if ($dx[0] < $dx[1]) {
  $near = 0;
  $far = 1;
} else {
  $near = 1;
  $far = 0;
}

# calculate distance and bearing between last known position
# of the nearest tracker and the estimated station position.
 ($distance,$bearing) =
   drift_cog(
     $T{$trkr[$near]}{lat}[-1],
     $T{$trkr[$near]}{lon}[-1],
     $stn_lat1,
     $stn_lon1
 );

$oday = ( localtime($T{$trkr[$near]}{es}[-1]) )[3];
$omonth = ( localtime($T{$trkr[$near]}{es}[-1]) )[4];
$omonth =
  (JAN,FEB,MAR,APR,MAY,JUN,JUL,AUG,SEP,AUG,OCT,NOV,DEC)[$omonth];
$oyear = ( localtime($T{$trkr[$near]}{es}[-1]) )[5];
$oyear = sprintf("%02d", $oyear % 100);
$ohour = ( localtime($T{$trkr[$near]}{es}[-1]) )[2];
$ohour = sprintf("%02d", $ohour);
$omin = ( localtime($T{$trkr[$near]}{es}[-1]) )[1];
$omin = sprintf("%02d", $omin);
$osec = ( localtime($T{$trkr[$near]}{es}[-1]) )[0];
```

```
  $osec = sprintf("%02d", $osec);
  $lrt[$near] = "$oday-$omonth-$oyear $ohour:$omin:$osec";
  $lrp[$near] = ddm($T{$trkr[$near]}{lat}[-1]) . ', ' .
                ddm($T{$trkr[$near]}{lon}[-1]);
  $lrt[$far]  = localtime($T{$trkr[$far]}{es}[-1]);
  $lrp[$far]  = ddm($T{$trkr[$far]}{lat}[-1]) . ', ' .
                ddm($T{$trkr[$far]}{lon}[-1]);

  printf "  Predicted coordinates:  %s, %s (%s)\n",
    ddm($stn_lat1), ddm($stn_lon1), $lrt[$near];

  printf "  Predicted distance from last known position: %.3f km (%.1f nm)\n",
    $stn_drift, $stn_drift/1.852;
  printf "  Predicted bearing from last known position: %.1f degrees\n\n",
    $stn_brg;
  printf "    Nearest tracker: %s/%s (%s)\n",
    $T{$trkr[$near]}{name},$station{$T{$trkr[$near]}{name}},
    $lrt[$near];
  printf "    ... coordinates: %s\n", $lrp[$near];
  printf "    ... speed over ground:  %0.3f km/hr (%.3f knots)\n",
    $T{$trkr[$near]}{last_sog}, $T{$trkr[$near]}{last_sog}/1.852;
  printf "    ... course over ground: %0.1f degrees\n",
    $T{$trkr[$near]}{last_cog};

  printf "    ... distance to predicted station position: %.3f km (%.1f nm)\n",
    $distance, $distance/1.852;
  printf "    ... bearing to predicted station position: %.1f degrees\n",
    $bearing;

  # output predictions to file
  print PRED "<wpt lat=\"$stn_lat1\" lon=\"$stn_lon1\">\n";
  print PRED " <name>$stn$prediction_version</name>\n";
  print PRED " <desc>$lrt[$near]</desc>\n";
  print PRED " <sym>Dot</sym>\n";
  print PRED "</wpt>\n";

}

print PRED " <extensions>\n </extensions>\n</gpx>\n";

close (PRED);
close (STN);

sub ddm {
  my $deg = pop;
  my $int_deg = int($deg);
  my $min = (abs($deg)-abs($int_deg))*60;
  $min = sprintf "%.2f", $min;
  my $ddm = $int_deg . ' ' . $min;
  return ($ddm);
}

sub drift_cog {
  my $pi = 3.14159265358979323846;
  my $d2r = $pi/180;
  my $qmrad = 6372.795478;

  my $lat1 = shift(@_);
  my $lon1 = shift(@_);
  my $lat2 = shift(@_);
  my $lon2 = shift(@_);

  my $a = (90-$lat2) * $d2r;
  my $b = (90-$lat1) * $d2r;
  my $C = ($lon2-$lon1) * $d2r;
  my $c = acos(cos($a)*cos($b) + sin($a)*sin($b)*cos($C));
  my $A = acos((cos($a) - cos($c)*cos($b))/(sin($c)*sin($b)));
  if (sin($C) < 0) {
    $A = 2*$pi - $A;
  }
  my $dist = $qmrad*$c;
  $A = $A/$d2r;
  return ($dist, $A);
}

sub new_ll {
```

```
  my $pi = 3.14159265358979323846;
  my $degree = 180.0/$pi;
  my $radian = $pi/180.0;
  my $qmrad = 6372.795478;

  my $lat_0 = shift(@_);
  my $lon_0 = shift(@_);
  my $dx = shift(@_);
  my $hdg = shift(@_);
  my $lon_n = '';
  my $lat_n = '';

  my $A = $hdg*$radian;
  my $b = (90-$lat_0)*$radian;
  my $c = $dx/$qmrad;
  my $a = acos(cos($b)*cos($c) + sin($b)*sin($c)*cos($A));
  $lat_n = 90 - $a*$degree;
  my $C = acos((cos($c)-cos($b)*cos($a))/(sin($b)*sin($a)));
  if ( sin( $hdg*$radian ) > 0 ) {
    $lon_n = $lon_0 + $C*$degree;
  } else {
    $lon_n = $lon_0 - $C*$degree;
  }

  return ($lat_n,$lon_n);
}
```

Weather and Ice Support

Ken Asmus, Environment Canada, Canadian Ice Service

The Canadian Ice Service (CIS), in partnership with the Danish Meteorological Service (DMI) are providing weather and ice information support to the LORITA Project. A number of standard meteorological products as well as a number of modified/special products are made available from CIS and DMI with the co-operation of the Prairie and Arctic Storm Prediction Centre and the Canadian Meteorological Aviation Centre - West.

These products are automatically uploaded to an FTP site and can be downloaded at the LORITA Base Camp at CFS Alert.

The following is a summary of available products daily:

Weather Support

* Graphical Forecast Aviation (NavCanada: extension to LORITA-1 area). Products will include an icing, freezing level and turbulence forecast, and a clouds and weather forecast (GFACN37). The area covered will be expanded across the LORITA-1 operational area of interest. This work is performed by CMAC-W.
* IABP data: International Arctic Buoy Program. Provision of ice drift information. An IABP buoy will be provided by Ed Hudson, PASPC, for deployment at the most northern point of the LORITA-1 line.
* GEM Pressure & Winds: Marine Wind Prognosis 00h, 12, 24, 36, 48h for LORITA-1 area.
* Public Forecast for Alert and LORITA-1 area (FXCN23). A special LORITA-1/Lincoln Sea section will be added to the FXCN23 by PASPC for the duration of the field program.
* Weather Warnings for Alert and LORITA-1 area – provided by PASPC.
* Complete Surface Analysis Chart 00, 06, 12 and 18Z.
* Forecast wind visualization products for LORITA-1 area, provided by PASPC.
* Public and Extended forecasts for High Arctic Area of Nunavut, issued by PASPC.

Ice Support

* Production of additional Regional Ice Analysis Chart for Eastern Arctic: mid-March and mid-April - by CIS.
* Preparation of an image analysis product for the Nares Strait/Kane Basin/ Smith Sound area, including an embedded Ice Bridge text message - by CIS.
* Tracker analysis of operational SAR data (RADARSAT and/or ENVISAT ASAR) obtained during the field experiment - by CIS.
* Archive of Ice motion analysis - by CIS.
* RADARSAT SAR Image Analysis using WMO code. Drift arrows capability to indicate past motion - by DMI.
* Ice Warnings and text messages for Lincoln Sea area - by DMI.
* Provision of special LORITA area NOAA AVHRR images (VIS and IR) - by MSC Edmonton.
* NOAA AVHRR and RadarSat Quick Look products as well as a 4-day Wind and Ice Motion forecasts - by DMI.
* Archive: At the end of the project a copy of all image analysis in a PDF or gif format will be

made available on CD and on a digital format - by DMI.

Communications

Access to the Internet and the FTP site are provided through the courtesy of Andrew Platt, Manager of the Global Atmospheric Watch (GAW) Lab in Alert. There is a PC and printer available to download and print all ice and weather products available on the FTP site as well as via WWW sites.

Daily Routine

The daily routine for Weather and Ice Information support as follows:

* 05:30 - 07:00 acquire, print, produce briefing packages (aircrew and science team)
* 06:30 aircrew briefings package ready for Dave Maloley
* 07:00 - 07:30 breakfast
* 07:30 - 08:30 science briefing and meeting, receive actual weather from the Ice Camp and FAX to ARWC and upload to FTP site
* 08:30 - 11:30 monitor weather and provide advice and updates as required
* 11:30 - 12:00 lunch
* 12:15 - 13:00 download current update weather and ice products and brief Dave Maloley and/or chief scientist as required
* 13:00 - 15:30 monitor weather and provide advice and updates as required
* 15:30 - 17:00 off (available if required for updates to weather/ice)
* 17:00 - 17:15 Dinner
* 17:15 - 18:00 update weather and ice products
* 18:00 - 18:30 provide briefing to chief scientists and Dave Maloley at their planning meeting

Other Activities

* Set up and tested the portable Campbell Scientific Weather Station to be deployed at the Ice Camp. Showed Jorgen Shafte, Ice Camp Manager, how to set up and operate the station. It was deployed on April 4.
* The Ice Camp is providing at full weather report at 12Z daily. These reports are faxed to the Arctic Weather Centre.
* Reviewed the installation of the Met Buoy provided by Arctic Weather Centre with Mike Gorveatt (ice camp) who will look after it's installation on the ice. It was temporarily set up at the Ice Camp and will be relocated the first opportunity to the most northern point possible.
* Provided a special aviation weather briefing for the Greenland Air flight crew.
* Transferred weather and ice monitoring duties to Christian Marcussen .

Observations

* The project is highly dependant on the weather and ice situation.
* In retrospect, it probably would have been good to have a weather and ice specialist assigned to the entire project.
* RadarSat data has been of limited usefulness due to a) low resolution products - communications bandwidth limitations and b) timeliness/frequency of data availability.
* The NOAA AVHRR products from the Resolute Bay receiving station are the most useful product.
* DMI has provided very good false colour coded AVHRR images - these are very good due

to the clear skies in the area.

Comments

It has been a pleasure working with the LORITA Project. I am pleased that I was accepted as a full member of the team and I am very glad that no one wanted to "shoot the messenger" on the bad weather days!

I will be monitoring your progress from home and look forward to hearing the final results of LORITA-1 project in the future.

Driller's Report

Ron Verrall, Canadian Arctic Logistics Cooperation
John Boserup, Geological Survey of Denmark and Greenland

The Task

The placement of explosives for the LORITA-1 project involved the drilling of 10-inch (25-cm) holes followed by the lowering of 170 kg of explosive down each hole. (Some sites required two holes and a total of 340 kg of explosive.) Three helicopters were used in an assembly-line sequence: the first one carried the drill team and their equipment; the second delivered the explosive to the site, and the third helicopter carried the installation crew that prepared the explosives and lowered them down the hole(s).

This report describes the job carried out by the drilling crew – the crew in the first helicopter. In brief, they went to the site specified by the seismic planners, hunted in the immediate neighbourhood for appropriate ice and then drilled and marked the holes.

This report also describes the equipment that was available for drilling ice holes. It says what was used and why, and it makes suggestions for equipment that might be considered in future work of this kind.

Appropriate Ice

We had no trouble navigating to the planned location. This was made easy by modern GPS (Global Positioning System). Once there, our hunt for suitable ice began. Acting on instructions from the seismologists, we hunted along the seismic line for a suitable spot. We were told that location errors along the track were much less serious than errors across the track. In practice, we considered a cross-track error of 100 m to be large, and we tried to do much better than this.

We looked for ice that was thin enough to drill through easily but thick enough that it wasn't likely to be crushed in the following few days. Old annual ice – that is, ice that had been growing since the beginning of this year's season – was slightly more than 2 m thick. This was thicker than was convenient to drill through. Moreover, it tended to be covered with a thick layer of snow. We looked for ice that was newer, thinner and less snow-covered. An ice thickness between 1 m and 1.5 m was ideal.

Figures 1 and 2 shows the type of ice we looked for. The smooth areas marked by the black outline shows ice that looks very promising. The smoothness (lack of wind-formed sastrugi) indicates newness. Therefore, it should be reasonably thin. On the other hand, there is no open water or very thin ice in the neighbourhood. This indicates that the area is fairly stable.

Figure 3 shows ice that was not considered suitable. Although the ice on the right side of the lead is probably thick enough for our purposes, the ice in this area is obviously not stable. The open water indicates recent ice motion. This lack of stability strongly militates against the installation of explosives here. In a few days the holes might well be at the centre of a growing pressure ridge, in which case the explosives would probably be lost.

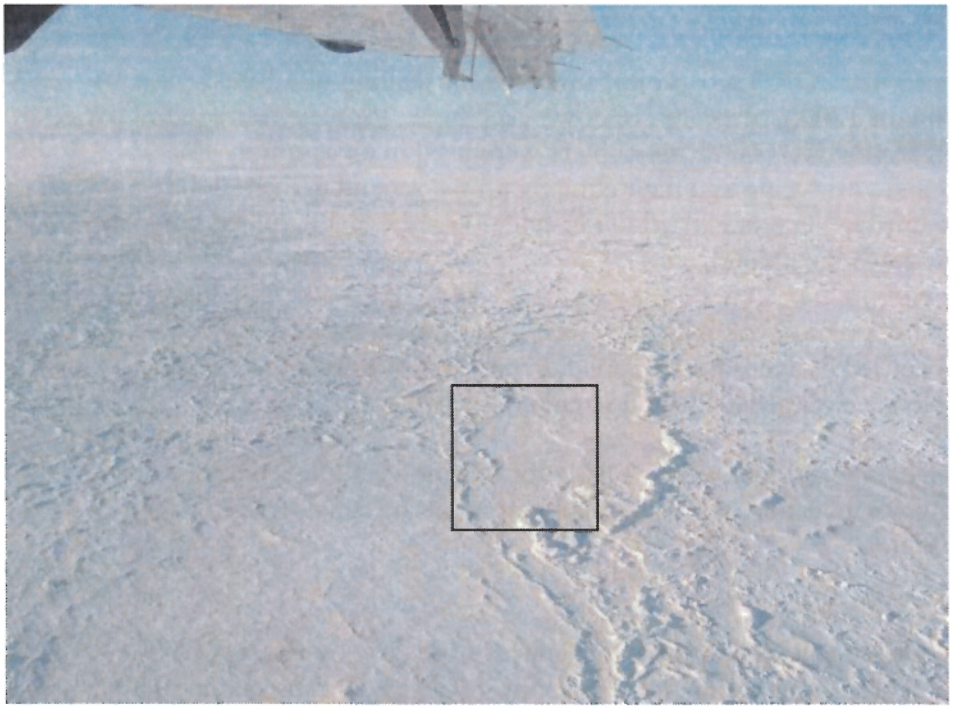


Figure 1: An example of thin first-year ice. The ice looks reasonably stable.

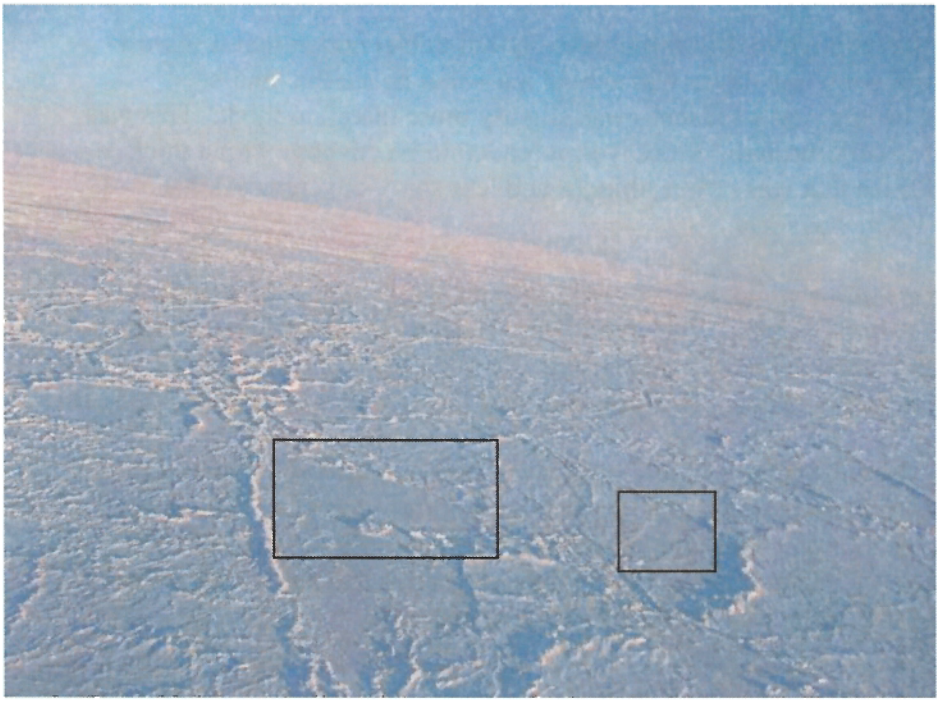


Figure 2: Two more examples of thin, stable first-year ice.

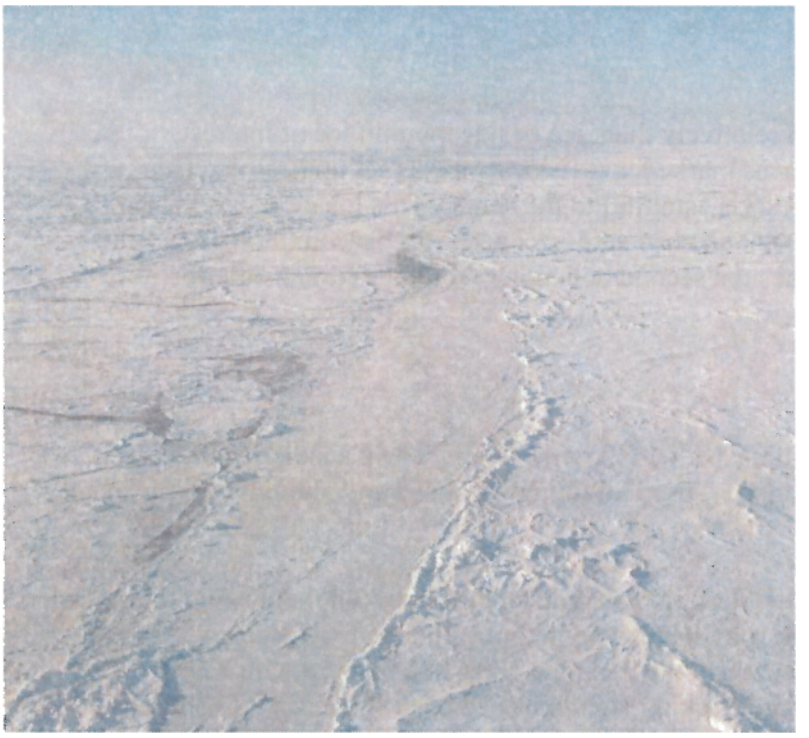


Figure 3: A partially frozen-over lead. The ice on the right-hand side is probably thick enough for our purposes. However, the recent ice motion in the area makes any sort of installation dangerous.

Figure 4 shows the helicopter sitting on ice that is definitely thick while we are working on the thinner ice. It is interesting that the thin ice was generally thicker than was predicted by its appearance. In this picture, for example, the ice was covered with frost flowers, something that is generally associated with ice thinner than about 30 cm. However, this ice was more than 1 m thick.

In practice, the helicopter would land on relatively thick ice beside the thin ice of interest. Once the holes were drilled and the site was marked, a GPS beacon was set up nearby. This beacon periodically broadcast its location (via satellite) to the south. This location was then accessible to us over the internet. Each shot site had an associated GPS beacon. Sometimes the lead helicopter would set it up; other times the second helicopter would be responsible for installing it.

Drilling Equipment

Two different systems were used for drilling 10-inch (25-cm) holes. The Canadian unit – supplied by the Geological Survey of Canada – used a Stihl power-head and aluminum 10-inch flukes. Its serial number is 114 036935.

Three of these power-heads were taken to Alert, the main difference between them being the gear box that decreased the engine's high rpm down to something suitable for the auger. Two of these gear boxes were marked with the number "40", and the other was marked with "333". These numbers seem to be the approximate working angular speed of the auger in "revolutions-per-minute". The ones marked "40" were far too slow for drilling in ice, whereas the one marked "333" was quite useable, although it was a bit too fast. The slower ones (marked "40") may have been designed for drilling in soil.

I understand that the faster gearboxes are no longer made and that the GSC has only the one left. Needless to say, it should be looked after with great care.

The drilling system brought by the Danes used a Stihl model BT 121 powerhead. The augers were made of steel. The rotational speed, which was approximately 190 rpm, was excellent.

Both systems had their advantages and disadvantages. The Canadian powerhead was the more powerful, but it was appreciably heavier. Its extra power would have been useful if we had been drilling through thick ice. As it was, with the maximum ice thickness being of the order of 2 metres, the lighter Danish powerhead was the one preferred. See Figure 5.

The Danish augers, being made of steel, were heavier than the aluminum augers brought by the Canadians. The difference in weight was not, however, large enough for us to prefer the Canadian drill. The Moira cutting blades used by the Danish drill were very sharp, and they cut through the ice much faster than did the Canadian cutters.

A third drill was used occasionally. John Boserup brought a 5-cm (2-inch)-diameter bit turned by a hand-held battery-powered drill. See Figure 6. This small bit cut its way through the ice very quickly, and we used it to measure the ice thickness – particularly when we suspected that the ice was thicker than we could handle with the bigger drills.

The small power-head (a Milwaukee drill) used a lithium-ion battery, which works very well in the cold. The drill's main disadvantage was that it had to be kept free of snow. If it were set on the ice, loose snow would melt in its workings, and the resulting water would soon freeze. The drill would then be useless until it was thawed out.

Figure 6: 5-cm drill in use.

Recommendations

Use the lighter Danish drill system for ice thinner than 3 metres.

Use the heavier Canadian drill system for ice thicker than 3 metres. Because of the weight of the drill and the slushy ice in the hole, make sure that there are at least three operators present. If the ice is thicker than 4 m, a tripod and block-and-tackle are recommended.

Obtain aluminum auger flights for the Danish system.

See whether it is possible to attach longer handles to the Danish powerhead.

Bring spare cutting blades for all systems.

The protective cover for the cutting auger is poor. Develop something better. Anything rubber should be tested to –45 degrees.

Had some trouble with thick gear-case oil in the Danish unit. Ask Stihl about what oil should be used in very cold weather.

Ask Stihl about problems that might arise if the fuel is too rich in oil.

Bring small axe to round off the corners of the ice holes.

The spark plug used this year on the Danish system was JC7Y. It worked well, but bring hotter plugs in case the weather gets really cold.

Bring short-handled shovel.

Tool box with visegrips, farmer's pins, spare sparkplugs, sparkplug wrench, spare cutting blades, tape measure or wooden ruler.

Get strainer with large holes. Perhaps a large spoon with large holes.

Make or buy a protective cover for the battery-powered drill.

Marine Observer's Report

Jopee Kigutak, Hunters and Trappers Organization, Grise Fiord , Nunavut

Introduction

Both Canada and Denmark have signed a treaty called the United Nations Convention on Law of the Sea (UNCLOS). Because I was not home when Ruth Jackson gave her presentation on UNCLOS, she gave me the same briefing. I learned what is required for Canada to claim additional territory in the North.

Canada has ten years in which to submit a claim the date is November 6, 2013 for an extended continental margin. The territory is not automatically acquired by Canada, water depth measurements and information on the subsurface geology provided by sound must be submitted to the Commission on the Limits of the Continental Shelf. To make this claim Canada is collecting these data by firing explosives. The sea ice prevents the data being collected in a less noisy fashion.

My impressions of the blast

Explosions were fired on LORITA (Lomonosov Ridge Test of Appurtenance) project. The word appurtenance means attached. The scientists had to show the geology of the ridge was similar to that near the coast. It was a joint project with Denmark. Because it was a joint project along their border only one experiment was needed to satisfy both countries claims, therefore half the amounts of explosives were detonated. The explosives were purchased from Western Explosives a Canadian company that is 51% aboriginal owned.

On Monday April 3, 2006 at 85^0N and 59^0W at the ice camp, before the testing of the power of the explosions began I walked around and looked for signs of animal tracks such at fox or polar bear. At least at this sight there were no signs of animals. Before the testing of the charges from small to large began, the shooter Dave Forsyth asked my permission to fire the charge.

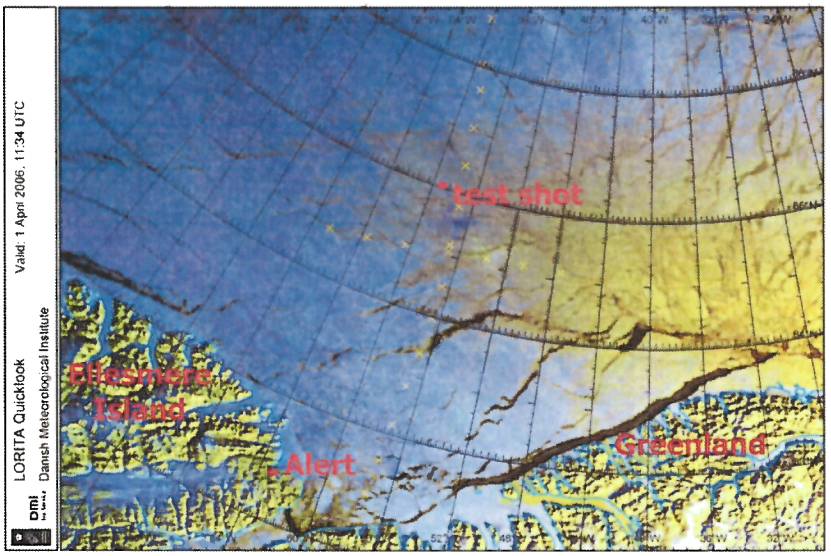


Figure 1 The red dots show the position of the test shot of 375 kg. The yellow x's indicate planned positions of other shots.

The purpose of the test shot was to record the absolute levels of the largest explosion that would be fired during the LORITA experiment. Two test shots of progressively greater size were fired primacord and a single 17.5 kg charge and then a 350 kg charge.
A Tourmaline hydrophone supplied by Fisheries and Oceans that can record the absolute level of the blast was placed in the water 100 meters from the charge. The large charge felt strong as the ice lifted beneath my feet. It lasted maybe 3 seconds as a strong sharp crack. It felt something like standing on a board that was hit from below with a sledge hammer. The ice was not damaged by the explosion.

Information on how the charges were loaded

We augered 10 inch diameter holes through the ice. The charges are custom manufactured to 8 inches in diameter to fit the round holes (Fig. 2). The charges and primacord are lowered on a rope with a round plywood plate at the base of the charge. They are lowered 100 m below the surface of the ice and tied off at an axe handle at the top. The rope is .5 inch manila rope, a natural fiber, with sufficient safety margin in strength to support up to 175 kg per charge. Charges of 350 kg were hung on two ropes. The specific gravity of the pentolite is 1.6 and therefore the charges will weigh roughly 60% in water than in air. The breaking strength of the rope is 1202 kg.

Figure 2 the charge shape for this experiment. The centre hole will be threaded with rope and the perimeter holes will be laced with primacord.

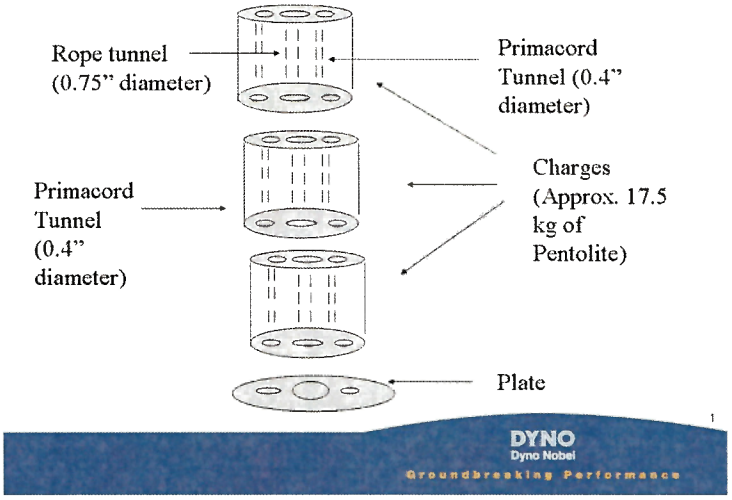


Figure 3 showing orange charges being laid out on the ice.

Table 1 Common Sound Sources and Levels

Sound Source	Noise Level dB	Reference
Motorboat outboard	80	www.nonoise.com
Motorboat inboard	110	www.nonoise.com
Gun Shot	140	www.nonoise.com
Ice Breaker	180-185	Richardson et al. (1995)
Natural Background - Pack-ice Breaking	180	Greening and Zakarauskas (1994) Richardson et al. (1995)
Bowhead Whale Song	158-189	Richardson et al. (1995)
Beluga echolocation	206-225	Richardson et al. (1995)
Explosives	To be completed	This Study

Information on the ice is important to understand the distribution of animals in the region. The satellite information shown in the Figure 1 was combined with observations while flying in the Twin Otter. On the way back to Alert from the ice camp we looked at the ice from the aircraft. The vast majority of the ice is either frozen this winter or young flows. Little multiyear ice was spotted in this area.

The next day April 4, 2006 Tuesday was sunny and bright -26 to -34^{0}C at Alert. I flew from Alert to the camp and then towards Greenland with Ron. On the return flight the Twin Otter flew low southward towards Nares Strait. However it was difficult to check for signs of animal life because it was really foggy and I could not see.

In general, the ice showed variable surface patterns. Sometimes flat and wind blown, others areas had young block shaped ridges 10 feet high. In other regions the ice was crushed in big rubble fields. There were also regions with leads with black ice. This darker ice was drilled and found to be a surprising 3 feet in thickness.

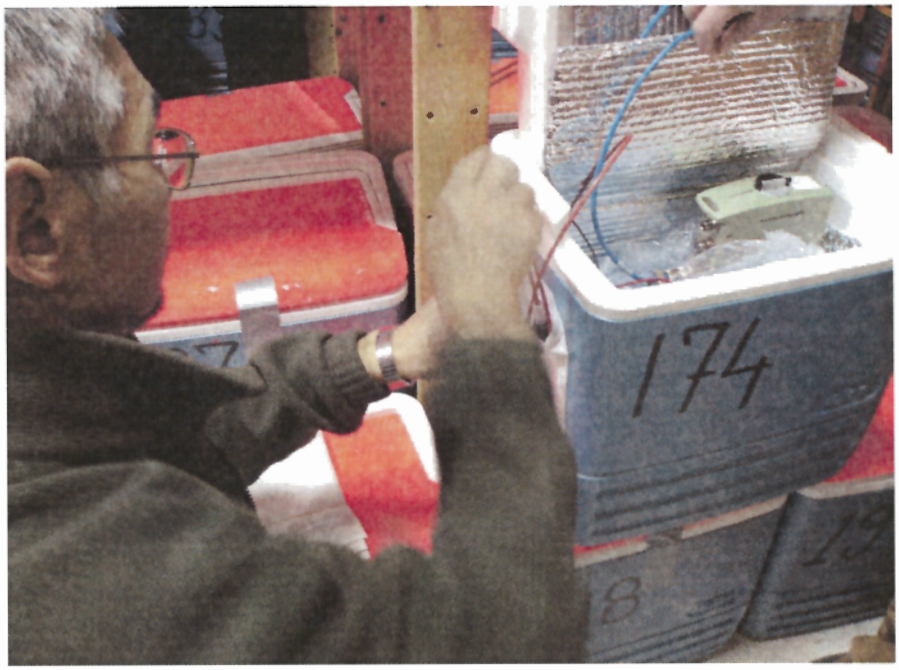
Summary:
The explosions were loud but lasted a short time. During my two week stay and several trips over the sea ice I did not see any fresh or even old tracks. Of course I cannot see what is under the ice. I cannot tell if any thing in the water was killed.

Other scientific activities I participated in:

John Shimeld and I (who I shared a room with) worked at getting beacons unpacked. The

beacons were built for this experiment. John will leave them on the ice to track its motion so they can find their instruments after they left them on the moving sea ice. Sometimes the ice trackers indicated the sea ice moved 100 m an hour. They were made by a Canadian company called CarteNav located in Dartmouth, Nova Scotia.

I helped set up the equipment that records the sounds the explosives make. The instruments are called seismometers. The green case is the electronics that records the sound. The blue box with the orange top is an insulated box to keep them warm at -30^{0}C. The red cable is attached to a device that sits on the ice called a geophone.



This is a picture of the octagon tent I helped set up at the ice camp. The flags are to remind me that both Canada and Denmark were part of the LORITA project.

The scientists needed a camp on the ice near the middle of their experiment. The camp provided weather information and an emergency runway for the 3 helicopters, Long Rangers and a Twin Otter. The camp was situated on the most promising flow that the experienced pilot Paul Rask could find. It is probably only 6 feet thick, the scientists would have preferred a flow that was twice that thickness but there was nothing suitable in the region.

I flew to the camp with 4 other people to set it up. They were called: Jorgen Skafte, Greg Middleton, Mike Gorveatt and Ron Verrall. The Twin Otter reached the Ice Camp mid morning. During the time we were there we set up three tents. They were about 8 feet in diameter. It took about twenty minutes to set up the first tent. We turned on the small round stove an OHR made by MIE Stoves of Richmond BC. It quickly heated up the tent. This was good because it was cold. We left on a Twin Otter later in the afternoon.

The picture above shows me standing on the flow at the ice camp with a pressure ridge in the back ground.

This photograph is of me and as planned Søren Bredvig from Denmark at the ice camp before we set the tents up. The boxes the tents were in are in the back ground.

Blaster's Report

Peer Jørgensen, Geological Survey of Denmark and Greenland
Tim Cartwright, Geological Survey of Canada (Ottawa)

Early in the project on April 3, 2006 we carried out two test shots with purpose of testing the detonators, primacord and charges, ensuring all the blasters had an agreed method of loading and blasting and monitoring the absolute level of the blasts.

The first blast was done with one 17.5 kg charge 100 m under the ice. The primacord was threaded through down and up again through the two small holes in the charges and taped together above the charges so only on string of primacord continued to the surface. When blasting the full length of primacord (50 m on the surface) was rolled out and two detonators attached serially, and finally a 100 m cable was rolled to the shot box. The blast was a success. The full charge (two holes with each 10 charges – 350 kg) was detonated using the same principles as described above. Also this blast was successful.

The method for measuring the pressure pulse from the detonations, consisted of one pressure transducer lowered through the ice at a blast distance of 100 m radially, and 60 m below the ice surface. The recording device used was an Instantel Blastmate II, supplied for us under contract by Explotech Inc. of Ottawa, Ontario. The unit was to have been preconfigured for the expected energy levels and sensor used. However during the test shots described previously, the unit triggered, but reported the energy levels in db, rather than the expected kPa. Upon examining the data, it was clear that something was wrong, and that the recorder was incorrectly configured, or that it had reset it's parameters to a default level. Therefore the data recorded was meaningless. After consulting with Explotech, it was determined that the unit was in fact configured incorrectly. A second attempt was made to measure the pressure pulse on April 28th during the ice camp demob, and although the parameters had been corrected as per Explotechs instructions, the unit failed to trigger on the blast. At this point, the expense in effort, in explosives, and project delays precluded any further attempts to monitor the blast pressure pulse.

Loading the shots was done by three teams: a drilling team of two, a loading team of three and a supply team of one who ferried the explosives out to the sites after drilling. This worked well, although the loading team occasionally had to wait for the explosives as the distance from the caches to the shots sites sometime was quite large, and the L4 doing the ferrying only could carry explosives for two holes (20 charges) at a time.

The loading team of three turned out to be ideal, as two holes could be loaded in 30 min, assuming the pilot assisted in disposing of the cardboard boxes the explosives came in. Each shot site was marked with two black garbage bags filled with snow, and a satellite tracker was left at each site.

Drilling team

Loading a hole

The blasting was done in three teams of two, which was ideal when carrying equipment from the helicopter (2-300 m off) to the blast site.

The two primacord lines (one from each hole) were rolled out together to there full length approx. 2m apart. At the end they were taped together and two detonators were attached serially; then approximately 100 m of shot cable leading to the shot box.

Each blasting team had assigned shooting times so no communication was required. Team 1 could blast at 00 and 30 minutes after the hour; team 2 at 10 and 40 minutes after the hour and team 3 at 20 and 50 minutes after the hour. Each team reported back to Dave M. when all blasts where done so recovery of receivers could commence.

Experience with equipment

Loading holes:

For each hole we used 100 m of manila rope, 150 m primacord, 1 wooden plate to prevent the charges from sliding off the rope at the base of the charge string, 1 pickaxe handle to anchor the rope over the hole at the surface and 10 charges of 17.5 kg. All worked well as

planned.

Blasting

There were problems with the trigger pulse from the GPS clock built into the shot boxes, forcing us to use the internal clock (calibrated in the morning) with out the continuous calibration intended. A technician from Ottawa, Bob Schieman came to Alert to solve the problem, and it turned out the GPS receiver issued 4 decimal points instead of the expected 3 due to the good GPS receiving conditions at Alert. The software was amended to deal with this, there after the shot boxes worked fine. The GPS display became difficult to read below -10°C, making it necessary to keep the shot boxes warm. It should be considered replacing the display with one better suited for cold temperatures.

Lowering the charges

Rolling out the primacord

Hole loaded

Total explosives shipped 9975 kg

Table
Number of shots fired in water

Latitude	Longitude	shot #	Size
84.988840	-59.553406	Test	17.5 kg
84.988840	-59.553406	Test	350 kg
82.487142	-56.231821	IS1	350 kg
82.766678	-56.358237	IS2	350 kg
83.062134	-56.446777	IS3	350 kg
83.346954	-56.594986	IS4	350 kg
83.665392	-56.857670	IS5	350 kg
83.933876	-56.914535	IS6	175 kg
83.652748	-056.951839	OS1	350 kg
83.956904	-057.276713	OS2	350 kg
84.227171	-057.993619	OS3	350 kg
84.513775	-058.342814	OS4	350 kg
84.776401	-057.530572	OS5	350 kg
85.107256	-059.490388	OS6	350 kg
85.404848	-060.050325	OS7	350 kg
85.568831	-059.522121	OS8	350 kg

```
85.797167 -059.157278  OS9  350 kg
86.283670 -060.620370 OS10  350 kg

84.46083  -62.71648    XS1  175 kg
84.48553  -60.11095    XS2  175 kg
84.51347  -58.30102    XS3  175 kg
84.53013  -56.21233    XS4  175 kg
84.53613  -54.63715    XS5  175 kg
84.55125  -52.59493    XS6  175 kg
```

The remainder of the explosives 3132.5 were detonated in the air on the ice at the camp to dispose of them. This occurred due to the pervasive poor weather that prevented as many charges as planned being fired.

Ice Camp Logistics

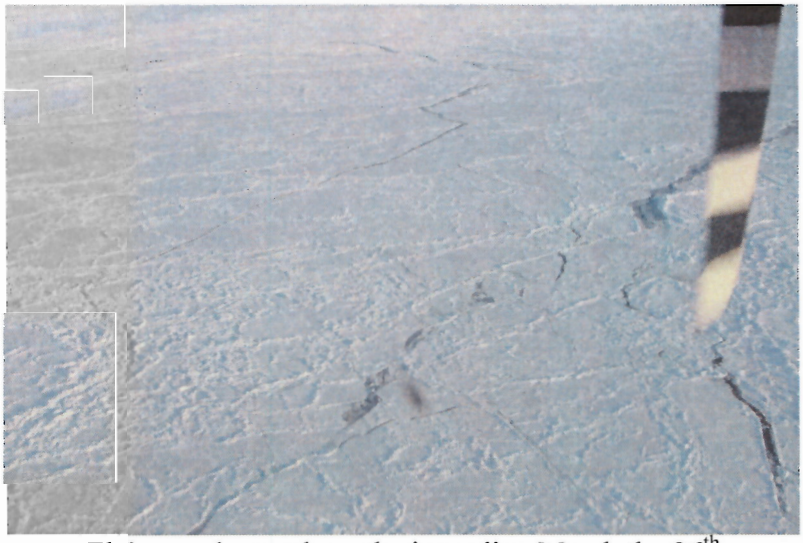
Jorgen Skafte,

The camp was set up to provide a depot for fuel and explosives, and as an alternative for aircrafts working in the area. The camp was planned to be located close to the crossing of the inner line and the cross line. Because of the condition of the ice, the camp was moved approximately 40 kilometers further to the north. A single channel seismic system was set up and operated for 17 days. A weather station was logging temperature, pressure and wind every 15 minute for 24 days.

Establishing the ice camp

Satellite images showed wide leads in the area, where we planning to operate. We did not have very much help using the satellite images. The resolution was not good enough and we got no information about the movement of the ice in the area where we were supposed to work. Doing your own observations from a plane still seems to be the best (and only) way to locate a suitable area for a camp site.

We made the first search for a camp site on March the 26th. Flying up the inner line to the planned position of the camp, we saw some very wide leads, mostly first year ice and a lot of crushed ice.



Flying to the north on the inner line March the 26th

At the position 84°37,193 N and 57°10,251 W a piece of multi year ice next to a refrozen lead was selected. We landed, marked the runway and left a VHF beacon on top of a drum with fuel.
On March the 27th we returned with 5 more drums of fuel. Because several new leads had opened around the site, we decided to move the camp to a position north of the last visual east-west going lead.

The first site as it looked on March the 26th and the 27th Runway marked with red line

In an area with only first year ice and a lot of newer ridges we found only one location, where it was possible to establish a runway for the Twin Otter. We decided to leave the fuel and a new VHF beacon and then observe the movements of the ice. We measured the thickness of ice to be more than four feet. Later we found a variation of the thickness from five to seven feet.

Our first landing and marking of the runway March the 27th

For the next five days, the Twin Otter made several trips to the site with fuel and equipment for the camp, without observing any movements in the area.
Although it is preferred to establish a camp on a multi year float and we had some strong winds, we never saw any cracks or noticed any activities from the ridges around the camp.

Drift of the ice

From March the 27th until April the 28th we moved 97 km to the west. The total distance was 127 km.

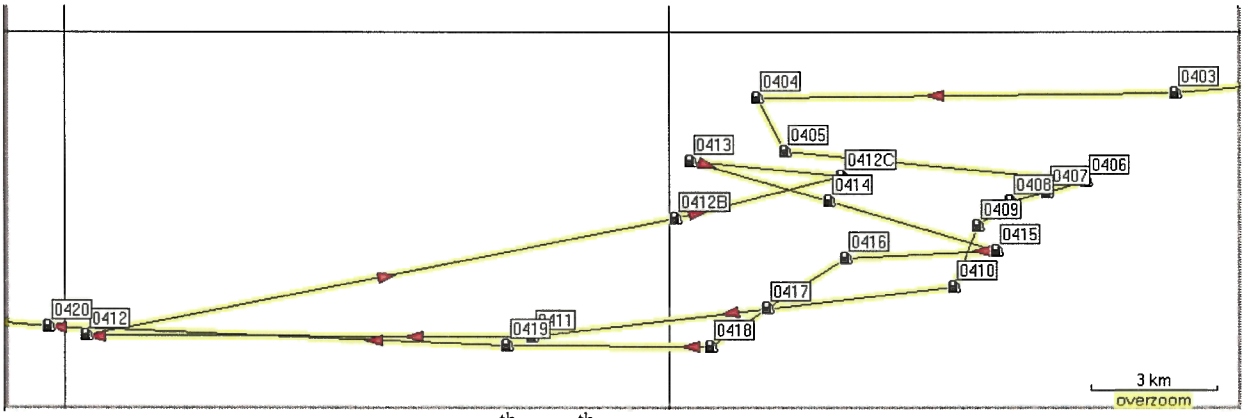
Mdd	dist. day	dist. accu.	heading	mdd	dist. day	dist. accu.	heading
329							
330	4.2	4.2	266°	413	1.3	50.2	285°
331	4.4	8.6	276°	414	1.5	51.7	130°
401	5.2	13.8	275°	415	1.8	53.5	132°
402	7.1	20.9	265°	416	1.2	54.7	262°
403	3.4	24.3	256°	417	1.3	56.1	208°
404	3.4	27.7	268°	418	1.1	57.1	206°
405	1.3	29.0	170°	419	1.7	58.8	271°
406	2.5	31.5	106°	420	3.8	62.5	277°
407	0.4	32.0	231°	421	8.4	70.9	288°
408	0.4	32.3	232°	422	7.4	78.3	287°
409	0.7	33.0	204°	423	9.3	87.7	263°
410	1.5	34.5	188°	424	4.1	91.8	245°
411	3.6	38.1	251°	425	4.9	96.8	237°
412	3.6	41.7	271°	426	6.1	103.0	244°
412B	5.5	47.3	59°	427	9.8	113.0	251°
412C	1.7	48.9	52°	428	14.0	127.0	265°

The movement of the ice camp as registered at 7:00 AM, 412 – 412B – 412C shows the day of the storm

On the 12th of April when we had a strong wind from the west, from 7:00 AM to 12:45 AM we moved 5.5 km.

Compared with the data from the weather station it looks like the wind has considerable influence on the drift of the ice. Above 3 m/sec the wind controlled the drift and if we have had a constant wind for a longer period and the wind dropped, it would result in a drift in the opposite direction.

The movement of the ice camp as registered at 7:00 AM, 0326 shows the first site

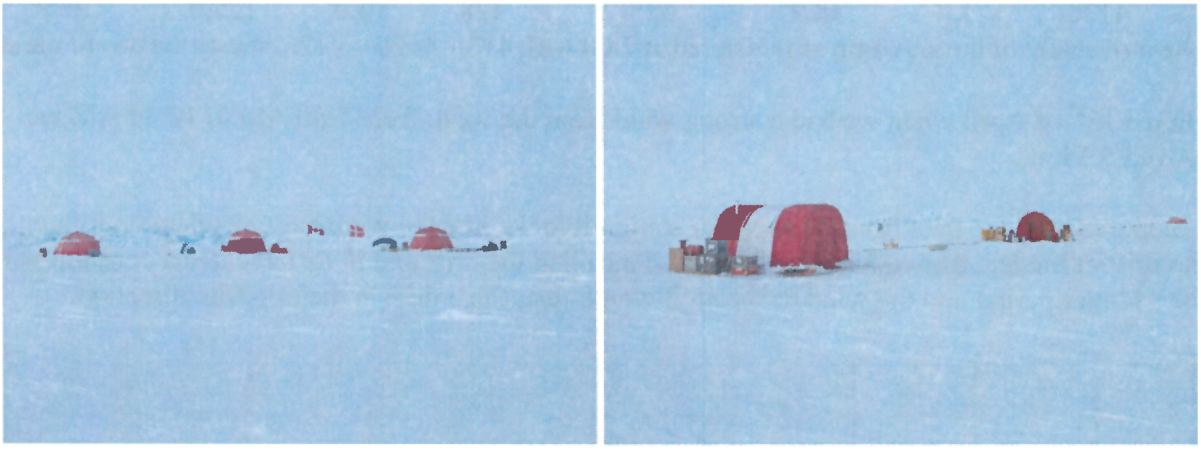


Details showing the movements April 4th – 20th, 0412 – 0412B – 0412C shows the day of the storm

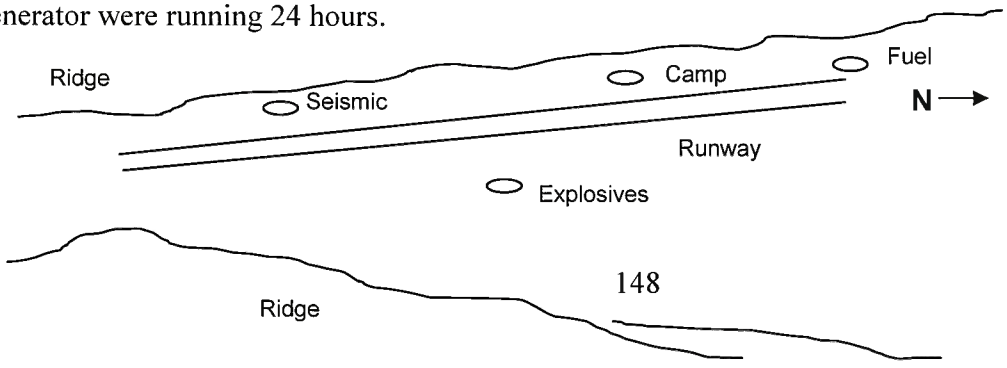
Layout of the camp

The main camp included three Octagon tents, one was used as a kitchen and by visitors, when they had to rest, one was set up with radio, computer for the weather station and were used as accommodation for one person, the last tent was used for sleeping by the two operators of the seismic system, because they were doing a twelve by twelve hour shift.

The seismic site included a 10x10 foot Weatherhaven for the compressor, air gun and the generator, and a 12x12 foot Weatherhaven for the electronics. It was planed to place the generator in the compressor tent, but it was to hot in there, therefore the generator was placed outside the tent.


The camp and the seismic site

The seismic site was raised at some distance from the camp because the compressor and the generator were running 24 hours.



View from the north end of the runway

The footpath between the two sites was in case of poor visibility marked with garbage bags every 7.5 meters. For safety reason a propane stove, some food, sleeping bags and communication equipment were stored at the seismic site.

The runway

The runway was about 250 meters long and 20 meters wide. We did not have to do much to eliminate the few bumps on the runway.

The runway was marked with garbage bags filled with snow. It is an easy way to mark a runway compared to flags on bamboo pools. But the bags also created drifts across the runway. Therefore we had to level the runway. To do that we modified a bunk by tightening the springs with rope and wire clips, Jerry cans were used to adjust the weight. It worked fine as long as we had the low temperatures, but when the temperature rose to -8° C the snow got to heavy and the springs started to expand.

The bunk drag

The runway before and after grooming with the bunk drag

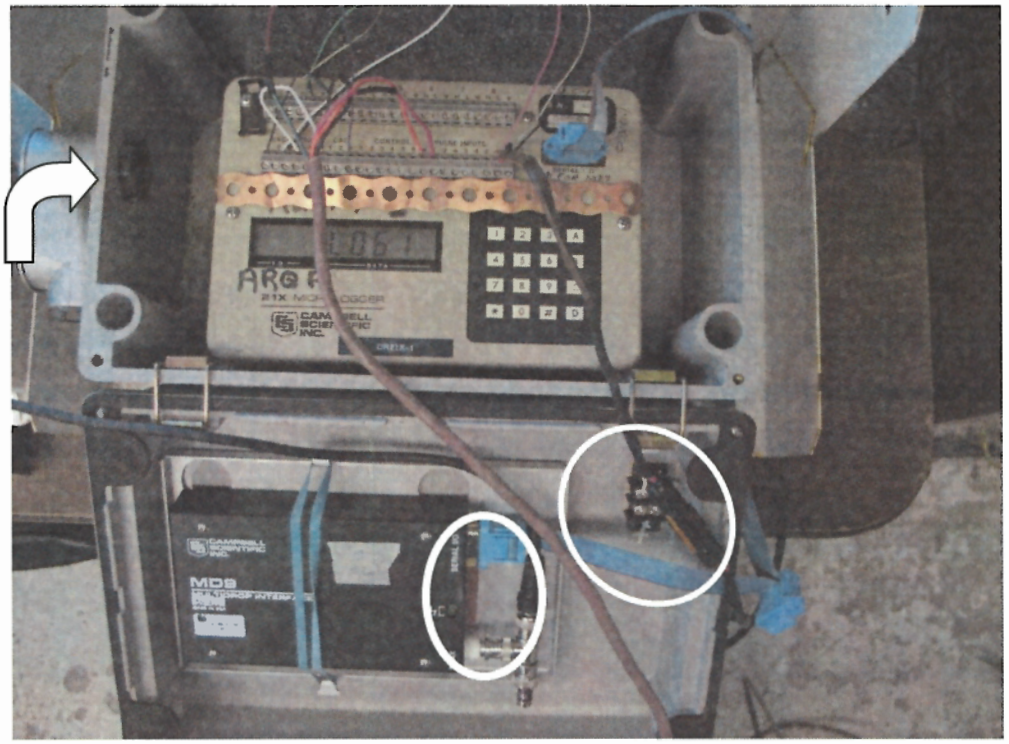
When we had a marginal visibility on April the 18th the garbage bags did not help the pilot because he had to approach from a very low level and many of the bags were partly covered by the drifts and the roughness of the surface.

From my former experience and from what I have seen this year, runway markers on two bamboo pools seems to work better, when it comes to a situation with poor visibility and that is where you really need the marks.

Weather station

A weather station from Canadian Ice Service was set up at the camp. The station registered the temperature, barometric pressure, wind speed and direction every 15 minutes starting April the 4th at 21:00Z and ending the 24th at 15:00Z.

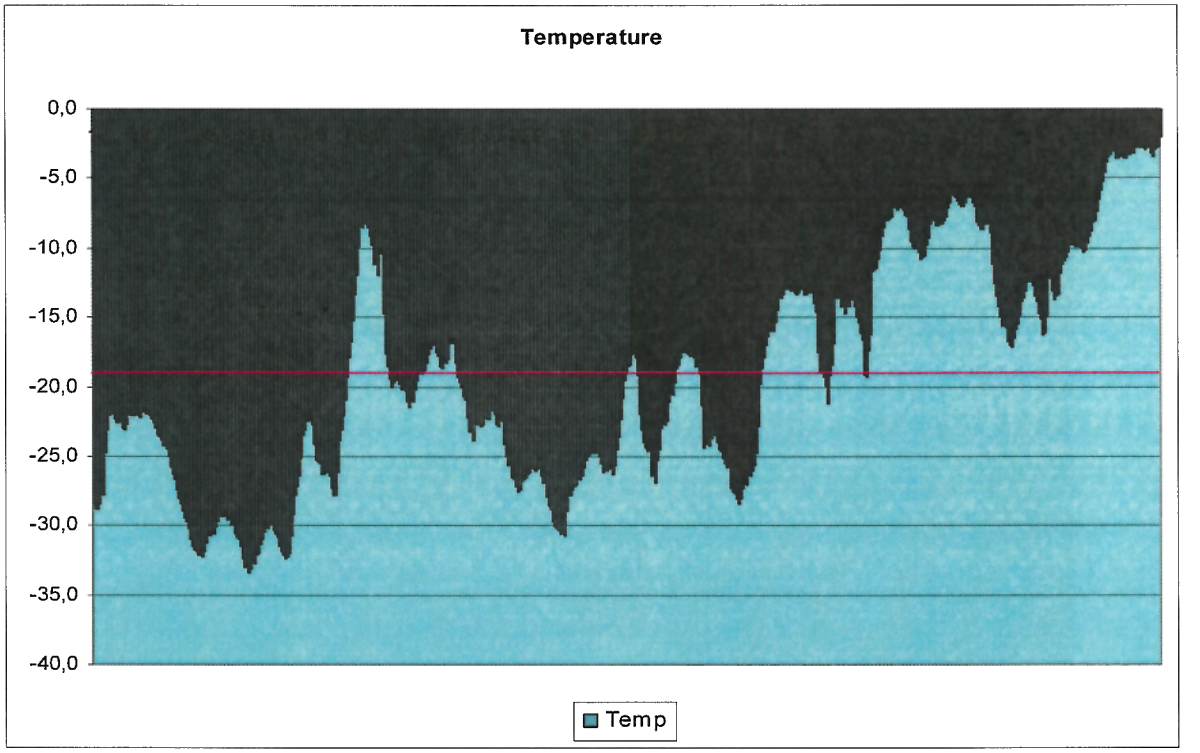
The system had to be put together at the site. The only problem was that all the cables had to be put through a 90° clamp on the box for the data logger. When the temperature was around -30°C, the cables were not flexible anymore and some cables were too thick because they were attached with fuses wrapped in tape or mounted with a connector. The risk of damaging something is too high.



The data logger when demonstrated at Alert not using the clamp to the left

A power supply for a serial converter broke down. It was possible to take the cable from the power supply and feed the converter from a car battery.

The system made it more comfortable to register and pass the information to the aircrafts and to Alert and it gave the opportunity to monitor the continuous change in the weather.
A small handheld weather tracker was also delivered. It worked fine except for the anemometer, which froze when the temperature got below -20°C. (For a summary of the weather see appendix 1).



Temperature at the camp for 24 days: low -33.4°C, high -1.8°C, avg. -18.7°C

Equipment

Most of the equipment for the camp was delivered from DRDC's storage in Alert; some was brought up from either Ottawa or Resolute.

The camp was kept as small as possible with the capacity to accommodate up to twelve in case the aircraft could not make it back to Alert due to the weather conditions. (For a list of equipment brought to the ice see appendix 2).

Activities April 02nd – 28th

The ice camp was manned from April the 02nd until April the 28th.
The seismic system was operated from April the 06th until April the 22nd.
The weather station was active from April the 04th until April the 28th.
The weather buoy was permanently activated on April the 23rd.
The blasters did a test on April the 3rd.
Test of bathymetric equipment on April the 7th.
TSD measurements and water samples was taken on April the 21st.
Aircrafts landing:

Twin Otter: 28
Helicopters: 36

Storing:

Fuel for aircrafts: 67 drums (Jet B, JA-1 and JP-8)
Fuel for the camp: 9 drums (heat: 3, generator and compressor: 6)
Explosives: ≈ 5.8 tons

Appendix 1 – summary of the data from the weather system at the ice camp

Date	Time Z	Temp C	Baro mB	Dir	Speed m/sec
04-apr	21:00	-28,5	1016,5	258	1,1
05-apr	0:00	-28,3	1017,2	247	2,0
	6:00	-22,0	1018,8	195	3,2
	12:00	-21,6	1020,6	185	3,7
	18:00	-22,1	1022,4	249	1,8
06-apr	0:00	-21,6	1025,3	252	4,0
	6:00	-22,8	1028,1	247	3,8
	12:00	-24,2	1031,3	244	3,6
	18:00	-27,4	1033,1	232	3,8
07-apr	0:00	-30,3	1034,6	227	2,0
	6:00	-32,1	1034,6	200	0,0
	12:00	-30,4	1032,8	116	0,0
	18:00	-29,3	1030,0	68	1,5
08-apr	0:00	-29,9	1028,6	15	0,0
	6:00	-33,0	1027,1	338	1,0
	12:00	-31,7	1025,7	14	2,1
	18:00	-30,2	1023,8	327	1,5
09-apr	0:00	-31,2	1022,1	53	1,6
	6:00	-31,2	1019,5	63	1,9
	12:00	-24,0	1016,3	67	1,6
	18:00	-22,3	1012,5	33	3,2
10-apr	0:00	-26,2	1009,2	18	2,0
	6:00	-27,8	1006,3	335	2,1
	12:00	-19,7	1002,3	330	3,4
	18:00	-10,5	997,4	18	5,0
11-apr	0:00	-8,5	996,1	34	6,0
	6:00	-10,3	996,4	15	4,2
	12:00	-19,3	999,1	106	6,1
	18:00	-20,1	1002,0	96	7,0
12-apr	0:00	-21,1	1001,7	66	3,0
	6:00	-18,5	996,1	295	2,6
	12:00	-17,3	986,3	254	8,4
	18:00	-18,0	991,4	197	9,3
13-apr	0:00	-19,3	997,1	144	4,4
	6:00	-23,0	997,4	55	1,2
	12:00	-22,7	996,9	48	1,4
	18:00	-20,7	997,9	56	0,4
14-apr	0:00	-22,6	1000,2	57	0,0
	6:00	-26,6	1004,3	244	0,1
	12:00	-26,2	1009,8	212	1,1
	18:00	-25,4	1013,7	261	0,6

15-apr	0:00	-28,5	1016,5	340	1,6
	6:00	-30,6	1018,0	314	0,3
	12:00	-27,3	1019,9	150	1,5
	18:00	-25,7	1020,8	85	1,3
16-apr	0:00	-24,7	1022,1	97	1,9
	Time	**Temp**	**Baro**		**Speed**
Date	**Z**	**C**	**mB**	**Dir**	**m/sec**
	6:00	-26,1	1023,0	72	1,2
	12:00	-24,6	1024,5	34	1,7
	18:00	-18,6	1024,0	21	2,1
17-apr	0:00	-18,6	1024,1		1,0
	6:00	-23,6	1023,4	350	0,9
	12:00	-22,7	1023,3	297	1,2
	18:00	-20,5	1022,8	256	2,0
18-apr	0:00	-17,6	1022,8	312	1,8
	6:00	-17,8	1023,4	322	0,0
	12:00	-23,8	1024,2	202	1,4
	18:00	-23,5	1024,6	180	1,6
19-apr	0:00	-25,7	1025,3	182	1,8
	6:00	-28,3	1025,2	250	0,0
	12:00	-26,4	1025,1	295	1,3
	18:00	-18,5	1024,1	342	1,9
20-apr	0:00	-15,9	1022,9	14	2,4
	6:00	-12,9	1021,5	63	2,9
	12:00	-13,3	1020,1	63	5,0
	18:00	-13,2	1016,6	65	3,5
21-apr	0:00	-14,6	1013,0	82	2,2
	6:00	-19,2	1010,9	45	3,0
	12:00	-13,1	1009,9	63	3,2
	18:00	-13,2	1009,1	61	2,1
22-apr	0:00	-15,9	1009,2	67	0,7
	6:00	-11,2	1008,8	80	2,7
	12:00	-8,0	1008,1	78	4,0
	18:00	-7,2	1007,4	76	5,1
23-apr	0:00	-7,7	1009,4	70	5,9
	6:00	-10,2	1011,6	65	5,7
	12:00	-8,1	1014,2	60	3,7
	18:00	-8,2	1017,5	126	4,2
24-apr	0:00	-5,7	1020,6	75	2,7
	6:00	-6,9	1021,6	49	3,2
	12:00	-6,9	1023,1	71	3,5
	18:00	-8,2	1023,7	65	4,2
25-apr	0:00	-13,7	1024,8	58	3,3
	6:00	-16,7	1024,8	51	2,5
	12:00	-14,1	1025,3	55	4,1
	18:00	-12,3	1024,8	45	4,8
26-apr	0:00	-16,2	1024,8	44	2,8

	6:00	-13,3	1024,3	54	3,9
	12:00	-10,7	1024,1	56	4,9
	18:00	-9,8	1022,0	51	5,4
27-apr	0:00	-9,4	1019,5	48	5,6
	6:00	-6,4	1014,8	56	4,6
	12:00	-3,3	1009,6	64	5,6
	18:00	-3,3	1005,5	69	6,4
28-apr	0:00	-3,1	1000,2	76	5,7
	Time	**Temp**	**Baro**		**Speed**
Date	**Z**	**C**	**mB**	**Dir**	**m/sec**
	6:00	-2,7	995,2	71	4,9
	12:00	-2,9	992,1	90	4,7

Appendix 2 – List of equipment

Description	#	Remarks
Octagon tent	3	
Hurry tent	1	
10x10 Weatherhaven tent	1	
12x12 Weatherhaven tent	1	
Plywood	68	
Stove	5	
Stovepipe	5	
Fire extinguishers	6	
Fuel pump	3	
10 gall. Fuel drum	5	
Jerry can	2	
10mm rope	1	
6 ft. table	2	
Small table	3	
Chair	10	
Bunk	5	+4
Foamy	10	
Sleeping bag (heavy)	12	
Kitchen box	1	
Snow melter	1	
Shovel	3	+ 1 snow shovel
Shotgun with ammo.	1	
First aid kit	1	
Survival sledge	1	
HF radio	2	1 replaced
Iridium phone	2	
VHF radio (camp)	2	
VHF radio (Air)	2	
Battery for VHF radios	2	boxes
2.5 kVA generator	1	
3.7 kVA generators	2	

Oil for generators	1	5 gall.
Spare parts for generator	1	box
Extension cord	5	
Battery charger	1	
12V battery	3	
Solar panel	2	
Skidoo	1	1 as replacement
Sledge	1	
Banana sledge	2	
Tool box	1	
Jerry can - mixed oil	2	For Skidoo
Bamboo pole	10	
4" Finbore drill	1	

Seismic Reflection Activities at the Ice Camp

Greg Middleton, Geological Survey of Canada (Atlantic)

Overview

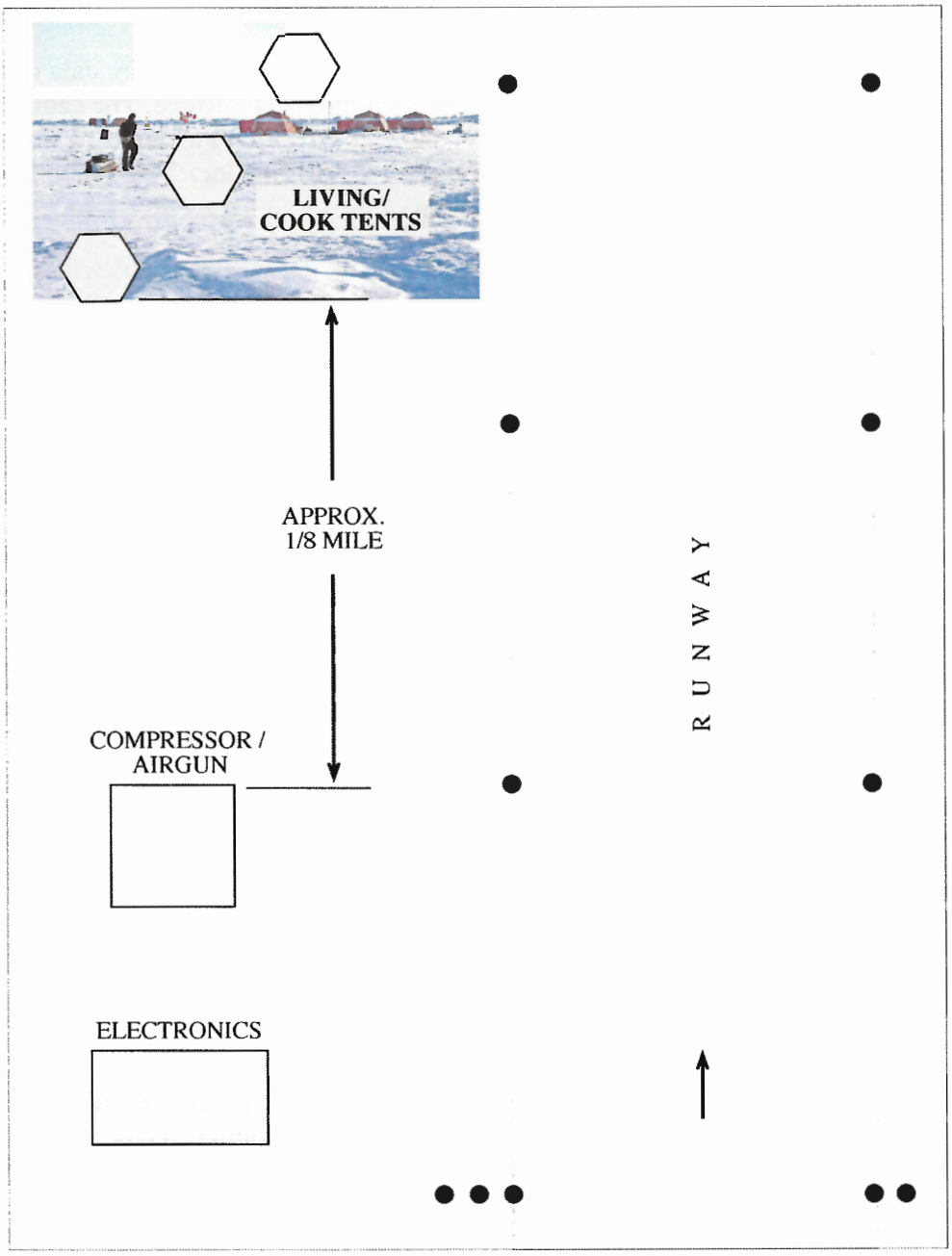
The Lorita-1 field camp was set up to support the Lorita-1 field program to acquire data on the nature of the earth crust beneath the Greenland/Ellesmere margin and Lomonosov Ridge. The camp was established to increase safety, provide a depot for fuel and explosives, and to deploy a single channel seismic system to determine the sediment thickness beneath the drifting ice. This section explains the set up and operation of the single channel seismic system.

Equipment

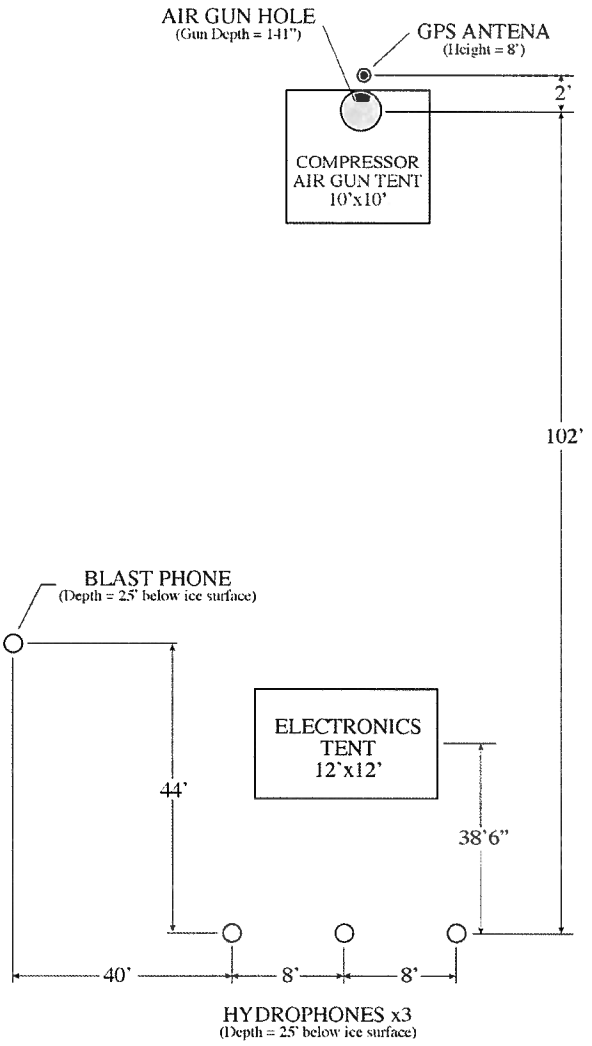
10 cu. In. sleeve gun with a 6 cu. In. insert model # 10-1049
Compressor Jordair Model # J-1K100-DH
Air storage bottles
Chemical injector for anti-freeze Sigma pump w/ 3/8 " piston, Model # 32CP36
Chemical Injector pressure regulator Prostar Platinum, Model # 2124301-75-000
Antifreeze N0-TOX2 Tanner systems, St. Joseph, MN
Air pressure control valve
Three IKB Arctic Hydrophones
Blast phone
IKB Four channel Hydrophone Amplifier SCU-6 s/n 026
Hewlett Packard Oscilloscope 54601A 100mhz. 4 channel
GSC DIG # 4—Data
GSC DIG # 8—Blast phone
GSC MITS firing controller
Regulus II system
AGC air gun trigger source
Krohn-Hite filter model # 3323R
EPC model 9801 graphic recorder
Yanmar 3700 KW Diesel powered Generator

System layout

This seismic system was set up in two separate tents. The compressor, generator, air gun, air bottles, chemical injector, and air pressure valve were in a 10 ft. by 10 ft. Weathhaven tent and the electronics were in a 12 ft. by 12 ft. Weatherhaven tent situated 50 meters apart. These two tents were themselves situated 500 meters from the main living and dining tents (see figure below). This was done mainly to keep the noise of the compressor, generator, and air gun from disturbing the watchkeeper that was off duty and the camp manager.

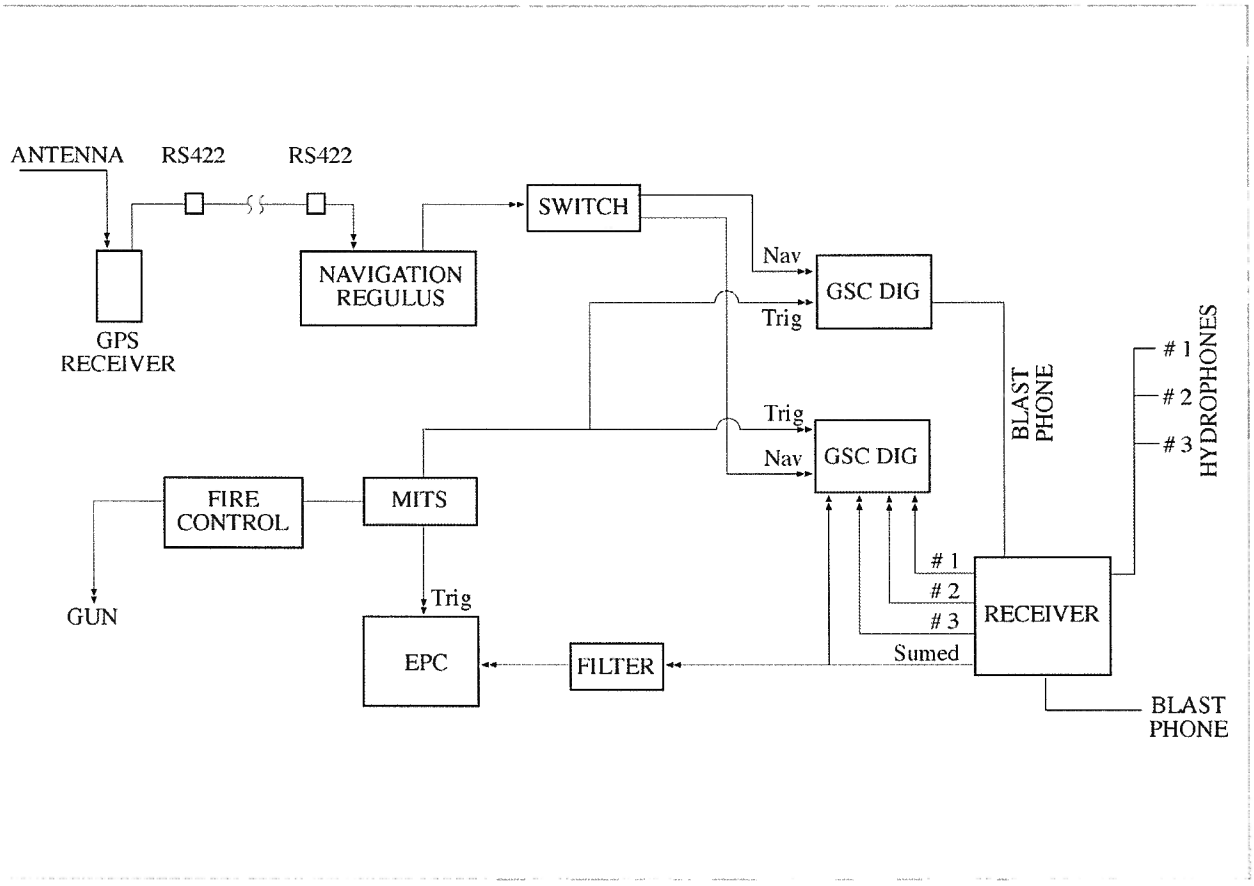


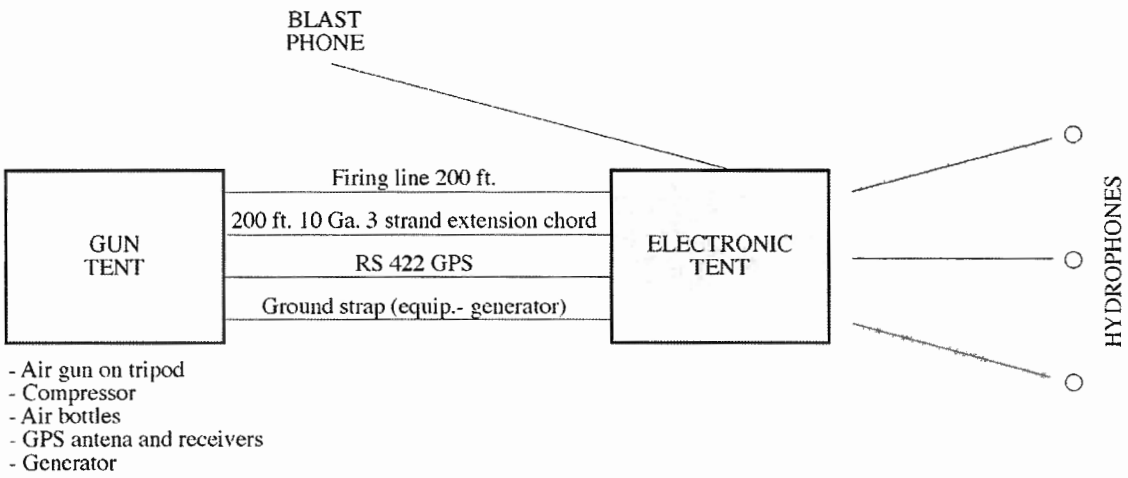
The three hydrophones were placed through the ice to a depth of 25 feet and were separated by 8 feet. They were located at a distance of 102 feet from the air gun. The blast phone was placed thought he ice to a depth of 25 feet with a distance of 44 feet from the hydrophones and 58 feet from the air gun. The sleeve gun was deployed in an ice hole at the back of the compressor tent and the gun was lowered to a depth of 141 inches. The attached drawing shows the lay out and the dimensions of the deployment.



Eqipment Setup

The attached schematic shows the setup and the cable routing for the electronics.

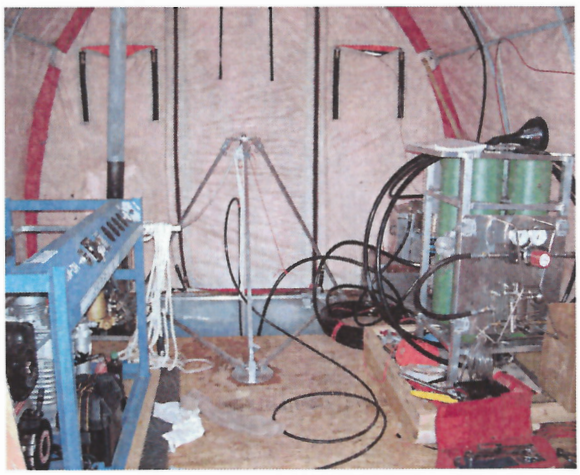




Recommendations

There are only two recommendations for this system. The first is the air pressure control valve. This value was too big for this system and should be replaced with a smaller unit.

The second is the need to bring in outside air for the compressor. This is just a plumbing problem that can be solved at BIO.



Inside of compressor tent. Compressor on the left.
Air supply bottles on the right.
Ice hole for air gun under the tri-pod.

Shows one side of the electronics tent.
MITS controller.
Regulus computer.
EPC recorder.

Outside of the compressor tent with living tents in the background.

Preliminary Processing of Seismic Reflection

John Shimeld, Geological Survey of Canada (Atlantic)

Introduction

The 6 in^3 airgun system was operated almost continuously for 16 days from 01:42 UTC April 7 to 23:00 UTC April 22, with only 8 minor gaps of less than 1 hour in duration due to required compressor maintenance and occasional freezing of the airgun. During operation of the airgun, signals were digitized and recorded in SEG-Y format from the blast-phone, from each of the three individual hydrophones, and from the summed signal of the three hydrophones. To ensure that all systems were functioning properly, the summed hydrophone signal was continuously plotted on an EPC chart recorder.

Results

An example of the source signal is plotted on Figure 1. Most of the signal energy is concentrated in the first trough and peak but a pronounced reverberation is present, likely because of oscillations in the gas bubble from the airgun known as a bubble pulse. At 13:00 UTC April 16th, the airgun was raised in 0.35 m increments from 4.3 to 3.6 m below the top of the ice in an effort to reduce the bubble pulse phenomenon (the ice was approximately 2.4 m thick). This reduced the amount of reverberation, but also reduced the total energy of the signal (Figure 1).

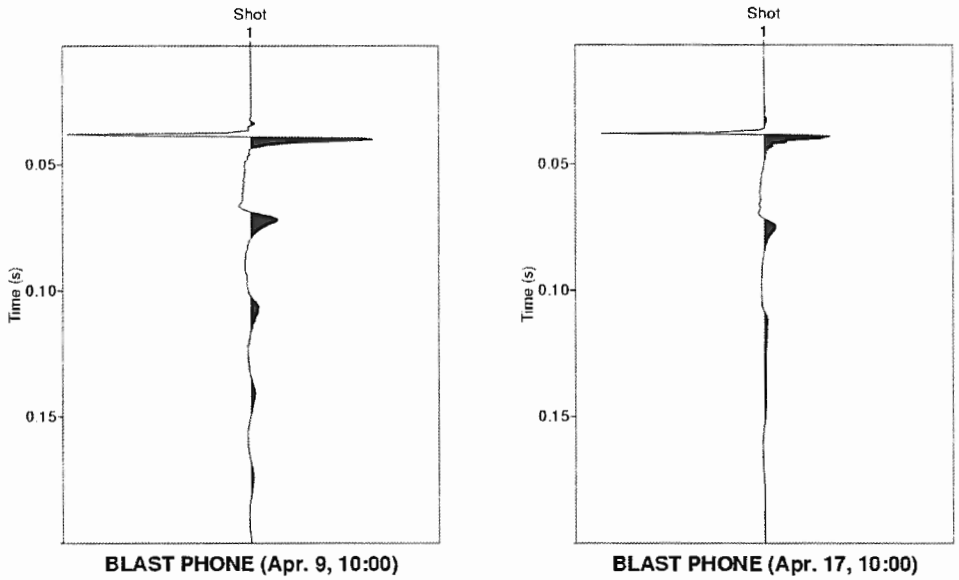


Figure 1: Example source wavelets, before and after raising the airgun to reduce the bubble pulse.

Reverberations in the source wavelet are readily apparent on plots of the autocorrelation function for each trace. An example is given in Figure 2.

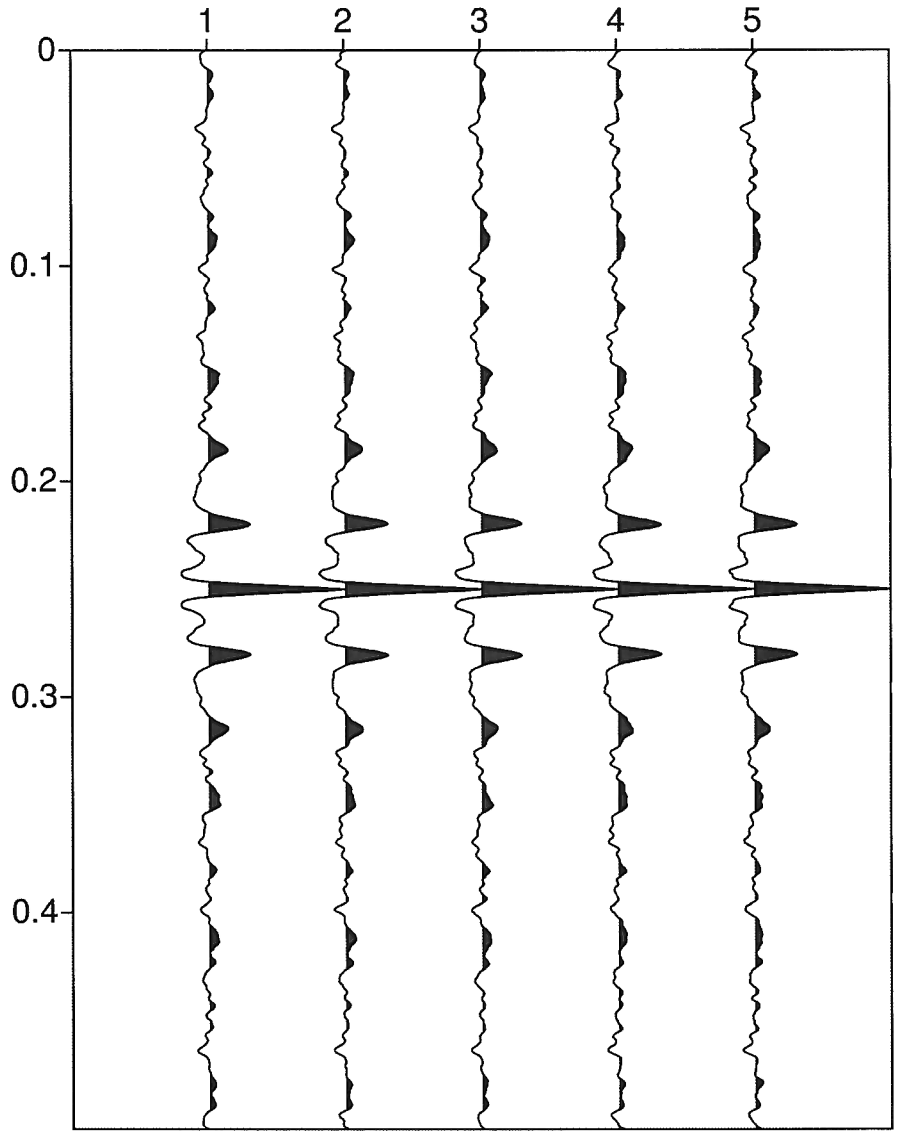


Figure 2: Autocorrelation function for the first five traces of the data after binning and stacking. The dominant period of the reverberations is 30 ms.

The geographic position of the airgun during the experiment is registered in every trace header of each SEG-Y data file. Since the positions were recorded in UTM coordinates, and since the ice camp drifted across more than one UTM zone, conversion to geographic latitude and longitude was necessary for proper plotting of the location data. This was accomplished with the mapproject command of the Generic Mapping Tools software package (http://gmt.soest.hawaii.edu/). The drift track of the ice camp during the seismic reflection program is plotted on Figures 3 and 4. The total line length is 58.2 km, including a WNW trending segment of about 28 km.

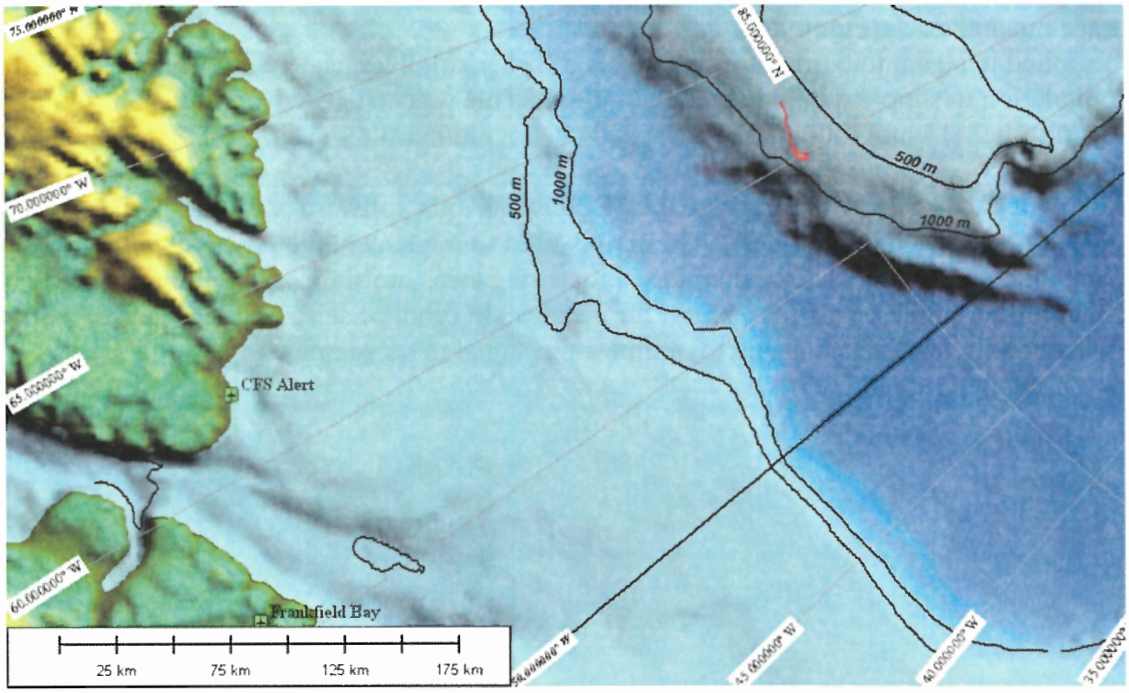


Figure 3: Regional map of the Lincoln Sea showing the drift (red line) of the ice camp during the seismic reflection experiment.

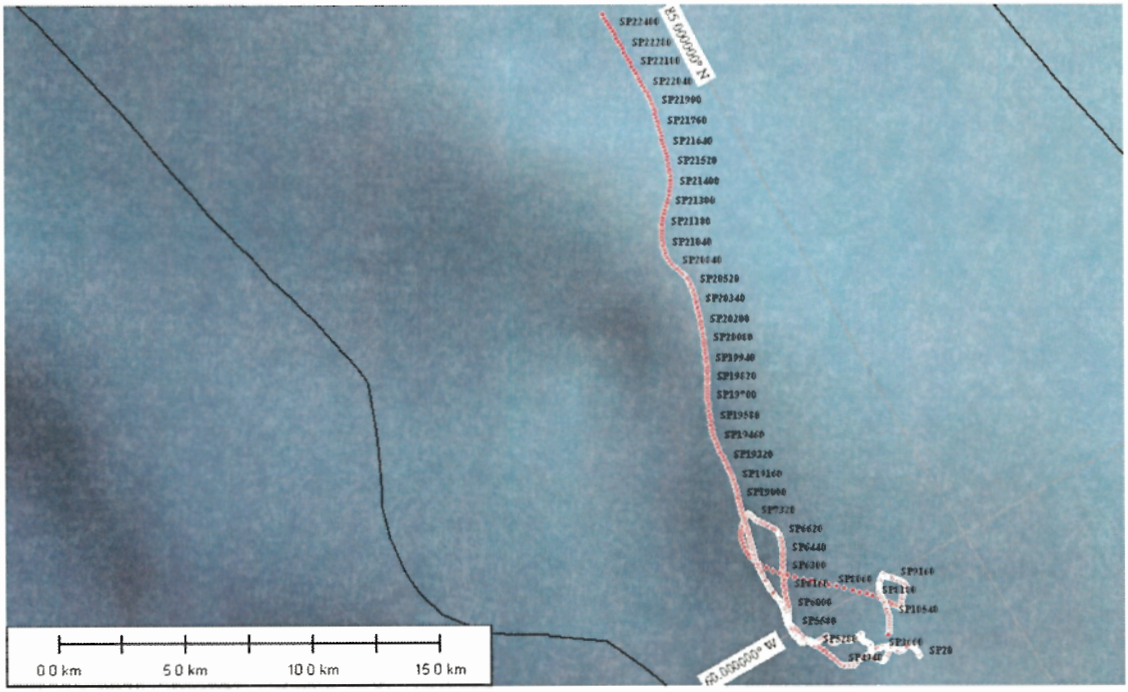


Figure 4: Detailed trackplot map of the seismic reflection data from April 7 (SP20) to April 22 (SP22400).

As a preliminary check of the data, the following processing steps listed below were applied to the summed hydrophone signal. The result of each processing step is plotted on the associated figure.

1) 10 trace bin and stack (Figure 5)
2) gain applied to signal to correct for the effects of spherical divergence with depth (Figure 6)
3) deconvolution to suppress bubble pulse (Figure 7). This was achieved by applying a spiking deconvolution filter (15 ms) followed by a gapped deconvolution filter (16 to 150 ms).

All processing was done using the freely available Seismic Unix software package (http://www.cwp.mines.edu/cwpcodes/). The scripts used to implement the processing are listed in Appendix a. It should be emphasized that these processing steps are simply a preliminary check of the data and that further processing is necessary, for instance, to produce seismic traces that are correctly spaced in the horizontal dimension and to optimize the signal to noise ratio.

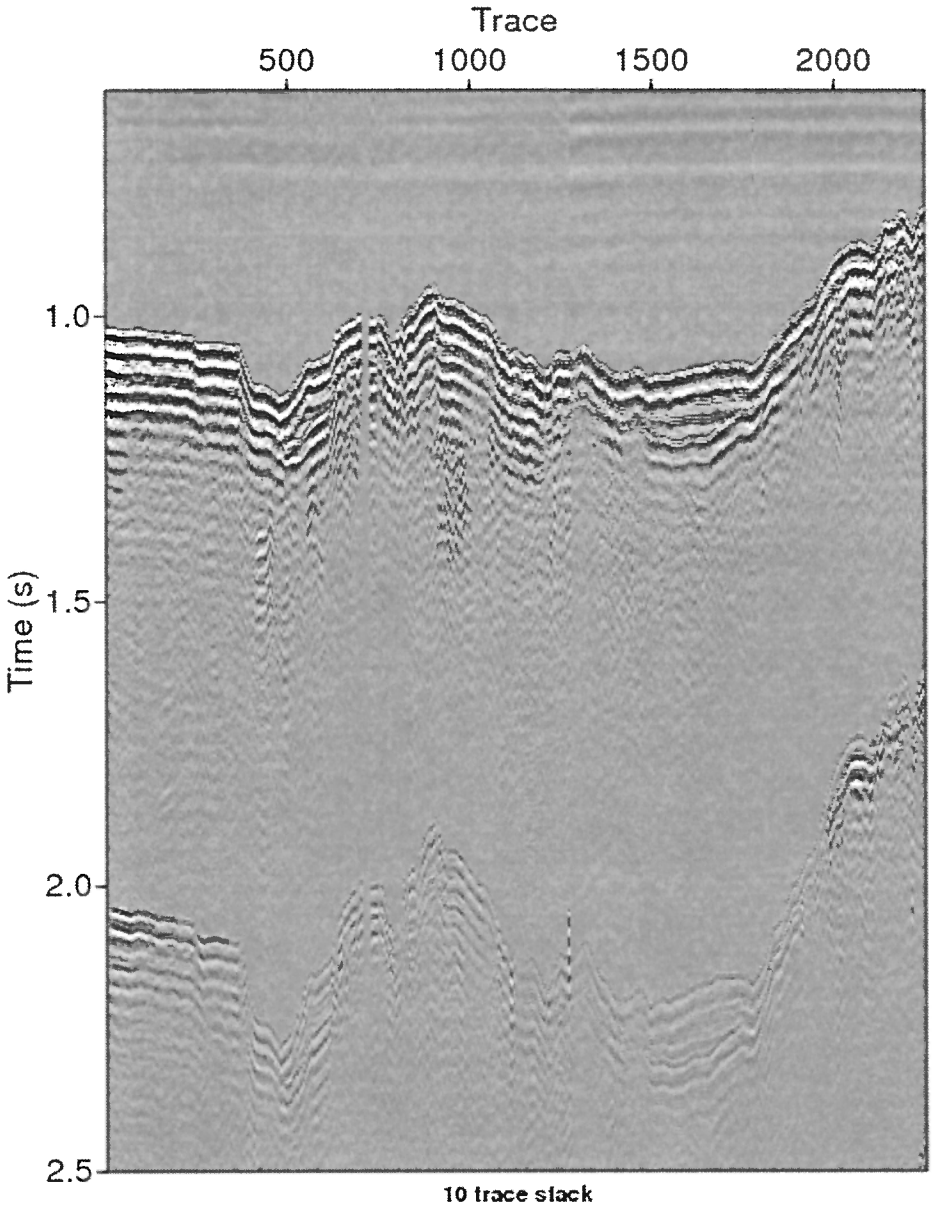


Figure 5: Results of binning and stacking 10 traces.

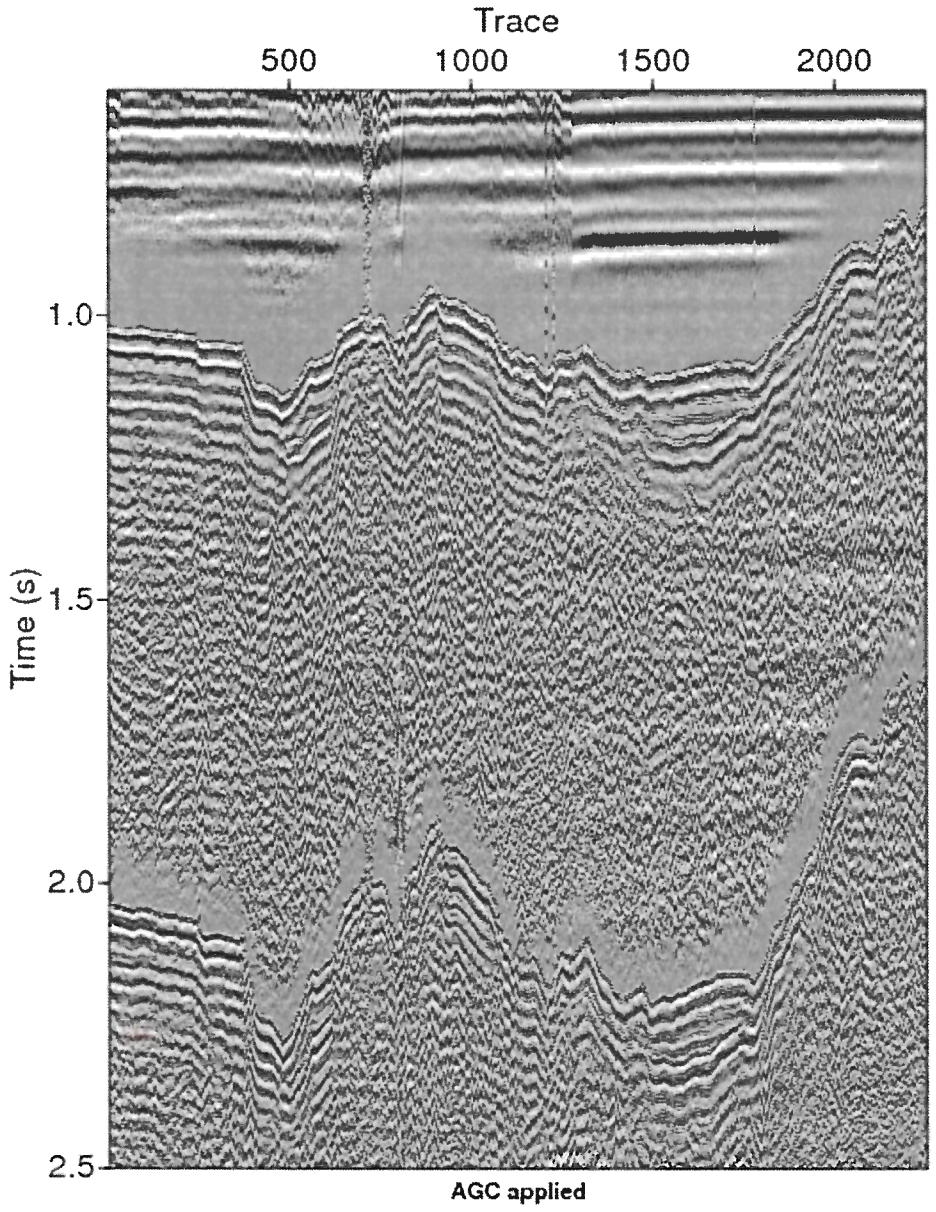


Figure 6: Results after application of automatic gain control to counter the effects of spherical divergence with depth in the signal.

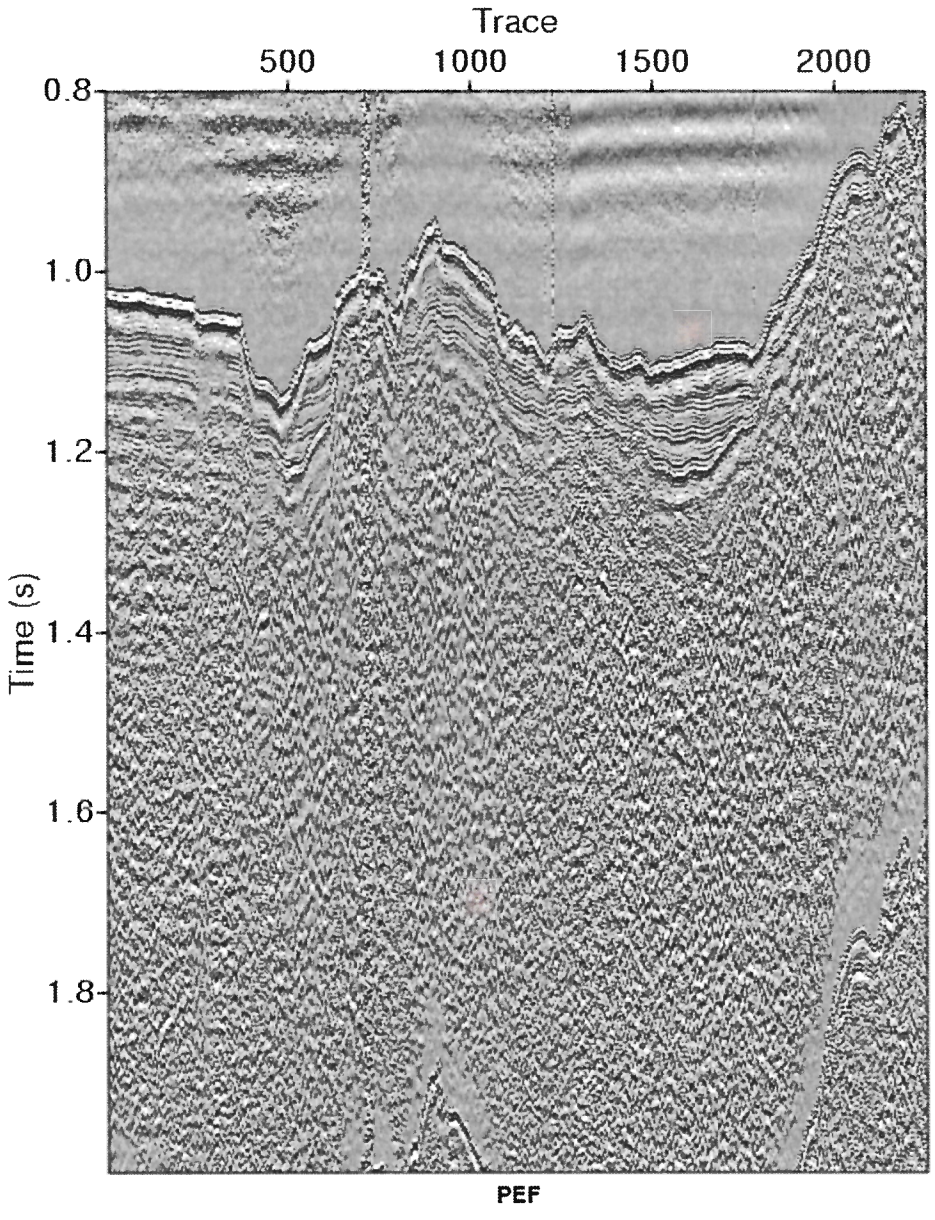


Figure 7: results after predictive deconvolution to subdue reverberations from the bubble pulse.

Preliminary Record Sections

It is evident from figures 5 through 7 that only a thin package of coherent reflections overlies acoustic basement. Generally this package is less than 200 ms in two-way time (twt). Distinct units separated by unconformities are present within the package, suggesting that it is comprised of geologically young, unlithified sediments. The underlying acoustic basement presumably includes deformed lithified sediments.

Using a comparable system, in 2004 the GreenIce project acquired seismic reflection data across the flank of Lomonosov Ridge, approximately 125 km to the west of the Lorita data. The GreenIce data revealed sediment thicknesses ranging from 1000 ms twt along the deepest-water portion of the line (water bottom at 1500 ms twt) to less than 100 ms in shallower water (1000 to 700 ms twt) (Kristoffersen and Mikkelsen, Marine Geology, v. 225, p. 265-278, 2006). The seismic reflection results from Lorita-1 seem consistent with those of the GreenIce project.

Conclusions

Preliminary processing confirms that the airgun, hydrophone, and recording systems operated properly during the Lorita-1 experiment. The source wavelet exhibits significant reverberation due to the bubble pulse, but this can be suppressed effectively through application of deconvolution filters. Overall, the data quality is good and the data appear to be consistent with data previously acquired by the GreenIce 2004 project.

APPENDIX a: Program listings for preliminary processing of the seismic reflection data

AUTOCORRELATION:

```
#!/usr/bin/bash

suwind < 00.all_data.su count=5 |
sugain gagc=1 wagc=0.5 |
suacor ntout=1001 |
supswigp d1=0.0005 > 00.auto
```

BIN AND STACK:

```
#!/bin/bash

sushw < ./data/all_raw_summed_traces.su \
  key=ep,tracl \
  a=1,1 \
  c=1,1\
  j=1,10 | \
sugain mbal=1 | \
sustack key=tracl > 03.dat.stack_10.su

suwind < 03.dat.stack_10.su \
  dt=0.0005 \
  tmin=0.8 \
  tmax=2.0 | \

supsimage \
  nbpi=600\
  title="10 trace stack"\
  titlesize=12 \
  label1='Time (s)' \
  label2='Trace' \
  d1=0.0005 \
  style=seismic \
  key=tracl \
  perc=99 \
```

➢ 03.fig.stack_10.eps

AUTOMATIC GAIN CONTROL:

```
#!/bin/bash
sugain < 03.dat.stack_10.su gagc=1 wagc=0.5 > 04.dat.gain.su
suwind < 04.dat.gain.su \
  dt=0.0005 \
  tmin=0.8 \
  tmax=2.0 | \
supsimage \
  nbpi=600\
  title="AGC applied"\
  titlesize=12 \
  label1='Time (s)' \
  label2='Trace' \
  d1=0.0005 \
  style=seismic \
  key=tracl \
  perc=99 \
```

- 04.fig.gain.eps

SPIKING AND GAP DECONVOLUTION:

```
#!/bin/bash
supef < 04.dat.gain.su maxlag=0.0150 |
supef minlag=0.016 maxlag=0.150 |
sufilter f=5,35,180,240 amps=0,1,1,0 > 05.dat.pef.su
suwind < 05.dat.pef.su \
  dt=0.0005 \
  tmin=0.8 \
  tmax=2.0 | \
supsimage \
  nbpi=600 \
  title="PEF" \
  titlesize=12 \
  label1='Time (s)' \
  label2='Trace' \
  d1=0.0005 \
  key=tracl \
  style=seismic \
  perc=95 \
> 05.fig.pef.eps
```

Position of Shots and Receivers

Inner Line Shot Locations

Longitude	Latitude	Station
-56.231821	82.487142	IS1
-56.358237	82.766678	IS2
-56.446777	83.062134	IS3
-56.594986	83.346954	IS4
-56.857670	83.665392	IS5
-56.914535	83.933876	IS6

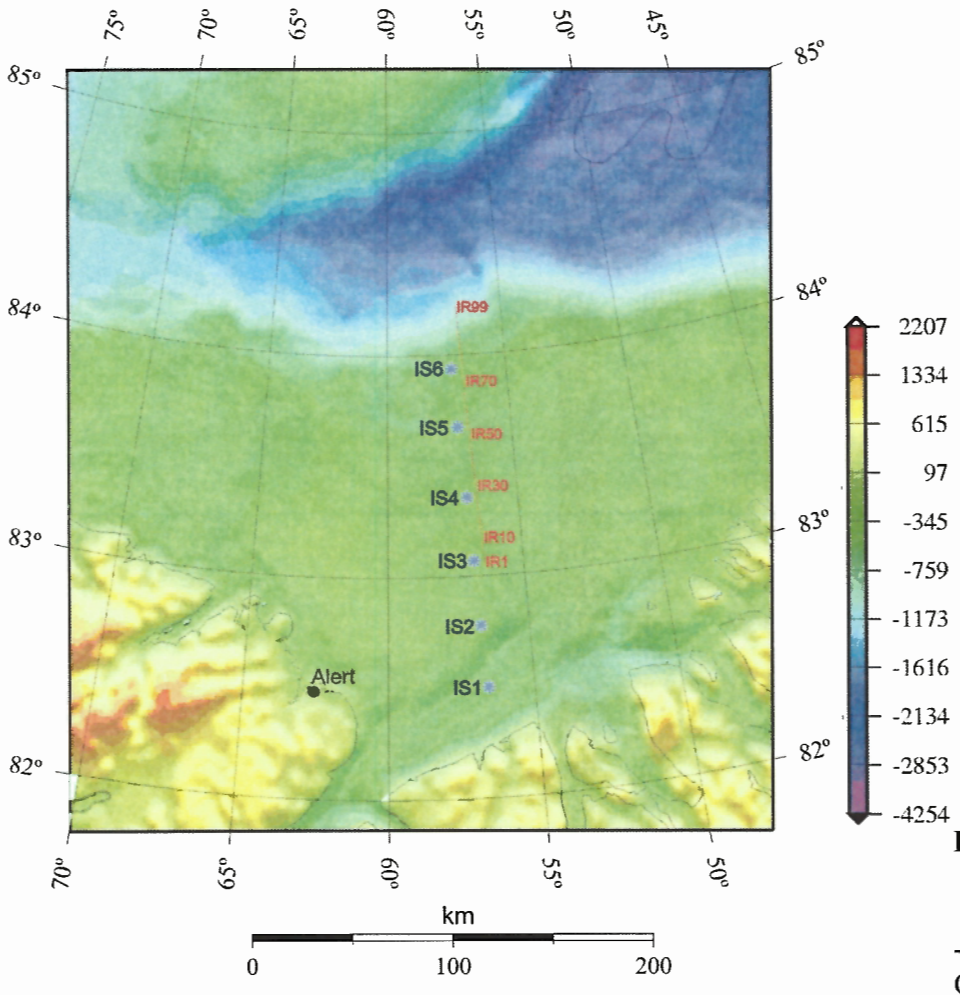
Inner Line Receiver Positions for shot IS 3

Longitude	Latitude	Station	Cooler	Taurus
-57.00480	84.21490	IR 99	197	569
-56.98620	84.20480	IR 98	196	567
-56.98090	84.19240	IR 97	201	192
-56.96950	84.18080	IR 96	198	570
-56.96470	84.16800	IR 0	195	562
-56.93270	84.14220	IR 93	199	573
-56.93650	84.13700	IR 92	181	525
-56.93710	84.11950	IR 91	187	549
-56.93150	84.10870	IR 90	202	201
-56.92600	84.09920	IR 89	193	555
-56.91520	84.08840	IR 88	203	207
-56.90860	84.07640	IR 87	205	214
-56.90860	84.06460	IR 86	194	559
-56.88830	84.05200	IR 85	206	218
-56.88700	84.04000	IR 84	200	572
-56.88150	84.03010	IR831	204	210
-56.88460	84.02980	IR 83	186	563
-56.88200	84.01850	IR 82	184	556
-56.86220	84.00510	IR 81	190	561
-56.86530	83.99430	IR 80	191	565
-56.85700	83.98280	IR 79	185	560
-56.84950	83.97180	IR 78	182	524
-56.84250	83.95990	IR 77	180	445
-56.84550	83.95590	IR 76	179	527
-56.82870	83.93660	IR 75	175	533
-56.82540	83.92460	IR 74	174	535
-56.82280	83.91370	IR 73	173	536
-56.80970	83.90190	IR 72	172	537
-56.80480	83.89000	IR 71	171	538
-56.79540	83.87810	IR 70	170	539
-56.79170	83.86620	IR 69	169	540
-56.78210	83.85470	IR 68	176	531
-56.79880	83.84370	IR 67	178	529
-56.82640	83.82520	IR 66	168	541
-56.81430	83.81370	IR 65	166	543
-56.80790	83.80230	IR 64	165	544
-56.80470	83.79230	IR 63	164	496

-56.78680	83.76740	IR 61	161	489
-56.78330	83.75610	IR 60	151	473
-56.77520	83.74320	IR 59	150	471
-56.78170	83.73440	IR 58	149	470
-56.76900	83.71010	IR 56	147	468
-56.75680	83.69750	IR 55	143	451
-56.74400	83.68490	IR 54	142	447
-56.73150	83.67510	IR 53	101	455
-56.72400	83.66180	IR 52	155	477
-56.71260	83.65070	IR 51	156	480
-56.69930	83.63890	IR 50	152	475
-56.68320	83.62470	IR 49	162	490
-56.68230	83.61390	IR 48	153	499
-56.68470	83.60480	IR 47	154	476
-56.69110	83.58960	IR 46	158	482
-56.68780	83.57950	IR 45	157	481
-56.68350	83.56680	IR 44	144	429
-56.67140	83.55510	IR 95	195	484
-56.66660	83.54410	IR 42	146	466
-56.65990	83.53120	IR 41	145	465
-56.66050	83.52110	IR 40	141	393
-56.63950	83.50810	IR 39	140	452
-56.63920	83.49760	IR 38	138	457
-56.63840	83.48480	IR 37	137	454
-56.63060	83.47270	IR 36	136	449
-56.62030	83.46250	IR 35	135	381
-56.61970	83.45140	IR 34	134	443
-56.60910	83.43860	IR 33	133	453
-56.60330	83.42840	IR 32	132	432
-56.60370	83.41390	IR 31	131	380
-56.59140	83.40370	IR 30	130	444
-56.58700	83.39130	IR 29	129	440
-56.58620	83.37910	IR 28	160	121
-56.58180	83.36760	IR 27	128	435
-56.57660	83.35590	IR 26	127	437
-56.57130	83.34390	IR 25	126	428
-56.56620	83.33250	IR 24	125	424
-56.56130	83.32050	IR 23	123	419
-56.55530	83.30920	IR 22	122	408
-56.54900	83.29760	IR 21	121	404
-56.54300	83.28560	IR 20	120	422
-56.53780	83.27410	IR 19	119	439
-56.53310	83.26210	IR 18	118	433
-56.53070	83.25060	IR 17	117	430
-56.50760	83.24240	IR 16	113	416
-56.50190	83.23000	IR 15	116	427
-56.49410	83.21880	IR 14	115	423
-56.48980	83.20710	IR 13	114	420

-56.48470	83.19520	IR	12	112	411
-56.47910	83.18290	IR	11	109	431
-56.47150	83.17190	IR	10	110	456
-56.47300	83.15920	IR	9	107	458
-56.46660	83.14730	IR	8	108	434
-56.45750	83.13730	IR	7	103	410
-56.45990	83.12530	IR	6	106	407
-56.44920	83.11340	IR	5	105	442
-56.44630	83.10110	IR	4	111	526
-56.44270	83.09000	IR	3	102	469
-56.43820	83.07600	IR	2	104	394
-56.44480	83.06170	IR	1	167	542

Inner line plot showing the location of shots IS and receivers IR.



Outer Locations
Longitude

83.652748

Line Shot

Latitude Station
-056.951839
OS1

-057.276713 83.956904 OS2
-057.993619 84.227171 OS3
-058.342814 84.513775 OS4
-057.530572 84.776401 OS5
-059.490388 85.107256 OS6
-060.050325 85.404848 OS7
-059.522121 85.568831 OS8
-059.157278 85.797167 OS9
-060.620370 86.283670 OS10

Outer Line Receiver Positions for shot OS 6

Longitude	Latitude	Station	Cooler	Taurus
-59.57770	85.45940	OR182	0 0 2006:17:30:0	
-59.56610	85.44670	OR181	0 0 2006:17:30:0	
-59.55390	85.43240	OR180	0 0 2006:17:30:0	
-59.53080	85.41700	OR179	0 0 2006:17:30:0	
-59.49420	85.40430	OR178	0 0 2006:17:30:0	
-59.65340	85.36530	OR177	207	257
-59.63110	85.35260	OR176	142	447
-59.60700	85.33750	OR175	141	393
-59.58920	85.32360	OR174	136	449
-59.57390	85.30900	OR173	212	253
-59.54300	85.28280	OR171	235	262
-59.52110	85.26720	OR170	236	239
-59.50710	85.25360	OR169	241	267
-59.48870	85.23930	OR168	243	268
-59.48000	85.22580	OR167	143	451
-59.46420	85.21120	OR166	220	219
-59.45890	85.19820	OR165	134	443
-59.46860	85.18300	OR164	227	260
-59.38890	85.17190	OR163	140	452
-59.39170	85.15570	OR162	226	254
-59.36750	85.14160	OR161	215	198
-59.13950	85.13840	OR159	192	550
-59.37210	85.13060	OR160	217	208
-59.12370	85.12390	OR158	246	280
-59.08640	85.10800	OR157	204	210
-59.02100	85.08130	OR155	197	569
-58.99530	85.06690	OR154	168	541
-58.98110	85.05360	OR153	149	470
-58.95380	85.03960	OR152	147	468
-58.92670	85.02640	OR151	116	427
-58.89280	85.01330	OR150	198	570
-58.86530	84.99980	OR149	162	490
-58.79440	84.98410	OR148	248	294
-58.77950	84.97330	OR147	156	480
-58.75300	84.95810	OR146	193	555

-58.73580	84.94620	OR145	158	482
-58.74060	84.93040	OR144	249	300
-58.72500	84.91750	OR143	194	559
-58.68690	84.89480	OR142	172	537
-58.68910	84.88220	OR141	151	473
-58.66800	84.87050	OR140	201	192
-58.65090	84.85480	OR139	245	279
-58.63520	84.84210	OR138	191	565
-58.61450	84.82800	OR137	199	573
-58.60540	84.81410	OR136	170	539
-58.59080	84.79980	OR135	195	562
-58.57220	84.78760	OR134	161	489
-58.56940	84.77460	OR133	183	551
-58.53860	84.76000	OR132	169	540
-58.53160	84.74350	OR131	167	542
-58.51590	84.73270	OR130	150	471
-58.48970	84.71590	OR129	179	527
-58.47840	84.69050	OR127	165	544
-58.57400	84.65440	OR126	222	265
-58.56760	84.64160	OR125	146	466
-58.53040	84.62560	OR124	145	465
-58.52400	84.61050	OR123	130	444
-58.51030	84.60010	OR122	218	212
-58.47530	84.58260	OR121	214	109
-58.45500	84.56900	OR120	133	453
-58.44630	84.55400	OR119	233	216
-58.42620	84.54190	OR118	144	429
-58.41680	84.52930	OR117	208	263
-58.40410	84.50690	OR116	205	214
-58.38980	84.49860	OR115	216	203
-58.37700	84.48680	OR114	223	241
-58.35510	84.47070	OR113	138	457
-58.37710	84.45820	OR112	117	430
-58.34910	84.44500	OR111	229	200
-58.33430	84.43070	OR110	232	213
-58.34690	84.41800	OR109	122	408
-58.33020	84.40270	OR108	224	247
-58.31950	84.38800	OR107	238	249
-58.31100	84.37660	OR106	234	255
-58.24360	84.36200	OR105	228	151
-58.21410	84.34560	OR104	209	240
-58.20380	84.33250	OR103	230	204
-58.19310	84.31840	OR102	219	215
-58.17460	84.30540	OR101	225	251
-58.17200	84.29100	OR100	239	252
-58.16110	84.27700	OR 99	211	250
-58.16000	84.26410	OR 98	107	458
-58.14410	84.25130	OR 97	118	433

-58.13990	84.23880	OR 96	111	526
-58.12720	84.22290	OR 95	119	439
-58.12040	84.21070	OR 94	110	456
-58.11460	84.19500	OR 93	104	394
-58.10670	84.18200	OR 92	121	404
-58.09010	84.16730	OR 91	108	434
-58.08270	84.15360	OR 90	103	410
-58.07880	84.14550	OR 89	102	469
-57.40240	84.14100	OR 88	101	455
-57.38190	84.12700	OR 87	128	435
-57.32730	84.10710	OR 86	114	420
-57.31170	84.09580	OR 85	106	407
-57.31260	84.08330	OR 84	131	380
-57.30350	84.06900	OR 83	129	440
-57.30580	84.05590	OR 82	125	424
-57.29470	84.04380	OR 81	126	428
-57.27490	84.02730	OR 80	105	442
-57.26040	84.01460	OR 79	127	437
-57.24400	84.00060	OR 78	109	431
-57.23730	83.98750	OR 77	132	432
-57.22560	83.97330	OR 76	112	411
-57.21250	83.95830	OR 75	113	416

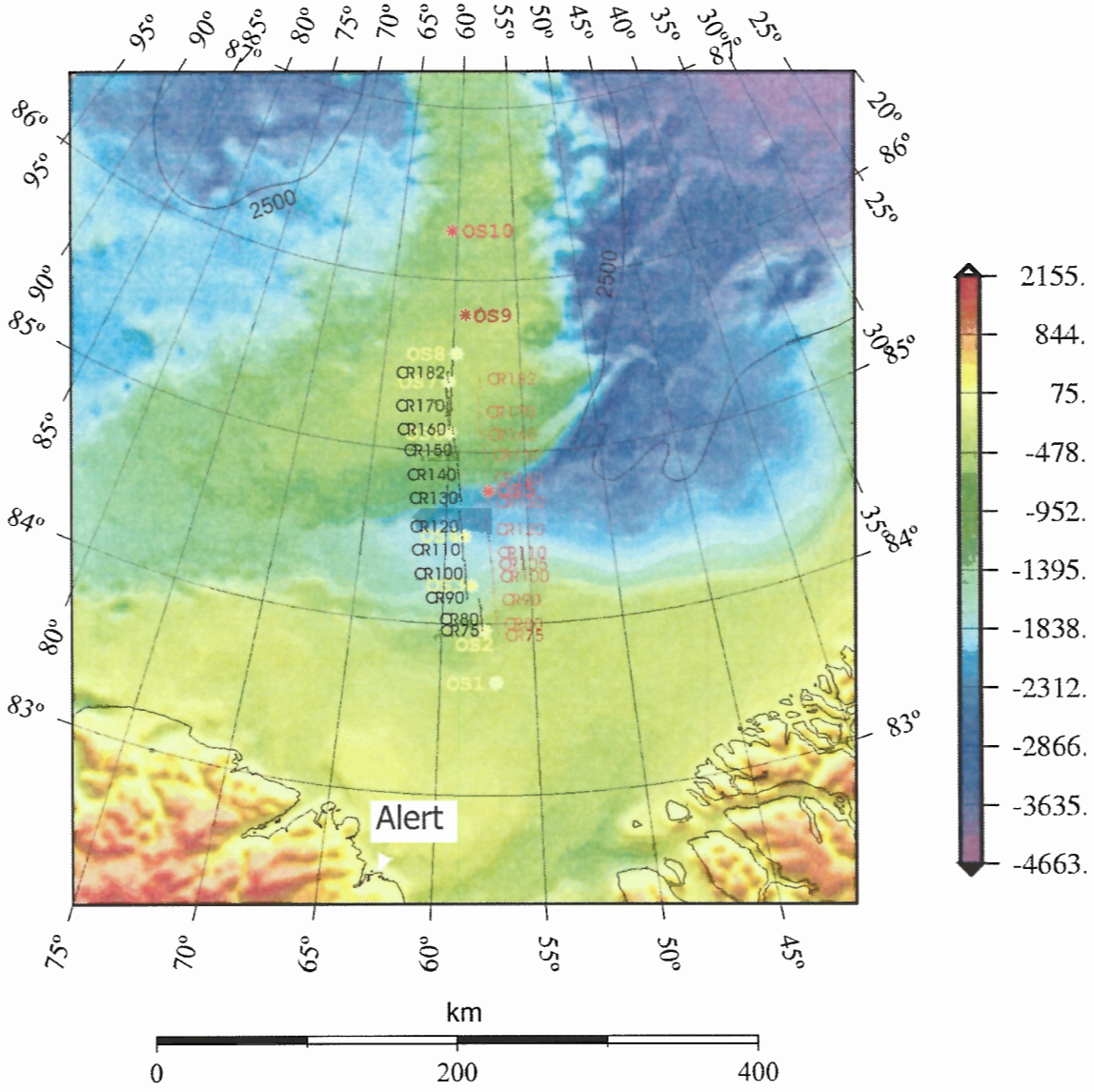
Outer Line Receiver Positions for shot OS10

Longitude	Latitude	Station	Cooler	Taurus
-57.96860	85.42320	OR182	0 0 2006:1:0:0	
-57.96180	85.41050	OR181	0 0 2006:1:0:0	
-57.95480	85.39620	OR180	0 0 2006:1:0:0	
-57.93760	85.38070	OR179	0 0 2006:1:0:0	
-57.91380	85.36870	OR178	0 0 2006:1:0:0	
-58.10070	85.33110	OR177	207	257
-58.08400	85.31830	OR176	142	447
-58.06630	85.30320	OR175	141	393
-58.05420	85.28930	OR174	136	449
-58.04090	85.27550	OR173	212	253
-58.02140	85.24940	OR171	235	262
-58.00470	85.23410	OR170	236	239
-57.99220	85.22150	OR169	241	267
-57.97720	85.20720	OR168	243	268
-57.97680	85.19390	OR167	143	451
-57.96440	85.17930	OR166	220	219
-57.96200	85.16630	OR165	134	443
-57.97510	85.15120	OR164	227	260
-57.91160	85.14090	OR163	140	452
-57.92160	85.12470	OR162	226	254
-57.90360	85.11050	OR161	215	198
-57.67810	85.10670	OR159	192	550

-57.91280	85.09950	OR160	217	208
-57.66890	85.09220	OR158	246	280
-57.65790	85.07770	OR157	204	210
-57.62550	85.05130	OR155	197	569
-57.60720	85.03690	OR154	168	541
-57.60180	85.02350	OR153	149	470
-57.58540	85.00950	OR152	147	468
-57.57690	84.99610	OR151	116	427
-57.56360	84.98240	OR150	198	570
-57.55280	84.96870	OR149	162	490
-57.54000	84.95410	OR148	248	294
-57.52790	84.94330	OR147	156	480
-57.51630	84.92770	OR146	193	555
-57.50320	84.91580	OR145	158	482
-57.51410	84.89990	OR144	249	300
-57.50320	84.88700	OR143	194	559
-57.46320	84.87100	OR142	172	537
-57.47030	84.85840	OR141	151	473
-57.45360	84.84660	OR140	201	192
-57.44240	84.83090	OR139	245	279
-57.43630	84.81790	OR138	191	565
-57.42090	84.80370	OR137	199	573
-57.41710	84.78980	OR136	170	539
-57.40780	84.77540	OR135	195	562
-57.39370	84.76320	OR134	161	489
-57.39570	84.75020	OR133	183	551
-57.37040	84.73550	OR132	169	540
-57.36930	84.71900	OR131	167	542
-57.35760	84.70820	OR130	150	471
-57.33760	84.69130	OR129	179	527
-57.33530	84.66590	OR127	165	544
-57.47130	84.63080	OR126	222	265
-57.46750	84.61790	OR125	146	466
-57.44000	84.60390	OR124	145	465
-57.43510	84.58880	OR123	130	444
-57.42270	84.57840	OR122	218	212
-57.40900	84.56240	OR121	214	109
-57.39300	84.54880	OR120	133	453
-57.38880	84.53380	OR119	233	216
-57.37250	84.52160	OR118	144	429
-57.36690	84.50890	OR117	208	263
-57.35650	84.48770	OR116	205	214
-57.34120	84.47940	OR115	216	203
-57.32710	84.46760	OR114	223	241
-57.30320	84.45150	OR113	138	457
-57.32360	84.43910	OR112	117	430
-57.29410	84.42590	OR111	229	200
-57.27760	84.41160	OR110	232	213

-57.28860	84.39890	OR109	122	408
-57.27010	84.38360	OR108	224	247
-57.25770	84.36890	OR107	238	249
-57.24790	84.35750	OR106	234	255
-57.20820	84.34390	OR105	228	151
-57.17910	84.32780	OR104	209	240
-57.17150	84.31500	OR103	230	204
-57.16180	84.30090	OR102	219	215
-57.14440	84.28790	OR101	225	251
-57.14290	84.27340	OR100	239	252
-57.13310	84.25940	OR 99	211	250
-57.13300	84.24650	OR 98	107	458
-57.11810	84.23370	OR 97	118	433
-57.11480	84.22120	OR 96	111	526
-57.10330	84.20540	OR 95	119	439
-57.09750	84.19310	OR 94	110	456
-57.09280	84.17740	OR 93	104	394
-57.08600	84.16440	OR 92	121	404
-57.07040	84.14970	OR 91	108	434
-57.06420	84.13600	OR 90	103	410
-57.06090	84.12790	OR 89	102	469
-57.02900	84.11230	OR 88	101	455
-57.03380	84.09720	OR 87	128	435
-57.00410	84.07830	OR 86	114	420
-56.99700	84.06700	OR 85	106	407
-56.99750	84.05450	OR 84	131	380
-56.98800	84.04020	OR 83	129	440
-56.98990	84.02710	OR 82	125	424
-56.97850	84.01510	OR 81	126	428
-56.96160	83.99860	OR 80	105	442
-56.94880	83.98590	OR 79	127	437
-56.93650	83.97190	OR 78	109	431
-56.93110	83.95870	OR 77	132	432
-56.92080	83.94450	OR 76	112	411
-56.90890	83.92950	OR 75	113	416

Outer line plot showing the location of shots OS and receivers OR.



Cross line Shot Locations

Longitude	Latitude	Station
-62.71648	84.46083	XS1
-60.11095	84.48553	XS2
-58.30102	84.51347	XS3
-56.21233	84.53013	XS4
-54.63715	84.53613	XS5
-52.59493	84.55125	XS6

Cross line Receiver positions at shot 4

Longitude	Latitude	Station
-61.8982	84.4585	XR1
-61.7692	84.4608	XR2
-61.6400	84.4631	XR3
-61.5108	84.4653	XR4
-61.3814	84.4675	XR5
-61.2520	84.4697	XR6
-61.1224	84.4718	XR7
-60.9928	84.4739	XR8
-60.8630	84.4760	XR9
-60.7332	84.4781	XR10
-60.6032	84.4801	XR11
-60.4732	84.4822.	XR12
-60.3430	84.4841	XR13
-60.2128	84.4861	XR14
-60.0825	84.4880	XR15
-59.9521	84.4899	XR16
-59.8216	84.4918	XR17
-59.6910	84.4936 .	XR18
-59.5603	84.4954	XR19
-59.4296	84.4972	XR20
-59.2987	84.4990	XR21
-59.1678	84.5007	XR22
-59.0368	84.5024	XR23
-58.9057	84.5041	XR24
-58.7745	84.5057	XR25
-58.6433	84.5073	XR26
-58.5120	84.5089	XR27
-58.3806	84.5104	XR28
-58.2491	84.5120	XR29
-58.1176	84.5135	XR30
-57.9860	84.5149	XR31
-57.8543	84.5164	XR32
-57.7226	84.5178	XR33
-57.5907	84.5192	XR34
-57.4589	84.5205	XR35
-57.3269	84.5218	XR36

-57.1949	84.5231	XR37
-57.0629	84.5244	XR38
-56.9307	84.5256	XR39
-56.7985	84.5268	XR40
-56.6663	84.5280	XR41
-56.5340	84.5292	XR42
-56.4016	84.5303	XR43
-56.2692	84.5314	XR44
-56.1368	84.5324	XR45
-56.0043	84.5335	XR46
-55.8717	84.5345	XR47
-55.7391	84.5355	XR48
-55.6064	84.5364	XR49
-55.4737	84.5373	XR50
-55.3410	84.5382	XR51
-55.2082	84.5391	XR52
-55.0754	84.5399	XR53
-54.9425	84.5407	XR54
-54.8096	84.5415	XR55
-54.6767	84.5422	XR56
-54.5437	84.5429	XR57
-54.4107	84.5436	XR58
-54.2776	84.5443	XR59
-54.1446	84.5449	XR60
-54.0115	84.5455	XR61
-53.8783	84.5460	XR62
-53.7452	84.5466	XR63
-53.6120	84.5471	XR64
-53.4788	84.5476	XR65
-53.3456	84.5480	XR66
-53.2123	84.5484	XR67
-53.0790	84.5488	XR68
-52.9457	84.5492	XR69
-52.8124	84.5495	XR70
-52.6791	84.5498	XR71
-52.5461	84.5501	XR72

Cross line plot showing the location of shots XS and receivers XR.