I.S.I.S. FIELD REPORT 1988

Ice Island Sampling and Investigation of Sediments

A.G.C. Field Project 88200
G.S.C. Project 7248486

D.C. Mosher, P.J. Mudie, and G.V. Sonnichsen

Atlantic Geoscience Centre
Geological Survey of Canada
Bedford Institute of Oceanography
P.O.Box 1006, Dartmouth, N.S.
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AGC Open File No. 2043

Ice Island Contribution No. 18

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INTRODUCTION

The purpose of this report is to document the field work accomplished by AGC on the Canadian Ice Island, Hobson's Choice, in 1988, and to report the salient features of the scientific experiments and initial results. This field report is the fourth in a series of environmental marine geology studies of the surficial sediments on the Canadian Polar Margin (see REFERENCES for earlier reports). These Ice Island studies have been made possible by funding from the Frontier Geoscience Program, in order to carry out the first survey of sediments , living and fossil biota which occur in and under the permanent pack ice cover on the continental shelves of the Arctic Ocean north of Latitude 80 degrees N . Field work in this environment has been made possible by the logistical support of the Polar Continental Shelf Program (see Jackson, 1989). The 44 m-thick ice island and surrounding multiyear sea ice has required the development of special techniques for geological sampling, and for the maintenance of laboratory facilities on the Ice Island. These field methods are reported here in detail, in order to make available the expertise acquired by AGC's Program Support subdivision, which is relevant to the Arctic sea ice work of exploration companies and defence research exercises. Details of the scientific studies have or are being reported elsewhere in scientific journals (see REFERENCES).

ISIS 1988 SPRING PROGRAM
(MARCH 21 - APRIL 23, 1988)

Personnel

Mike Gorveatt..............AGC/PSS (March 21 - April 12)
Fred Jodrey................AGC/PSS (April 5 - April 21)
Larry Johnson..............AGC/PSS (March 21 - April 12)
Don Locke..................AGC/PSS (March 21 - APril 12)
Dave Mosher................AGC/EMG (March 21 - April 21)
Peta Mudie.................AGC/EMG (April 5 - April 21)
Gary Sonnichsen............AGC/EMG (March 21 - April 21)

In collaboration with:

Neil Hamilton..............Dalhousie University (Dal)
Trevor Hoskins.............Dal
Keith Louden...............Dal
Bob Moore..................Dal
Geoff Ridal................Dal
Ron Perkin.................IOS/Frozen Sea
Dennis Richards.............IOS/Frozen Sea

OBJECTIVES

During the fall and winter, 1987, the Canadian Ice Island drifted westwards across Sverdrup Channel and Meighen Island Bank, and by March 1988, it was on the west side of Peary Channel near Lat. 80o08.0'N and Long. 105 40.3'W (Fig. 1). The Quaternary marine geology and oceanography of this part of the Canadian Polar Margin have not previously been studied although the area is of special interest: (1) as a transition zone between the cold, dry eastern High Arctic islands (Axel Heiberg and Ellesmere) and the relatively warm, western Parry Islands-Beaufort Sea region; 2) Peary Channel is the Arctic gateway to Norwegian Bay which is presently being mapped in detail by AGC (Praeg,1988; Sonnichen et al., 1989) and the CHS.

Primary aims of the 1988 I.S.I.S Spring Program included the following scientific objectives:

A. To obtain continuous bathymetric records and high resolution acoustic profiles (Fig. 2) of the surficial sediments (top 100 - 500 m) along the drift track of the Ice Island.

B. To obtain long sediment cores for lithostratigraphic, biostratigraphic, and geotechnical studies, using the new 7-ton Hawbolt winch and a new piston coring system (Gorveatt and Chin Yee, 1988). This new corer design employs an acoustic release in place of the conventional trigger arm and trigger weight core, and it uses removable collar-type couplings and set screws to connect the core barrels instead of threads .

C. To sample bottom sediments at oceanographic stations on traverses across the continental margin north of Meighen Island (Line A) and north of Ellef Ringnes Island (line B) (Fig. 1). This mobile sampling (MOBS) operation from helicopters (Mudie and Mosher, 1987) was to be carried out in liason with the Dalhousie University heat flow program (Keith Louden) who would establish a temporary camp and fuel caches on ice floes over the continental slope.

D. To collaborate with oceanographers from IOS (R. Perkins and D. Richards) and Dalhousie University (R. Moore) in obtaining CTD profiles across the polar margin, in testing a model of ice-driven convective surface water circulation, using an Arctic current meter (see Appendix 1) amd measurements of non-reactive gas concentrations, e.g. Argon, Krypton, Neon (see Appendix 2).

E. To collaborate with biological oceanographers (B. Hargrave) at BIO in studies of suspended sediment transport, biological productivity, benthic mixing and organochloride pesticide levels on the Canadian Polar Margin.

F. To compile a videotape recording of the Ice Island geological work in the spring and summer sectors of the field season, and to record ice conditions (roughness, sediment distribution) as seen from the air during shelf crossings, and on the Ice Island and adjacent multiyear ice.

In addition to, and in conjunction with these scientific objectives, several technical projects were needed to improve and maintain the AGC geology lab and equipment.

A. <u>Construction</u>: Adjoin the coring hut and the winch pump hut built last spring. Install an Incinolet washroom in this adjoinment. Adjoin the melter hut and the coring hut by constructing a porch between the two.

B. <u>Maintenance</u>: Snow clearing, building repairs, roof repairs, change oil and all filters in generator motor, fueling, stove additions and repairs, flush hydrohole.

C. <u>Sampling</u>: Add new heel block (Metrox system) and load guage to main winch system, repair Hawbolt winch (new brake, eliminate knocking noise). Activate boiler system - add glycol, run new hoses, repair/modify pumps, melt hole, rig up coring system with new collars, acoustic release, and the disposable bottom sensing magnetic-switch designed by D. Heffler at AGC. Set up and run camera stations with UMEL camera system.

D. <u>Seismics</u>: Activate 12 kHz, 3.5 kHz, and sparker systems.

E. <u>MOBS</u>: Improve equipment for the MOBS program.

Hydrohole Sampling (D. Mosher, M. Gorveatt)

A total of 4 piston cores, 2 gravity cores, 6 grabs and 1 camera station were completed during the spring program (Table 1). Core recovery was often small but this result is now known to be a function of sediment type, not coring operation (see Results). The acoustic releases on the piston cores (Fig. 3) performed well. This system is much better for lowering the core through the hydrohole compared to the shortened trigger arm and gravity core release mechanism used in previous years (Mudie et al., 1985). The new core barrel collars replacing the threaded barrels (Fig. 4) are also a vast improvement for rigging a core vertically. Several problems still exist with the coring operation. The piston did not split in each attempt at coring, with the result being implosion of the core liner and wash-out of large sections of sediment. The reason for the piston not splitting is not known. The piston core tends to "blow away" about 0.5 m of the surface sediment and therefore a gravity core should be taken in conjunction with a piston core. Similarly a gravity core does not sample the top 0.10 m of the sediment column and hence it is advisable to take a grab sample in conjunction with the cores. Given the generally slow rate of drift of the Ice Island it is feasible to complete all three tasks without too much distance between sample locations.

A new brake was installed on the coring winch (Hawbolt). The winch performed well except for a knocking noise that occurs on payout. Adjustment of the hand brake was found to permit faster payout before the knocking noise commenced. The Metrox metre block and readout was a valuable addition and a necessity for the piston coring operation. It is suggested that such a readout be purchased for the Ice Island, as it probably costs more to ship it in and out for each program than to buy one.

Gravity coring, grab sampling, and bottom photography were routine, as decribed by Mudie et al., 1985 . The UMEL camera system worked well and the film was developed on site, showing a muddy bottom with rare worm trails and scattered ice-rafted detritus (Fig. 5).

MOBS: Helicopter Sampling (G. Sonnichsen, D. Mosher)

A through-the-ice sediment sampling program was conducted along two 120 km north - south transects which started in the nearshore areas of Ellef Ringnes and Meighen Islands (Lines A and B, Fig. 1). Stations were selected to sample across bathymetric contours to a maximum of 2000 metres water depth which is the maximum capacity of the portable winch. A Bell 206L Long Ranger helicopter with an externally mounted cargo basket was used to transport two technicians and equipment to the sample sites. The use of this larger helicopter, compared with two Bell 206B's used in 1987, saved considerable flying hours and expense. Portions of both transects were completed in conjunction with physical oceanographers from IOS in another helicopter who collected CTD data from a second hole which was augered at each site.

Most stations were located fairly accurately (+ 2 km) from the air using the Omega VLF navigation system. Once on the ice the position was more accurately determined from the Transit Satellite System, using a MX5102 satellite receiver. The position of the sample stations was adjusted to avoid second- and multi-year ice which is 3 to 10m thick, and to drill on the relatively thin (2 - 3 m) first-year ice or on recently frozen leads (Fig. 6). Ice thicknesses at the stations varied from 0.20 m over the leads to 2.3 m on the first-year ice.

Twenty-five samples (Table 1) were collected through 10" (25.4 cm) holes drilled through the ice using an aluminum auger which was driven with an 1 1/4 " reversible electric drill and powered by a 3000 Watt Honda generator. At each station, a Dietz-LaFonde grab sampler with a shortened trip arm was used to collect the top 8 cm of sediment. Short cores were then collected with a 45 kg gravity corer fitted with a plastic liner, which also served as a core barrel. The end of the liner was fitted with a catcher and a modified stainless steel cutter. The sampling tools were lowered with an electric winch which was powered by the Honda generator. The winch was designed in-house by Systems Engineering specifically for such helicopter supported sampling programs and carries 2000 metres of 3/16" Kevlar. Several problems were encountered with the winch and modifications before next years program are necessary. The major problem is the sprockets are out of alignment. This causes the chain to come off and causes excess wear in the clutch bushings. Another problem occurred when the drum broke free of the axle, so that the hand brake no longer worked. F. Jodrey will consult with systems engineers concerning design changes. The circuit breaker in the generator had to be disconnected as it kept blowing. In the cold temperatures it was deemed that the generator would not overheat by carrying too much load.

Video documentary (D. Mosher)

Approximately 2 hours of video was taped which included shots of spring snow conditions, general camp operations, core hut operations, equipment, inventory and sampling procedures, the MOBS program and sampling procedures, and seismic reflection operations (Jim Hunter, Ottawa). The use of helicopters during this program provided the opportunity to acquire aerial footage of the Ice Island, the camp, and good shots of sea ice conditions. The 8 mm original tapes have been copied to two 3/4' master tapes for editing. A short documentary for open file will be produced from this collection after splicing with selected coverage of the summer field camp operations and ice conditions.

SUMMARY OF MAIN RESULTS (P. Mudie)

The Ice Island surficial geology program started two weeks earlier this year to allow for repair of the AGC field lab in addition to study of the surficial sediments on the continental shelf and slope north of Meighen and Ellef Ringnes Islands. Ice cover, surficial geology, and hydrography have not previously been studied north of 80oN in this part of the Canadian Polar Margin. Geological field work this year was therefore coordinated with 1) a physical oceanography program operated from helicopters along 120 km traverses across the margin (Fig. 1); 2) heat flow studies from Ice Island and from a remote camp over the continental slope; and 3) chemical oceanography studies from the remote camp. Lab work was later carried out in liason with DREP and Dal. U. (Mayer and Marsters, 1989) to study the geotechnical properties of the surficial sediments. A new coring system with an acoustic piston release and barrel-coupling sleeves, designed by AGC Program Support, was tested successfully (Figs 3, 4). Bathymetry was obtained from 12 kHz and 3.5 kHz bottom and sub-bottom profilers which were run in conjunction with an EG&G 8.5 kJ sparker seismic profiler installed in the hydrohole. These systems provided shallow seismic records for about the top 150 m of sediments (Fig. 2).

Initial results of the spring geology program show that lithofacies in cores from this part of the Canadian polar margin can be correlated with cores from Axel Heiberg shelf (Hein and Mudie, in press; Hein et al., 1989). Late Pleistocene - early Holocene sedimentation rates are higher, however, in the region north and west of Meighen Island. This regional variation in sediment influx probably reflects the more extensive area of erodable Tertiary sedimentary bedrock which occurs in the Sverdrup Basin west and south of Axel Heiberg Island. Slightly warmer climate may also account for more extensive areas of open water, more frequent upward mixing of the warm Atlantic water layer, and more melt-out of ice-rafted detritus. In large deep channels, e.g. Peary Channel, frequent areas of hummocky bottom relief (Fig. 2) suggest that large amounts of ice-rafted sediment are periodically deposited and gravity flows may also contribute to the higher sedimentation rate. Unfortunately, V-shaped subsurface features and a dipping reflector seen in the sparker records (Fig. 2) could not be cored because of a layer of very stiff silty clay at a subbottom depth of ca. 150 cm. This apparently overconsolidated sediment layer appears to be a universal feature of both Arctic and Antarctic polar margins (Barker et al., 1988; Pudsey et al., 1988). In the Antarctic, it occurs at water depths (4.5 km) which are too great to have been deposited by grounded glacial ice. A consolidation test on a sample from core 88200-036 also indicates physical properties which are much weaker than those of basal till (H. Christian, AGC, pers. comm.). The occurrence of this stiff mud layer on the margins of both the northern and southern polar oceans therefore may be related to near-freezing bottom water temperatures and/or formation of gas hydrates rather than glacial ice extent (Elverhoi, pers. comm., 1988; Hunter, pers. comm., 1988). Future sampling should include detailed geochemical and geotechnical studies of this sediment layer.

Preliminary studies of benthic foraminifera from the 1988 MOBS and Ice Island samples indicate a transition from the species-rich Axel Heiberg fauna dominated by calcareous forms (Shroeder-Adams et al., in press a, b) to the lower diversity fauna dominated by arenaceous species which characterises the interisland channels of the eastern Sverdrup Basin (Vilks, 1969). Only one sample from the bank north of Ellef Ringnes contained living Geodia sponges. More extensive sampling of the banks above 150m water depth is needed, however, to determine whether or not the apparent sparsity of sponge "reefs" is a true reflection of different environmental conditions on the western polar margin, or merely an artifact of limited sample coverage in shallow (<300m) waters west of Meighen Island.

Oceanographic data collected by Perkin and Richards at 10 stations along transects A and B (Fig. 1) showed a strongly stratified water column, with a low salinity mixed Arctic Surface Layer above a -0.5 degree C thermocline at about 150 m water depth, near the top of the warm, saline Atlantic layer. An important observation is the increased salinity of this surface layer which is now 31.99 - 32.00 %o, compared to values of about 31.6%o and 31.9%o measured in 1986 and 1987, respectively. This trend may indicate increased mixing of the Arctic Surface and Atlantic Layers. Measurements of inert gases in the water samples collected at the shelf break by Moore (analysed at WHOI by B. Spitzer) showed undersaturation of Argon at depths of 200m to about 450 m. These data appear to support the model of Moore and Wallace (see Appendix 2) which predicts cooling of the Atlantic Layer by contact with the pack-ice cover, without any involvement of air-sea interactions in open water leads. If verified by further analysis, this model has very important implications concerning Arctic Ocean heat transfer mechanisms which are presently thought to be driven primarily by atmospheric circulation systems. Current meter measurements obtained from a depth of 50 m for two days in April (Fig. 7), recorded no consistent flow direction during this time when the Ice Island was moving northward at speeds of up to 400 m/hr.

ISIS SUMMER PROGRAM
(June 21 - July 7, 1988)

Personnel:

Barry Hargrave.............	DFO	(June 21 - July 5)
Allan Law..................	AGC/PS	(June 21 - July 5)
David Mosher...............	AGC/EMG	(June 21 - July 5)
Bob Murphy.................	AGC/PS	(June 21 - July 5)
Gary Sonnichsen............	AGC/EMG	(June 21 - July 5)
Peta Mudie.................	AGC/EMG	(June 30 - July 5)
Terry John Hearn...........	AGC/PS	(June 30 - Aug. 12)

OBJECTIVES

During the month of May, 1988, the Ice Island drifted southwest across Ellef Ringnes bank to the east side of Prince Gustaf Adolf Sea. It then remained almost stationary in this position until our arrival on June 21st and it moved little until the last week in July . It was considered that if the AGC facilities on the Ice Island were manned by the end of June, then the equipment and necessary seismic systems would be ready in time for large scale island drift which usually occurs in summer. Occupation of the Island at this time would also allow preparation for the melt season which caused significant damage in 1987 when the AGC facilities were unmanned.

The summer field program therefore included both scientific and technical objectives:

1) Scientific objectives:

A) Collect bathymetry, sparker and 3.5 kHz shallow seismic profiles.

B) Collect piston cores and grabsamples and conduct preliminary geotechnical studies on these samples.

C) Complete filming of the videodocumentary.

D) Collaborate with Hargrave (AOL) in biological sampling and suspended sediment studies.

E) Deploy the IOS Arctic current meter.

2) Technical/Maintenance Objectives

A) Open AGC hydrohole (1.5 m diam) for geological studies
B) Repair roofing on AGC buildings
C) Boiler maintenance (heat exchanger)
D) Melt water control
E) Repair 7-t Hawboldt winch
F) Melt small hydrohole for oceanography and grounding the sparker

The following section of this field report gives details of the technical problems involved in maintaining the Ice Island marine geology lab during a warmer than average meltwater season. These problems have lead to a list of recommendations for the 1989 field season (see RECOMMENDATIONS) and an inventory of items that must be provided by next field season (Appendix 4)

TECHNICAL REPORTS

Field Log

The first field party arrived at Resolute 03:00 (LT), on JD173. Other passengers (seismic crew) and our gear required two Twin Otter flights to Ice Island. Law, Hargrave and Mosher arrived on the Island with first flight at 12:10 LT, Julian Day 173. Sonnichsen and Murphy followed with remainder of equipment on the next flight, arriving at 21:00 LT). First tasks were to open up camp (which required substantial shovelling), fire up the stoves (replaced stove at rear of core hut), and ascertain that all winches, generators, boilers, etc. were functioning. Upon arrival the ceiling of the core hut was dripping lots of water, especially around the gantry, the dry lab area, and the porch. The floors and counters were covered with 5 to 15 cm of ice, including the electronic equipment that was left on the counters in the dry lab (e.g. UGR). Drying up this area was considered a priority in order to set up the seismic equipment. By the time Mudie and Hearn reached the Ice Island five days later (JD 179), the core hut was dry, and final repairs were being made to the roof. By then, however, rapid melting was in progress, and it became essential to start constructing drainage channels around the AGC field lab. This work continued until departure of all except Hearn on July 5. Hearn remained on the Island until August 12 (JD225) during which time flood control, pump and roof repair were his main tasks. From August 12 to October 1, the AGC Lab was attended by the Camp Manager, M. Schmidt, who agreed to fill the hydrohole with clean water so it could be reamed out in spring, 1989. Unfortunately, even after freezing was well under way, it was not possible to fill the hydrohole which must contain some large subterranean cracks.

Roof and Floor

The roof of what comprised the old core hut (before the addition for the new winch) was ripped up, the boards and old insulation were removed, and water was removed from inside the roof. This water was 5 cm deep in places. New vapour barrier, and new insulation was installed, the boards were replaced, and new rolled roofing was implaced with generous amounts of tar. Rolled roofing was also layed on the new additions of this past spring, namely the porch and washroom. The insulation in the porch had fallen due to meltwater. It was used in the roof of the core hut so was not replaced in the porch.

A floor was installed in the porch to raise the floor above the meltwater. The Kohler motor was lifted onto this floor, but one hydraulic hose was anchored deep into the ice underneath the motor and could not be excavated. There was enough slack to move the motor but it will be difficult to extract the hose without damaging it. A replacement hose should be installed in 1989.

Generator

The AGC generator was started at 08:00 LT/176 and run until 10:00 LT/187. Changed oil and oil filter in generator at 19:00 LT/179. Did not change air or fuel filters. Need more oil for future operations (HD-X-40).

Boilers

About 30 L of warm muriatic acid (about 10 % solution) was pumped through the heat exchanger to try and flush dirt out of the system. The small pump used for circulating water in the hydrohole was used to pump this solution through the heat exchanger. The acid was circulated for about 3 hours. It should be ascertained that the water pipes in the exchanger are stainless steel or iron and not copper if this procedure is to be repeated. The acid reacted with the metal of the pump, so a plastic pump would be preferable to perform this operation in future.

Glycol was added to the expansion tank to bring the level to about half way up the tank. The boilers were run between 180 and 200 degrees F for a total of about 50 hours for melting the main hole, a second hole, and to assist in trench deepening. The boilers ran out of diesel during the melting of the second hole. Fuel was added to the tank, the lines were bled, and it was necessary to restart the boilers by depressing the the red reset button inside of the front panel. At the end of operations the glycol was drained from the boiler system into the 45 gal drums at the back of the boiler hut.

Hydroholes

A primer hole was augered in the ice of the main hydrohole. At about 1 meter this hole broke through to water. There was some problem getting either submersible pump to work. It was realized that they were both single phase pumps (not three phase as previously thought for the larger pump). A break in the wire to the pump (red wire) was also discovered and repaired. This break was probably responsible for the blowing of fuses experienced in the spring. The larger pump was wired into the single phase junction box and appeared to work to maximum performance.

Commenced melting at 15:00LT/176 running boiler number 2, set at 180-200oC, resulting in an output temperature of about 140 degrees F. Lowered the straight nozzle 0.25m per 10 min. At 16:00 LT switched to spray nozzle and continued at same rate of descent for remainder of hole. Turned on boiler number 1 at 18:40 LT. Boilers cycled normally (about 2 min. off and 3-4 min. on) with an output temperature of about 145 - 150 degrees F.Finished melting at 20:00 LT/JD 177. Checked diameter of hole with 4 ft. ring and it successfully went through the ice with no problem.

Commenced melting the second hole (between the boiler hut and the storage tent) 16:45 LT/182. Started melting with Hargrave's 2 ft. ring, but it was found to be inefficient, so we changed to the regular straight nozzle lowered at a rate of 0.25 m every 5 min. This rate of descent resulted in about a 1 m diameter hole. Changed to the spray nozzle to melt the mouth of the hole wider (2 ft. ring would not fit through) and found we had to leave it at the mouth for several hours before we had at least a 2 ft. diameter hole at the mouth. Finished melting 13:00 LT/183. A groundline of braided wire for the sparker system was installed down this hole and an A-frame was built over it for lowering of benthic samplers (Fig. 8A) and plankton nets.

Meltwater Control

On arrival at the Ice Island, melting was not a significant problem, but the snow was soft. By Sunday, June 26th, melting was noticed around the buildings, and was especially bad in the porch. Snow was shovelled away from the front of the coring facility, but there was too much snow to shovel all around the buildings. By June 29th, meltwater in the porch and around the boiler hut was severe and was starting to come in the boiler hut around the sparker equipment. A trench and pit were dug by power saw, pick-axe and shovel to drain the water away from the south side of the buildings (Fig. 8B). A Wajax pump was used to empty the water from the pit. Meltwater was also over the floorboards in the core hut around where the core head is stored. This water was draining into the hydrohole.

Abundant oil (mostly old hydraulic oil) in the snow and subsequently in the meltwater proved to be a nuisance and in fact hazardous, as it was tracked on boots into the buildings, making the deck very slippery. The deck of the core hut was scrubbed and patches of rolled roofing were tacked onto the floor to provide some traction. Oily snow was shovelled and hauled to the dump, and oily water was bailed and poured into drums and hauled to the dump, but these efforts seemed to have little affect on eliminating the oil leakage.

By July 2, meltwater was flooding the winch end (west) of the core hut. Trenches and a pit were dug on the north side of the core hut to drain this area, and the second Wajax pump was used to drain this pit. The trench was extended along the North wall of the core hut in order to drain the flooding in the core hut around the core head. This trenching appeared to have little affect on the flooding in the middle of the core hut due to deep snow and the high level of ice along the core hut wall. By July 4th, abundant meltwater was noticed at the east end of the core hut. This water was up to the level of the floorboards. Again, due to deep drifts a trench could not be readily emplaced to drain the area. Repair of this area could not be done before the main party left on July 5, but it was hoped that Hearn could pump out this area after more snow melted and it was more obvious where the trench should be dug.

Severe flooding in the storage tent was noticed and left unattended for the most part. Instructions were left with Hearn who rebuilt the storage tent when meltwater control was complete.

Winches

One objective of this field trip was to adjust the hydraulics on the Hawbolt winch in order to eliminate the knocking noise made on payout (knocks only with large core head at payout greater than 30 to 40 meters per minute). This correction could supposedly be made by adjusting two set screws on the master control valve. Turning both of these valve adjustments full amounts in both clockwise and counterclockwise directions had no apparent affect on the knocking noise/payout rate. As was discovered in the spring, tightening the hand brake permitted a higher payout rate before the knocking commenced, so this method was used to adjust the payout rate. It was noticed that in going from stop to heave-in, the winch will pay-out several inches before heave-in commences. This fault was not noticed during previous trips to the Ice Island, so something may have been altered in turning the master control valve adjustments, or perhaps the hand brake merely needed to be tightened.

Two hydraulic leaks were spotted on the Hawbolt winch. One is where several hydraulic lines feed into the winch drum. The other is on a pressure guage on the power pack for the winch (i.e. by the Hatz diesel). This guage is located at the back of the unit, where several lines feed into the hydraulic tank, above and beside the heat-exchanger.

On June 29th the Hatz diesel winch motor stalled for no apparent reason. Upon investigation it was discovered that the fan belt had broken. It appeared that a metal clip, which holds a black, plastic cover over the fan, slipped off and got caught in the fan belt, resulting in it shredding. A safety mechanism automatically shuts the motor down when the belt breaks. A spare belt was found and installed after some difficulty. Another spare belt still exists.

The smaller winch worked well. A new valve stem is required for the level-wind controls, as a pair of vice-grips presently has to be used. The Kevlar cable is old and in rough shape. As recommended in 1987, a new one should be installed on the drum to avoid loss of expensive equipment. The Kohler motor worked well. It is now high and dry above the floor in the porch. A new ignition coil was installed on it because the old one was full of water. Perhaps a spare one should go up. Also, as mentioned previously, one of the hydraulic return lines is frozen in the ice and a replacement should installed.

Seismics

By 21:30 GMT/175 the 3.5 kHZ and 12 kHz seismic systems were running, though the Island was apparently stationary. Water depth was calculated to be 517 m. These systems ran nearly continuously for the duration of the trip. The recorders on both systems failed on J.D. 183. The EPC 4100 for the 3.5 kHz system was irreparable (sensor problem - no spares), so the EPC from the sparker system was put in in its place. The UGR for the 12 kHz system was not repaired until J.D. 184. Both systems were left running and maintained by Hearn through the summer. About 30 km of records were collected until early August when the recorders and transceivers had to be shipped back to AGC for maintenance and/or use in other programs.

The sparker was repaired. The plug from one of the capacitor banks to the trigger must have shorted and it blew up. The plug was no longer useable and no spare connectors were found, hence this capacitor bank could not be used. This is important to note when calculating the joules output of the sparker system. Also the trigger lamp (ionizing) wire and the electrodes were replaced in the trigger unit. The sparker was running as of J.D. 178, firing at 5 minute intervals, and charging to 2600 volts. Deployment and recovery of the sparker sled is difficult and requires 2-3 people. When the hydrohole was being used, the sled had to be removed, so the sparker record is intermittent. Data was recorded by EPC graphics and fm tape until the EPC had to be used as a replacement for the 3.5 kHz system on J.D. 183. After this time, sparker data was recorded on fm tape only. On JD186, the system was shut down for the remainder of the season, because it cannot be handled by one person. The hydrophone was taken out of the hole. In 1989, plans should be made for a separate hydrohole to contain the sparker hydrophones so that continuous records can be collected.

Coring/sampling

Piston coring operations were moderately successful, though several problems were encountered. Ten foot barrels were used for all piston coring attempts. The new system of barrel collars with set screws and the acoustic releases generally worked well. One of the barrels, however, was left from the spring program with a collar on it. This collar had siezed and it took great effort to remove it. It is suggested that in future the collars be separated from the barrels immediately after use and the sleeves be cleaned with emery paper and light oil. The hinged barrel clamps with pin-type closures were modified by welding handles on them, and threading set screws into them. These modified clamps were a great improvement because the set screws pinched the collar onto the barrel so that the barrel did not slide up the collar when it was being raised with the chain block. The trigger system was also modified by mounting the camera pinger trigger on the core head. A line with a weight on the end was run from the trigger down the length of the corer plus the free-fall height. This line is kept from tangling around the core pipe by an eye at the top of the barrel and a disposable guide at the bottom of the barrel. This system replaces the "Heffler" disposable magnetic switch system, and saves rigging time. A new trigger switch must now be provided for the camera frame.

The major problem remaining in the coring operation is that the piston is either not splitting, or it only splits when it reaches the top of the barrel. Two different split-pistons were used and both failed to split at the proper time. One pin, sawn 3/4 of the way through, was used in the piston and it did not split until the top of the barrel. We tried using aluminum welding rod but it also did not work properly. If the piston does not split when coring stiff glaciomarine sediments, the liner collapses instead of allowing flow-in as would occur in weaker sediments. All of the piston cores had collapsed liners, making it difficult to remove the liner from the barrel. Another effect of the stiff, cohesive sediment is that the fingers of the catcher were sheared off completely at one site, and hence there was no core recovery. After this incident, we placed two catchers at the bottom of all cores.

The short length of the piston cores obtained this year is a function of the nature of the sediment. The sediment at the base of the cores is extremely stiff, and it is unlikely that further penetration will be achieved in similar sediment. The new luggage-size "Jodrey boxes", designed to carry the cores back to BIO as excess baggage, were very useful.

<u>Sediment Physical Properties</u> (D. Mosher)

Hand penetrometer, Torvane measurements, and samples for bulk density/water content were taken from cores at points where the cores were cut, from within the catcher sample, and from Van Veen grab samples. Further measurements were made and samples taken in the lab at BIO (Table 2). These measurements were taken in an attempt to quantify the physical properties of the sediment layer which is extremely stiff and difficult to core into, to produce down-section profiles of the physical properties, and to relate these to the lithostratigraphy and to acoustic properties measured from cores taken in previous years (Mudie et al. 1986; Mudie and Hein, in press).

IOS current meter (D. Mosher, G. Sonnichsen)

The IOS current meter was deployed on the Kevlar cable of the small winch, using 10 ft extension pipes (similar to those used for Livingston corer) attached to the top of the meter to keep the current meter from rotating. The current meter was turned on at 13:30 GMT/186 and was tested by manually triggering it at this time. It reached its deployment depth of 48 m at 16:45 GMT/186. "North" was oriented towards the winch (i.e. roughly west) and with the addition of each extension rod, "North" was marked on the pipe. It is difficult to tell, however, whether North remained in this position during deployment, because slight deviations during the addition of 18 extension rods could add up to a significant change in orientation. Also it was noticed upon recovery that "North" on the cover of the current meter (which was used to align the meter) deviated from "North" on the side of the current meter by one rotation of the screw holes (i.e. about 30 degrees to the east). This means that, if "N" on the cover was still aligned roughly west at recovery, then the "N" of the current meter was directed towards west-southwest during deployment. Orientation of the current meter was maintained by locking two sets of vise-grips on the pipe above the opening of the hydrohole, and tying these off to the gantry.

Recovery of the current meter commenced about 15:00 GMT/187. The current meter was allowed to equilibrate to air temperature before opening the pressure case, and was shut off at about 21:00 GMT/187.

Video documentary (D. Mosher, P. Mudie)

Two hours of Video was taped during this trip to the Ice Island. Shots include good footage of the coring equipment and procedures, summer climate/melt conditions, core hut maintenance chores, and Hargrave's biological sampling program. This tape will be added to the spring tape collection and integrated with the proposed documentary for open file. The 8 mm original tapes have been copied to 3/4" format tape for editing.

SUMMARY OF MAIN RESULTS (P. Mudie)

From June 21 to July 6, the fourth summer season of the Ice Island geological sampling program (I.S.I.S.) was carried out by a team of 6 AGC technicians and marine geologists, and a biological oceanographer from DFO. The Island was located on the Canadian Polar Margin at the north end of Prince Gustaf Adolf Sea, ca. 100 km NW of Isachsen, Ellef Ringnes Island. This year, unusually warm weather (2-3 degrees C higher than normal in July) resulted in early opening of leads in pack ice, rapid melting of annual snow cover, and sluggish atmospheric circulation, with few storms to initiate movement of the pack ice. As a result the Ice Island moved only about 16 km, from July 23 to August 1 (JD 205-214) after its rapid 200 km move across Peary Channel during the spring breakup. These ice conditions may be typical of those expected to accompany rising global temperatures. The melting damaged much equipment in the AGC coring lab and required ca. 50 person-days for repairs to buildings and instruments and for construction of drainage trenches which had to be be maintained by an AGC summer student until freeze-up began in the first week of August.

Scientific studies included seismic profiling with 3.5 kHz and sparker systems (Fig. 2), piston and gravity cores, and grab samples, current meter measurements (Fig. 7), sampling of water, ice and sediments for organochloride pesticides, phytoplankton and benthic productivity (Fig. 8A). A summary of the oceanographic work is given in Appendix 3. Initial geological results show that the seabed at ca. 500 m water depth is underlain by an extremely stiff (impenetrable with coring techniques) layer of apparently overconsolidated mud with gravel. This stiff, cohesive sediment was probably deposited very rapidly during the last glacial stage; it is unlikely to have been deposited by grounded ice. Plankton and benthos samples indicate low productivity in the water column under the Ice Island. Microscope studies of snow and ice samples, however, show that the brown dust covering about 1000 square kilometers of sea ice this summer consists of algae, in contrast to the wind-blown clastic sediments previously described for the Arctic (Pfirman et al., 1988). These brown algae are important for both productivity of the surface water and for their effect on the albedo of the snow: like a clastic dust layer, the brown algae reduce the albedo and increase the rate of melting, but they do not increase radiation backscatter as occurs during Arctic dust storms.

The Arctic current meter study was designed to test a model of surface water ventilation by microcirculation cells generated by melt-thaw cycles or wind stress over open water leads. The results are being analysed in collaboration with R. Perkin at IOS. Initial data (Fig. 7) show periodic currents up to 12 cm/sec which have a much stronger cyclical component than those measured in spring. These cyclical events resemble tidal oscillations, however, rather than convection currents.

Pesticide residues are being analysed by Hargrave at BIO for comparison with concentrations measured at shallower depths and prior to snow melting in previous years. Baited traps (0.4 sq. meters diameter) were set on the sea bed to capture infaunal scavengers. Only amphipods were caught (see Appendix 3), suggesting a sparse benthic fauna in the deep outer shelf of Prince Gustaf Adolf Sea. This observation is consistent with the lack of burrow structures seen in sediment core X-radiographs and the absence of macro- or meiobenthos in the bottom photographs and in sieved Van Veen grab samples.

RECOMMENDATIONS FOR 1989 AND FUTURE

Any work involving getting on the roof of the coring complex (e.g. shovelling) requires caution. The rolled roofing is brittle, especially in the extreme cold. In places it is rolled over ridges, so there are gaps with no support underneath, and these puncture easily. It is this mistreatment that caused the roof to leak previously.

Electronic, or valuable equipment left in the core hut, even for short durations, should be covered. Serious damage could have occurred to the UGR this year as it was covered in ice by drips from the ceiling.

A plastic pump and heater should be used in any further acid treatment of the heat exchanger. Also it should be determined for certain what material the pipes are made of in the heat exchanger (e.g. stainless vs. copper). It is not likely that the exchanger needs to be treated again in the near future.

Meltwater flooding is a serious problem. The buildings are below the ice level now (due to drifting), hence any melting around the building floods into the building. The storage tent is a case example of how severe this flooding can become. There is up to 2 feet of water in it. Future buildings must be built on stilts to keep it off the ice surface by 1 - 2 feet. This was recommended in 1985. Even with a crew of 4, it was hard to keep a scientific program going and maintain the melt water problem. There has to be someone manning the facilities during this time of year. Trenching will probably occur around the buildings as the melt season progresses and hence skirting around the buildings is a necessity to prevent undercutting of the building. The wider the skirting the better. Provided the melting removes the drifts around the buildings this year, then in future years these drifts should be removed before melting commences. The drifts removed in April of this year had reformed by the time we arrived at the end of June, so sometime in May or early June may be the best time to remove the drifts.

The oil which has spilled around the coring facility over the years has not decomposed or drained off. It poses a serious problem and a hazard during the melt season. It enhances melting, and is tracked into the buildings, causing very slippery decks. Repeated removal of oily water in July was not enough to stop the apparently continuous oil seepage. The melt season is the only time the oil can be seen, however, so it has to be removed from the summer meltwater. Something is needed to soak up the oil or to degrade it to a harmless solution that can be drained off the island. Bailing and shovelling are not effective because large quantities of water or snow must be removed and disposed of in drums. The decks of the coring facility should also be painted with "no-slip" paint (i.e. send up a bag of sand to add to the paint).

In addition to the above, it seems advisable to change boots in the porch before the core hut is entered, especially in the summer when oil is easily tracked. Also it is highly recommended, now that coring is a regular process, that steel-toed boots be worn around the core hut. In fact if a make of Mukluk with hardened plastic toes (to prevent conduction of the cold) were to be found, then these should be worn all the time, even on the helicopter sampling program.

We are still unable to eliminate the knocking noise during pay out of the Hawbolt winch. Perhaps a hydraulics technician should be sent up to tune it. The leaks in the hydraulic system mentioned earlier should be repaired. For the small winch a new return hose is required to run from the motor to the winch. It is probably not possible to melt out the present hose without seriously undercutting the ice foundation under the porch, or damaging the hose.

Suggest a separate hydrohole (perhaps behind the melter hut) is needed to put the sparker sled and hydrophone below the ice. No machinery is needed to lower this gear and it could then be left down while other operations such as coring and heatflow took place down the main hole. A small tent covering the hole would provide comfort and protect the hole from drifting snow.

Allan Law suggested an LSR would make for a superior recorder in stop-start mode over the EPC presently used to record sparker data. Single string hydrophone array, with pre-amp may make for better sparker return signal. Perhaps geophysicist should look at the sparker system and how its installed in order to minimize signal to noise ratio, etc, and recommend how to process data.

Thought should be given to, and problem solved, as to why piston is not splitting in coring. Other aspects of coring working well.

Geotechnical measurements should be taken as soon as possible after coring (before transportation down south). Equipment such as the miniature shear vane could be easily set up in the core lab. This analysis would require core splitting. Subsamples for physical property measurements could be taken at this time (i.e. bulk density and water content).

Deployment of the IOS Arctic current meter worked well, but if its periodic use in the hydrohole is to be frequent, then the pipes should clip together, not thread into couplings which is time consuming. The aluminum pipes are on temporary loan from D.Scott, Dalhousie U., and they should be replaced with AGC/IOS fittings. Also, it is not practical to deploy a current meter suspended on pipes to depths much greater than achieved this summer (ca.50m). Thought should be given as to how best to measure currents to ocean depths beneath the ice (discuss with experts at BIO , e.g. Paul d'Entremont).

Repair and modifications are required to be made to the portable winch used in the MOBS programme (e.g. alignment of the sprockets, fixing drum to the axle, modification to clutch).

REFERENCES

Barker, P.F., Pudsey, C.J., Larter, R.D., Hamilton, I.W. and Anderson, J.B. 1988. Plio-Pleistocene glacial sedimentary processes on the Antarctic Peninsula continental shelf. Program and Abstracts of the Alfred Wegener Conference on Geologic History of the Polar Oceans, Bremen, FRG, p.31.

Gorveatt, M. and Chin Yee, M.C. 1988. Arctic Ice Island coring facility. Proceedings Oceans 88: 555 - 560.

Jackson, L. 1989. Ice island: ideal platform for studying Arctic Ocean and what lies beneath it. Canadian Geographic v. 108, no. 6: 38 - 49.

Hargrave, B.T., von Bodung, B., Conover, R.J., Fraser, A.J., Phillips, G. and Vass W.P. 1988. Seasonal changes in sedimentation of particulate matter and lipid content of zooplankton collected by sediment trap in the Arctic Ocean off Axel Heiberg Island. Polar Biology, in press.

Hein, F.J. and Mudie, P.J. In press. Glacial-marine sedimentation, Canadian Polar Margin north of Axel Heiberg Island. Marine Geology, submitted Nov. 1987.

Hein, F.J., Van Wagoner, N.A. and Mudie, P.J. 1989. Sedimentary facies and processes of deposition: Ice Island cores, Axel Heiberg Shelf, Canadian polar continental margin. Tectonophysics, in press.

Mayer, L.A. and Marsters, J. 1989. Measurement of geophysical properties of Arctic sediment cores. Unpublished report DSS Contract No. W77708-7-9408/01-SB, 50 pp.

Moore, R.M. and Wallace, D.W.R. 1988. A relationship between heat transfer to sea ice and temperature-salinity properties of Arctic Ocean waters. Journ. Geophys. Res. 93, no.C1, 565-571.

Mudie, P.J., Mosher, D.C., Van Wagoner, N.A., Aksu, A.E. and Macko, S.A. 1985. I.S.I.S Field Report 1985. GSC Open File No. 1333, 46 pp.

Mudie, P.J. and Mosher, D.C. 1987. I.S.I.S. Field Report 1987. AGC Open File, 14 pp.

Pfirman, S., Gascard, J.-C., Wollenburg, I., Mudie, P.J. and Abelman, A. 1988. High particulate content in Arctic Basin sea ice: observations from RV POLARSTERN, July and August 1987. Polar Research, in press.

Praeg, D.B.,1988. Geomorphology and bedrock geology of southern Norwegian Bay, Queen Elizabeth Islands, Northwest Territories. Geological Survey Canada Open File No. 1925, 18 pp.

Pudsey, C.J., Barker, P.F. and Hamilton, N. 1988. Weddell Sea abyssal sediments: a record of Antarctic bottom water flow. Marine Geology 81: 289-314.

Schroeder-Adams, C.J., Cole, F.E., Medioli, F.S., Mudie, P.J., Scott, D.B. and Dobbin, L. In press, a. Recent foraminifera seasonally ice-covered vs. perennially ice covered areas. Journ. Foram. Res., submitted July 1988.

Schroeder-Adams, C.J., Mudie, P.J., Cole, F.E. and Medioli, F.S. 1989. Late Holocene benthic shelf foraminifera beneath perennial sea ice on a High Arctic continental shelf (Canadian Ice Island Project). Tectonophysics, in press.

Sonnichsen, G.V., Praeg, D.B. and MacLean, B. 1989. Quaternary geology of southern Norwegian Bay. Geological Survey of Canada Open File, in press.

Vilks, G. 1969. Recent foraminifera in the Canadian Arctic. Micropaleontology 15, 35 - 60.

FIGURE CAPTIONS

Figure 1. Location map showing bathymetry of Canadian Polar Margin from Nansen Sound to the Parry Islands (Borden, Ellef and Amund Ringnes) and positions of the Ice Island sample sites in 1988 (solid squares) and in August 1987 (open squares). Lines A and B are the 1988 MOBS transects, with their sample sites (solid circles). Large circle delimits area sampled from the Ice Island in spring (samples 88200-01 to -08, -18,-19, -36, -37).

Figure 2. Examples of surficial sediment profiles obtained in Peary Channel using different sounder systems towed under the Ice Island at speeds of ca. 0.5 to 1 km/hr. A) 12 kHz sounder; B) 3.5 kHz echosounder; C) 8.5 kJ sparker.

Figure3. Photograph of the acoustic release being attached to the winch cable above the piston corer, replacing the trip arm-trigger weight system used in previous years.

Figure 4. Collar-type connector (co) used to join two Benthos piston corer barrels (1, 2) alongside the corer head (H). The lower barrel is place over the hydrohole by a clamp (cl). Plastic core liner (L) is empty because the corer did not penetrate to the second barrel.

Figure 5. Vertical photograph of the seabed at Site 88200-05 in Peary Channel, ca. 425 m, showing the soft muddy bottom with scattered ice rafted gravel (lower right) and featherstar or worm trails (upper left).

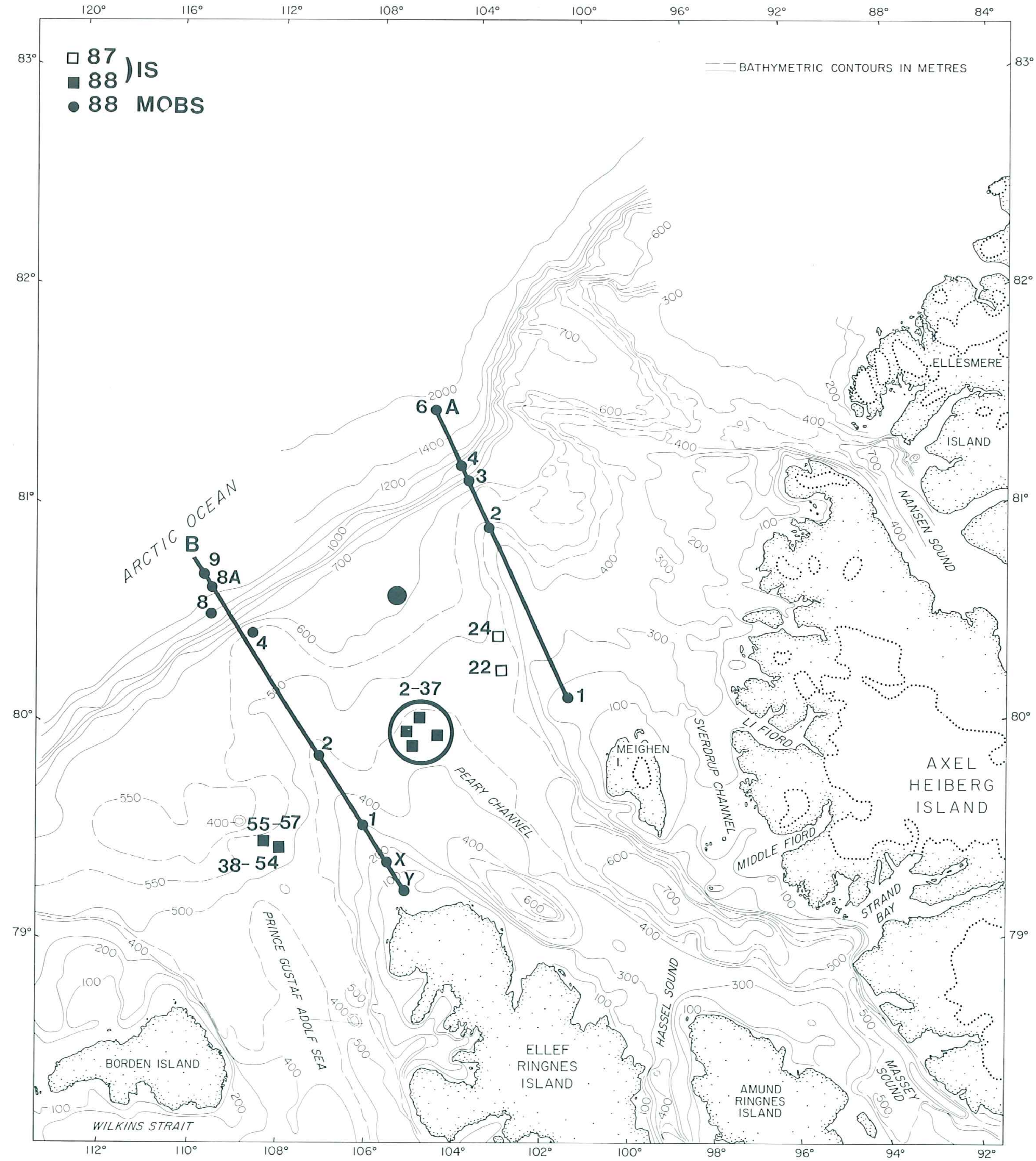
Figure 6A. Aerial view of the sea ice cover over the bank north of Ellef Ringnes Island on April 16, showing fields of snow-covered multiyear ice surrounded by pressure ridges, and a few narrow leads (bright spots, centre right).

6B. A-frame and winch set up for coring through thin ice over a newly frozen lead.

6C. A-frame set up and coring in a lead covered by only a few cm of refrozen water.

Figure 7. Current meter records for April 18, 19:20z to April 20, 19:00 (top) and for July 4, 16:50 to July 5, 15:30 (middle and bottom).

Figure 8. Main summer field activities. A) A-frame and winch block over the new oceanographic hydrohole , being used to lower a benthos sampler (BS) containing a baited amphipod trap (T). B) Meltwater collector pit being dug at the end of the drainage trench cut through the ice around the core hut; a small Wajax diesel pump (upper left) was used to empty the pit.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PEARY CHANNEL
PRINCE GUSTAF ADOLF SEA
BORDEN ISLAND
WILKINS STRAIT
ELLEF RINGNES ISLAND
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FIGURE 1

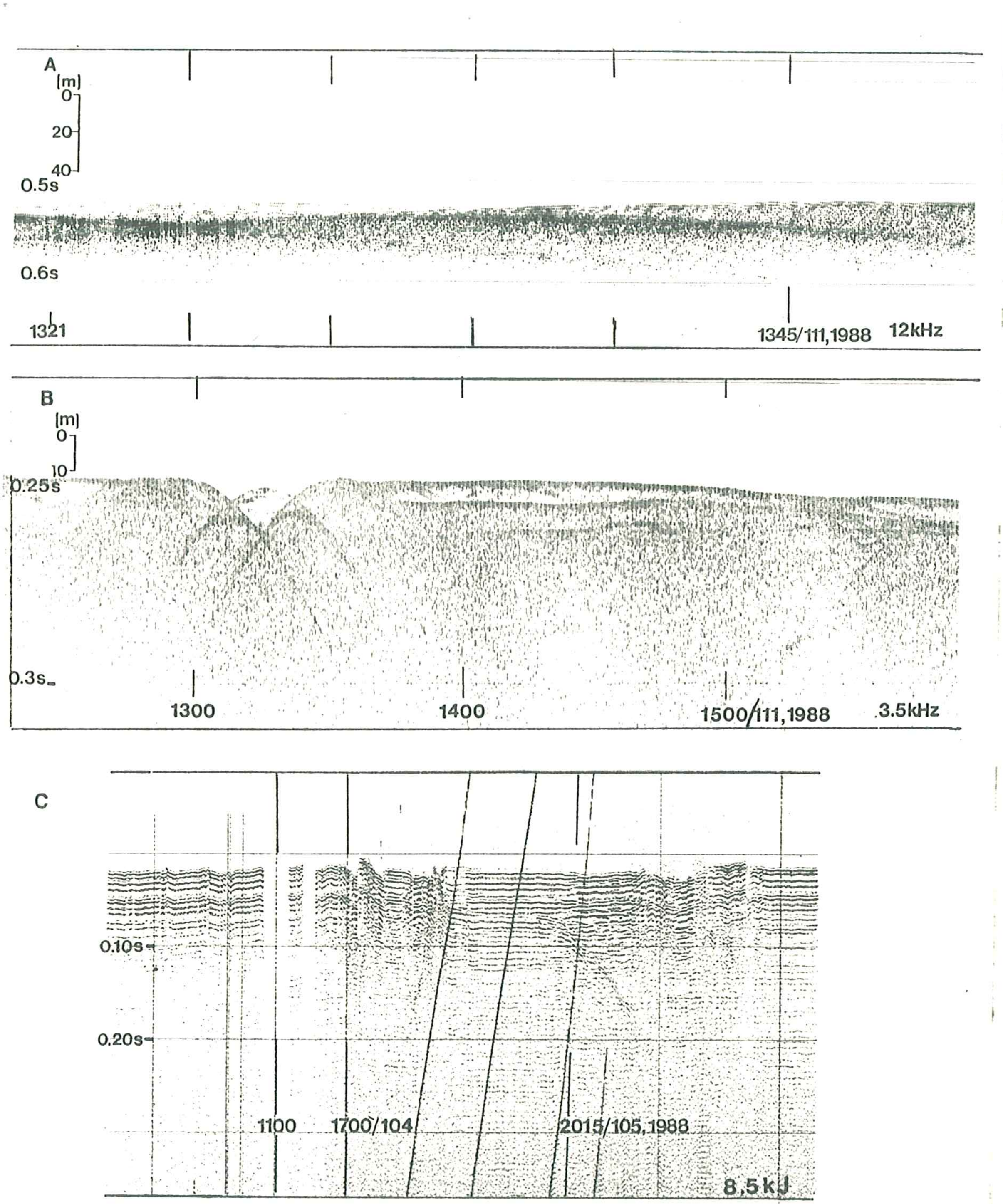
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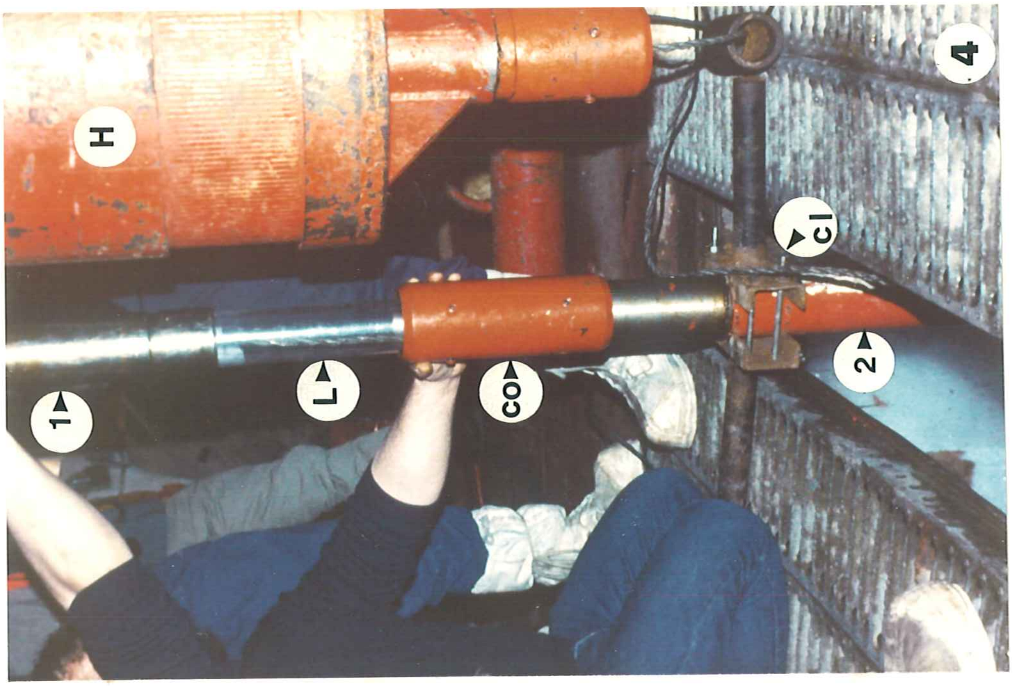
FIGURE 2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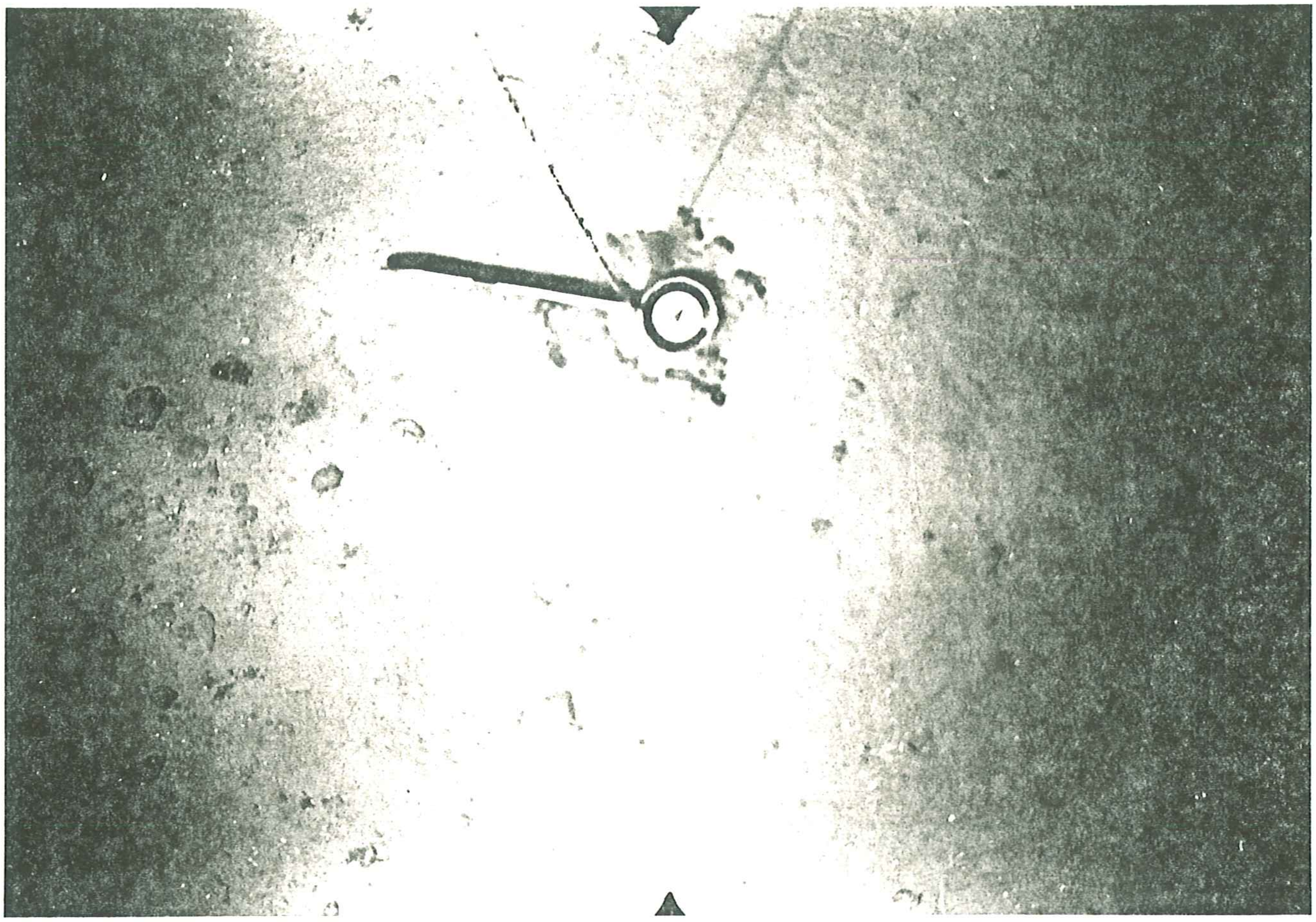

FIGURE 5

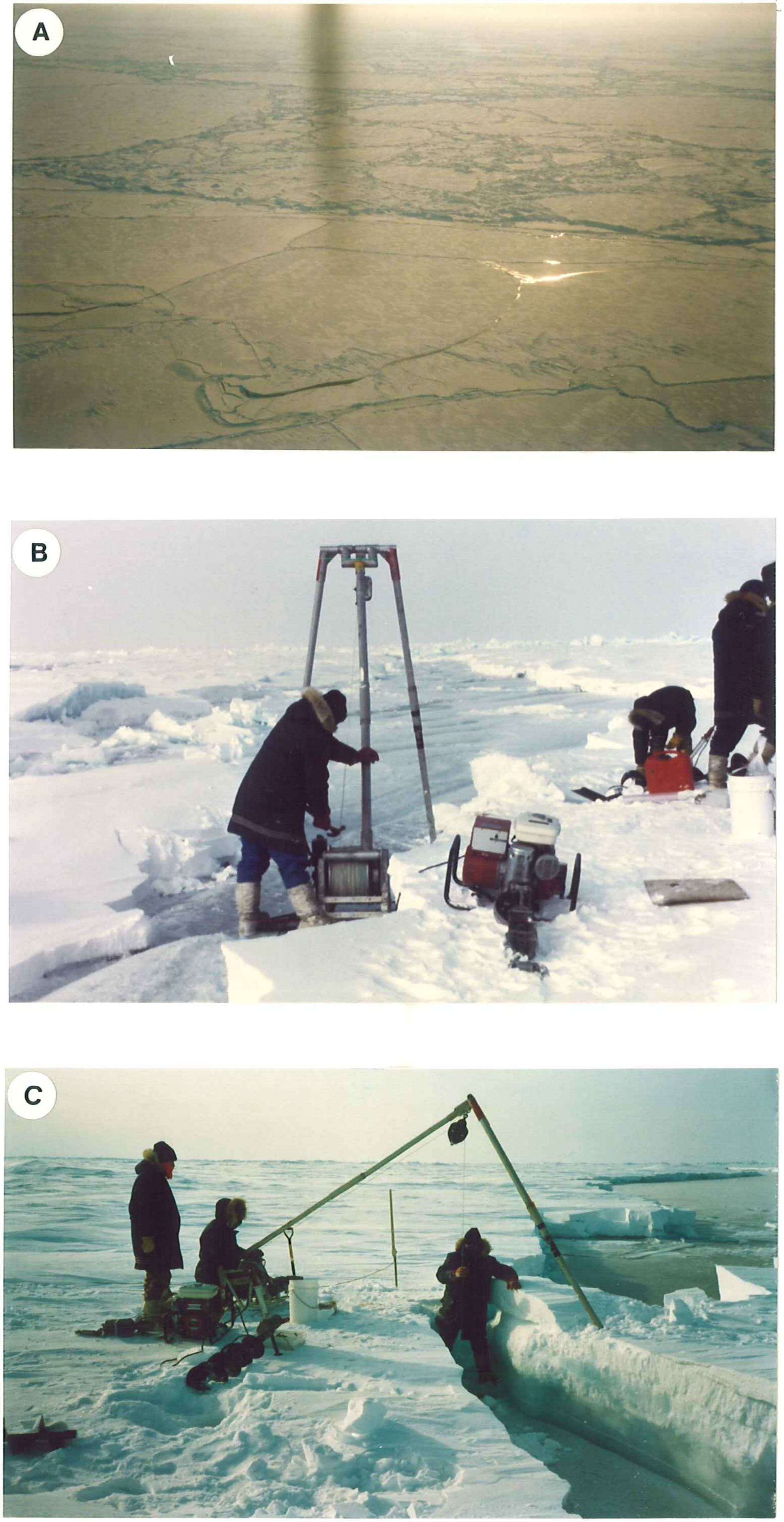

FIGURE 6

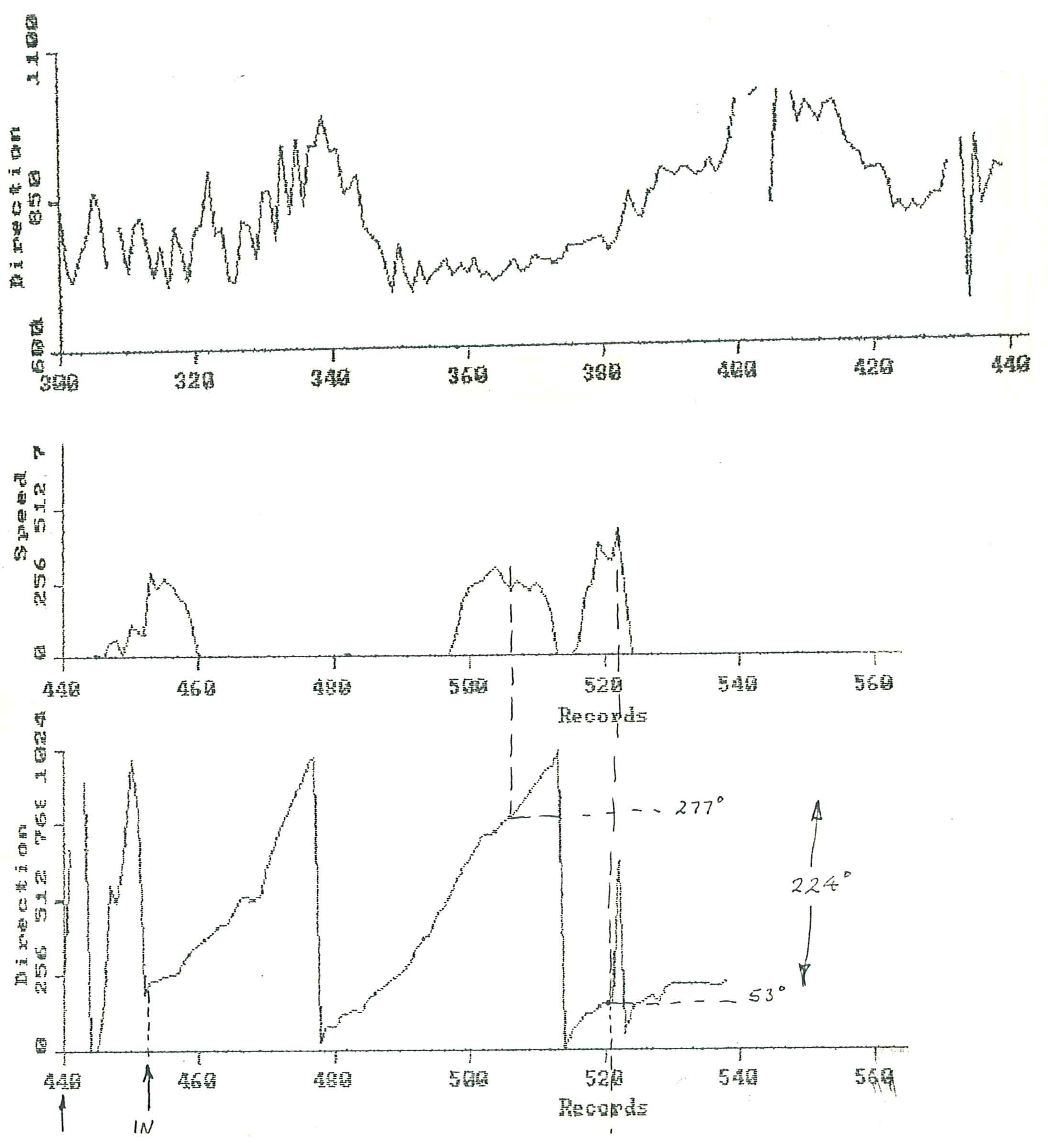
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FIGURE 7

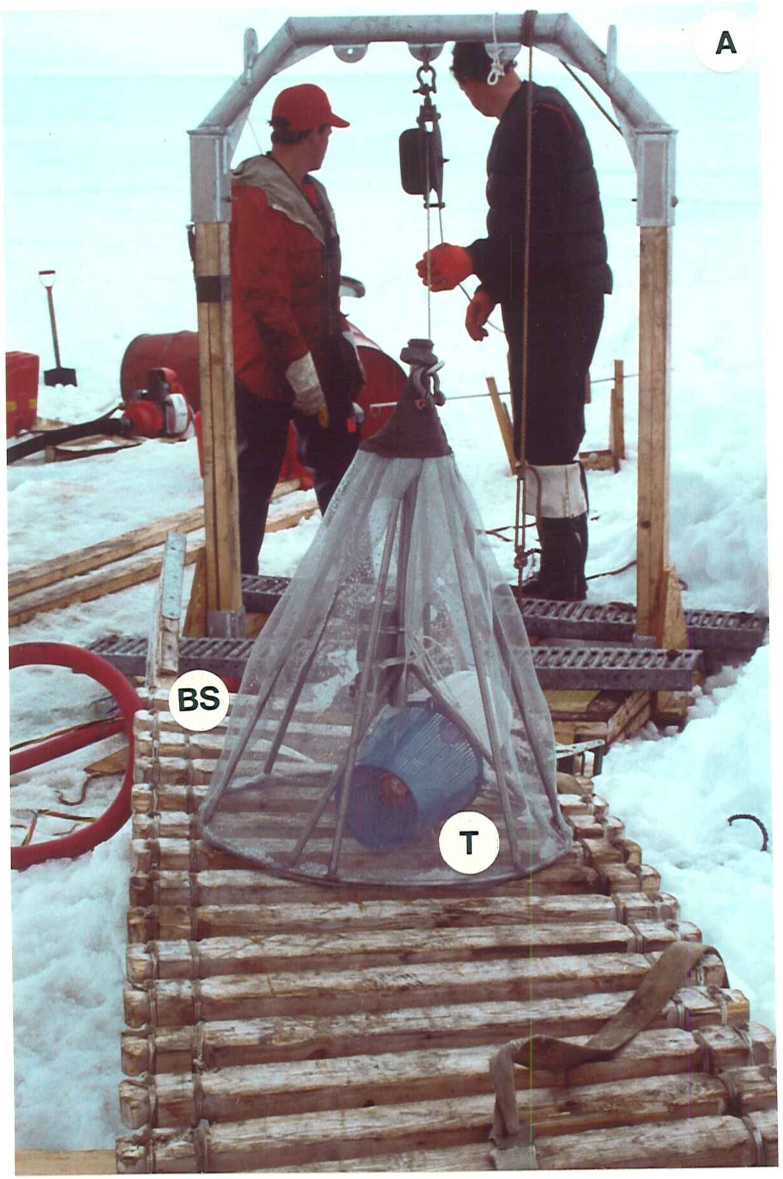

FIGURE 8

Table 1: ISIS 88200 Sample Records

Sample No.	Sample Type	Position Lat./Long.	Time (JD/GMT)	Water Depth (m)	Samples/Comments
88200-01	VV grab	80o07.88' 105o40.28'	095/19:54	427	2 bags bulk 1 bag surface 1 vial surface
88200-02	PC	80o07.85' 105o39.95'	096/1505	425	30 cm, hit bottom; no recovery
88200-03	Shipek	80o09.85' 105o51.72'	098/21:20	432	1 bag; 1 surface vial
88200-04	PC	80o10.00' 105o52.01'	099/00:16	424	Full penetration 242cm recovery liner collapsed
88200-05	Camera	80o10.37' 105o51.14'	099/16:15 -16:47	422 -429.5	Film developed
88200-06	Shipek	80o10.45' 105o45.20'	101/16:42	424	1 bag, surface
88200-07	GC	80o10.52' 105o45.17'	101/17:55	424	10 cm recovery
88200-08	PC	80o10.92' 105o44.25'	101/22:21	418	38 cm recovery; 6700 lb/2600 psi pull-out, liner collapsed
88200-09 (B2)	Dietz-LaFonde	80o00.37' 107o50.13'	103/17:00	441	1 bag; surface vial
88200-10	portable GC	80o00.37' 107o50.13'	103/17:47	441	23 cm recovery
88200-11 (A2)	Dietz-LaFonde	80o08.20' 103o34.30'	104/15:00	458	1bag; surface vial
88200-11G (A2)	portable GC	80o08.20' 103o34.30'	104/15:47	458	30 cm recovery
88200-12 (A3)	Dietz-LaFonde	81o18.50' 104o25.80'	104/16.30	597	1 bag
88200-12G (A3)	portable GC	81o18.50' 104o25.80'	104/17:00	597	73 cm recovery
88200-13	No Sample				
88200-14	Dietz-	81o20.90'	104/19:00	874	1bag

(A4)	grab	104o48.30'			
88200-14	portable	81o20.90'	104/19:47	874	55 cm recovery
(A4)	GC	104o48.30'			
88200-15	Dietz-	81o37.20'	104/22:00	1818	1 bag
(A6)	grab	105o58.30'			
88200-16G	portable	81o37.20'	104/23:00	1818	27 cm recovery
(A6)	GC	105o58.30'			
88200-17	Dietz-	80o22.70'	105/01:00	102	1 bag
(A1)	grab	?104o22.00'			
882000-18	Shipek	80o08.20'	104/15:47	458	1 bag
		103o34.30'			1 surface vial
88200-19	VV grab	80o08.48'	105/02:05	420	2 bags bulk; 1
		103o35.50'			bag surface;
					1 vial surface
88200-20	Dietz	80o54.12'	106/15:50	1820	1 bag; surface
(B9)	grab	112o41.49'			in vial
88200-21	portable	80o54.12'	106/16:58	1820	21 cm recovery,
(B9)	GC	112o41.49'			fell over?
88200-22	portable	80o54.17'	106/18:08	1831	80 cm recovery
(B9)	G.core	112o40.93'			
88200-23	Dietz	80o34.26'	106/20:30	1058	1bag; surface
(B8)	grab	111o44.07'			in vial
88200-24	portable	80o34.26'	106/16:58	1058	9 cm
(B8)	GC	111o44.07'			
88200-25	Dietz	80o32.21'	106/22:48	501	1 bag, surface
(B4)	grab	110o08.76'			in vial
88200-26	portable	80o32.08'	106/23:17	501	51 cm recovery
(B4)	GC	110o08.89'			
88200-27	Dietz	79o39.00'	107/17:00	221	1 bag, surface
(B1)	grab	106o27.10'			in vial
88200-28	portable	79o39.00'	107/17:30	221	22 cm
(B1)	GC	106o27.10'			
88200-29	Dietz	79o34.73'	107/18:15	155	1 bag; surface
(BX)		106o01.42'			in vial
88200-30	portable	79o34.73'	107/18:30	155	37 cm recovery
(BX)	GC	106o01.42'			
88200-30I	Ice	79o34.73'			
	sample	106o01.42'			
88200-31	Dietz	79o27.71'	107/19:15	79	1 bag; surface

(BY)	grab	105o32.39'			in vial
88200-32 (BY)	portable GC	79o27.30' 105o32.70'	107/19:30	77	No recovery
88200-33 (B8A)	Dietz grab	80o47.58' 111o50.46'	107/?22:00	1505	1 bag; 0-1 cm surface in vial
88200-34 (B8A)	portable GC	80o47.53' 111o50.55'	107/?23:30	1505	catcher only
88200-35 (B8A)	portable GC	80o47.53' 111o50.55'	108/?01:00	1505	12 cm recovery
88200-36	PC	80o08.43' 105o34.20'	108/18:35	429	149 cm recovery of 10ft AP; 2200psi pullout
88200-37	VV grab	80o08.43' 105o34.20'	108/21:45	424	2 bags bulk 1 bag surface 1 vial surface
88200-37C	Current meter	80o11.3' 105o26.4' to 80o13.10' 105o17.00'	109/1920 -110/1900	404 -424	Moving N at 400m/hr
88200-38	VV grab	79o37.30' 108o51.10'	178/20:45	513	2 bags bulk sample 1 bag surface sample 1 vial surface scraping
88200-39	GC	79o37.72' 108o49.10'	179/00:39	509	56 cm recovery, 1 catcher sample in vial
88200-40	PC	79o37.92' 108o47.30'	179/20:20	512	1800 psi pullout 68 cm core + 10 cm CC
88200-41	VV grab	79o37.92'	180/13:57 108o47.30'	512	2 bags bulk sample bag surface 1 vial surface
88200-42	PC	79o37.83' 108o46.95	181/22:00	512	2200 psi (7000 lb) pullout, 2 m apparent penetration; no recovery; CC destroyed on pullout,liner imploded
88200-43	PC	79o37.80' 108o46.78	182/14:02	513	2400 psi(7400 lb) pullout, 2m apparent penetration, 137 cm recovery, 13 cm CC Piston did not split; liner collapsed; (A-B = 137-61cm; C-D = 61-0cm)
88200-44	GC	79o37.80' 108o46.78'	182/18:39	513	22 cm recovery;corer fell over

88200-45	Plankton Tow (63 u)	79o37.78' 108o46.80'	183/21:00 -22:00	519	A) 43 - 75 m B) 450 - 43 m
88200-46	Sea Ice	79o37.80' 108o46.80'	184/01:30	519	Edge of lead
88200-47	Ridge Ice	79o37.80' 108o46.80'	184/20:00	519	100 m W of core hut
88200-48	Sea Ice algae	79o37.80' 108o46.80'	185/01:00	519	Macko hole in refrozen lead
88200-49	PC	79o37.80' 108o46.80'	185/16:16	517	2500 psi(7800 lb) pullout, 2m apparent penetration, 89 cm + 5 cm CC; piston did not split,liner imploded.
88200-50	GC	79o37.80' 108o46.80'	185/18:55	517	32 cm recovery
88200-51	VV grab	79o37.80' 108o46.80'	185/21:00	517	2 bags bulk 1 bag surface 1 surface vial 1 vertical slab
88200-52	Current meter	79o37.80' 108o46.80'	186/16:45 - 15:00	48	deployed with N to winch meter (roughly W);+/- no island drift
88200-53	VV grab	79o37.93' 108o46.80	198/18:39	517	1 surface vial, 1 bag surface , 1 bag bulk
88200-54	VV grab	79o38.95' 108o46.80	205/18:33	519	1 surface vial, 1 bag surface, 1 bag bulk
88200-55	VV grab	79o38.95' 109o14.93	205/18:44	549	1 surface vial, 1 bag surface, 1 bag bulk
88200-56	VV grab	79o41.64' 109o34.72	207:1346	546	1 surface vial, 1 bag surface, 1 bag bulk
88200-57	VV grab	79o41.64' 109o36.55	207/1800	544	1 surface vial, 1 bag surface, 1 bag bulk

Table 2: Physical Property Measurements

Penetr. = penetrometer; X indicates sample taken

Sample type	Sample no.	Depth (m)	Hand Penetr.	Torvane	Water content	Bulk density
grab	038	0.01	160 kPa			X
		0.05		0.5 kg/cm2	X	
		0.10				X
gravity	039	0.10			X	(compacted)
core		0.33				X
		0.40		1.06 kg/cm2		
		0.48		1.20 kg/cm2	X	
		0.56				X
piston core	040	0.69	828 kPa	8.00 kg/cm2		
piston	043	0.03				X
core		0.17		0.30 kg/cm2		X
		0.32		1.25 kg/cm2		X
		0.47		1.50 kg/cm2		X
		0.60				X
		0.61	148 kPa	1.8 kg/cm2		
		0.63		1.8 kg/cm2	X	
		0.80		5.0 kg/cm2	X	
		0.95		7.5 kg/cm2	X	
		1.18		5.0 kg/cm2		
		1.20-1.32	consolidation sample			
		1.49	823 kPa	6.5 kg/cm2		
		1.50			X	
piston	049	0.87	797 kPa	7.0 kg/cm2		
		0.90				X
grab	051	0.06	29 kPa		X	
		0.14	28 kPa	0.50 kg/cm2		

I.O.S, Pat Bay
Box 6000
Sidney, B.C. V8L 4B2
Nov. 3, 1987

Dr. Peta Mudie
A.G.C.
Dartmouth, Nova Scotia

Dear Peta,
I am sending you some diagrams of the way Denny and I thought to arrange for taking current measurements relative to the ice island. As I tried to explain to you on the phone, the determination of direction without a reliable magnetic compass is a recurring problem in the Arctic. In this instance, the current meter can be mounted on an aluminum pole which is oriented with a two line suspension. The two line suspension has a fixed orientation relative to the ice so that direction can be deduced from the oreintation of the ice island. The motion of the ice island must then be subtracted from the measured currents to get the true water current. Fig. 1 shows how we think that the current meter will be used. The crossbar holding the instrument can be canted over to facilitate raising and lowering through the ice hole. When fully deployed it gives a direction reference. The current meter will be set to log speed, direction, temp., salinity and pressure continuously every 15 min. without user intervention.

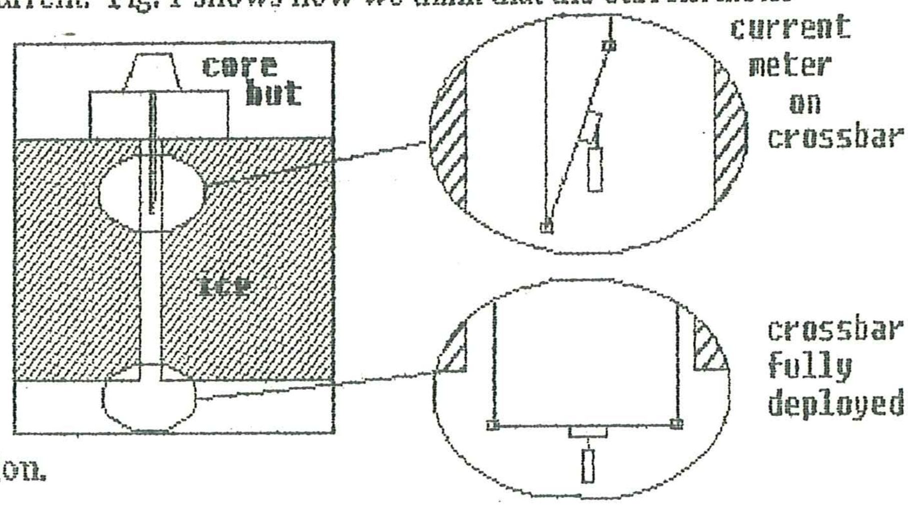

Fig. 1. Ice Island current meter.

These measurements will require considerable help from the navigation people in the way of a continuous log of ice island speed and course as well as orientation. Also the short record we will obtain from our brief stay will give us no more than a rough indication of the mean currents. For these reasons we should consider this a trial run for future reference. This type of measurement will be done more rigorously when a full fledged oceanography program can be mounted.

Another possibility is to freeze in some sensors and interrogate them from the surface. Direction reference is maintained with hydraulic hose. The sensors could be considered expendable. Perhaps a series of sensors like this may be some day used as a fixed installation for general use. (see Fig. 2)

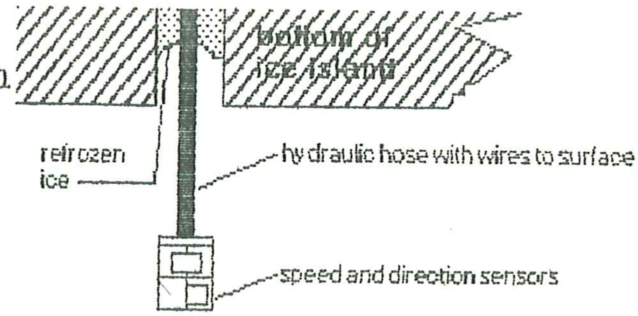

Fig. 2. Expendible sensors

In view of the problems, do you still feel that current measurements are worthwhile? As long as we were there to take care of the instrument, of course you would not have to assume any liability.

Sincerely,

Ron Perkin

Ron Perkin

APPENDIX 2. HEAT TRANSFER INVESTIGATION BY MEASUREMENT OF SATURATION LEVELS IN NON-REACTIVE RARE GASES (R.M. Moore)

Summary of progress in pertinent research

Using data that were collected at the LOREX and CESAR ice-camps as well as data from other Arctic Ocean locations, we have looked at the influence of direct heat transfer from Arctic Ocean waters to sea-ice on typical temperature-salinity relationships for this ocean.

The result (Moore and Wallace, 1987) was a very simple model that could account for major features of the temperature and salinity properties of Arctic waters in the upper 500m of the water column. This model, if it can be verified, would have important implications to studies of heat transfer from ocean to atmosphere in the Arctic Ocean. At present it is only possible to demonstrate that our model is consistent with the observed range of ice-melting rates, as well as with T-S relations at a number of Arctic sites. The proposed work is designed to test our hypothesis by using the influence which cooling seawater has on inert gas concentration anomalies. More details on the proposed experiment are given in the body of this proposal.

Other work on the Arctic Ocean that is in progress includes a study of the chemistry of the waters of the Beaufort Sea. The purpose of this work is determine the chemical processes that are occurring in this shallow, shelf sea, and to use them in conjunction with physical data to help describe the circulation in this area. Specifically we hope to determine to what extent the Beaufort Sea is a source of subsurface waters, or even deep waters, formed by salinization during ice formation, for the ocean as a whole. Amongst the chemical processes that are being looked at are the introduction of nutrient components to the waters during their residence over the continental shelf, and the ventilation of the waters (addition of oxygen, and release of carbon dioxide to the atmosphere). This work is being done in cooperation with the Ocean Physics Group at the Institute of Ocean Sciences, Sidney, B.C.; the experiment described below would also be done in cooperation with the same group.

Description of experiment

The aim of this experiment is to determine whether the upper water column in the Arctic Ocean has been cooled by the transfer of heat directly to sea-ice. Such a transfer would give the T-S properties that we have observed (Moore and Wallace, 1987) but it would also produce a change in the degree of saturation of all dissolved gases in the waters so cooled. The gases to be studied are those which are not involved in any chemical or biological processes in the water column, so that the degree of saturation is determined only by the initial equilibration of the water sample with the atmosphere followed by subsequent modification through such physical processes as cooling or salinity change. The concentration of the gas remains constant through these processes, but the solubility changes, and hence the saturation anomaly changes:

$$\text{Saturation anomaly} = \frac{\text{Concentration} - \text{Solubility}}{\text{Concentration}} \times 100\%$$

Thus a cooling of seawater which occurs through the transfer of sensible heat from the water to latent heat of fusion of sea-ice should result in an increased gas solubility but only a small, calculable change in the gas concentration; the net result is a decrease in the saturation anomaly for any gas. Identification of undersaturations of non-reactive gases in the depth range of interest would support our model of heat loss from the water column through ice-melting, and the magnitude of the saturation anomaly should permit an estimate to be made of the amount of cooling that has occurred through this process.

We propose to determine the degree of saturation of the rare gases, argon, krypton and xenon. For this purpose, water samples are to be collected from depths down to the Atlantic temperature maximum (ca. 450m) using Niskin sampling bottles on a hydro-wire. Samples of water will be returned to the laboratory in sealed vessels for measurement of the rare gases by isotope dilution mass spectrometry. We also propose to simultaneously collect water samples for measurement of dissolved nitrogen gas which can potentially give us the same information as the rare gases, but with the advantage that the nitrogen measurement should be possible using less sophisticated equipment.

APPENDIX 3:

BIOLOGICAL SAMPLING, ICE ISLAND JUNE 26- JULY 4, 1988 (B.T. Hargrave)

Organochlorine Pesticide Residues Measurements[1]

Samples of surface melt water (3), seawater dissolved and particulate phases at 10, 30, 300 and 450 m depth (5) and lysianassid amphipods attracted to bait in traps placed on the seabed at 515 m (8) were collected from the Ice Island. All water samples were taken from a hydrohole or at a remote site from the base camp to avoid contamination. Amphipods were collected from the seabed using a hole melted through the ice island at the main camp. Pesticide residues in samples will be analyzed for comparison with concentrations measured at shallower depths and prior to snow melting in previous years.

Population Estimates and Physiology of Scavenging Amphipods

Baited traps were exposed on the seabed under the Ice Island at 515-519 m over variable time periods (2 to 24 hrs). Movement of the island was negligible during most deployments. This allowed amphipods to detect odour trails arising from bait and to swim up-current to the trap. Major species collected were Anonyx sarsi, (200 individuals), Tmetonyx cicada (120 individuals) and Andaniexis sp. (80 individuals).

A stainless steel frame (0.4 sq. meters dia) was enclosed with 1 mm mesh screen and weighted to form a conical trap. Bait was placed in a trap within the funnel to attract amphipods from a known bottom area. Four deployments (2 to 16 hours each) yielded variable numbers of amphipods (0 to 325 individuals) with the highest number occurring when a hole in the mesh allowed amphipods external to the enclosed area acess to the bait. The other three collections yielded 0 to 33 individuals to provided a minimal estimate of population. It is assumed that only starved animals were attracted to the bait and that no individuals entered the trap from outside of the enclosed area. A sinlge Van Veen (0.1 sq. meter) grab was taken at 516 m and sieved through a 1 mm mesh. No lysianassid amphipods were observed.

Bait was protected in traps exposed on the seabed by enclosing it in Nitex mesh holders in some collections. Amphipods collected without food in their guts were incubated at 2-3 C in filtered seawater for comparison with animals that had been allowed to feed. Samples of seawater from experimental and control (seawater only) vials were taken at daily intervals over five days for measures of dissolved carbon dioxide and dissolved nutrients. Amphipods were not pressurized but they remained alive during incubation. Analyses will provide measures of respiration and nutrient excretion to allow calculations of energy requirements for these benthic species. Rates will be compared with estimates of pesticides residue accumulation in stored body lipids to calculate the turnover rates of organochlorine contaminants.

B. Hargrave

[1]For details, see attached report on Project 208 (p31)

PROJECT 208- A STUDY OF THE DISTRIBUTION OF CHLORINATED HYDROCARBON PESTICIDES AND PCB'S IN THE ARCTIC OCEAN USING A CANADIAN ICE ISLAND STATION

by

B.T. Hargrave

This brief report summarizes results from a sampling study for organochlorine containing compounds in various environmental compartments of the coastal Arctic Ocean, from May 19 to May 31, 1986. The 7 x 4 km ice island which is the site of the Canadian Polar Continental Shelf Project (PCSP) base camp was located about 50 km off the northern coast of Ellesmere Island (80 57.47 N and 97 36.29 W on May 28, 1986) off Cape Stallworthy. The island (45 m thick) was surrounded by fast one year ice (1.5 m thick) during our stay. There was little drift (maximum 400 m in 6 hr) but slow movement was occurring with a heading of 305 . Water depth under the island varied from 292 to 314 m.

Paul Erickson, Brain Fowler (Seakem Ltd.) and Peter Vass and Barry Hargrave (MEL) participated in the first of three sampling trips. All of our sampling efforts were successful with the exception of collection of fish. I placed baited hooks and traps under ice, mid-water (150 m) and above bottom (310 m) in six deployments without catching anything. All other samples were collected successfully. The in situ pumps were deployed fifteen times over the full water column (to 280 m) with volumes pumped between 200 and 360 liters. The atmospheric particulate and aerosol sampling (n=5 sampling periods over 12 days) was carried out as planned (up to 900 cubic meters of air per sample with the high volume pump, an order of magnitude less for aerosols). Ice and snow melt samples (approximately 70 liters) (n=3) were prefiltered and passed through XAD-2 resin columns. The GFC filters from air particulate and snow melt were grey-black in colour, but the ice left no visible particulates after melting and filtration.

The plankton tows went very well (n=65). These were vertical hauls over approximately 300 m using a variety of four mesh sized nets. The smallest mesh (20 microns) caught very little as most of the plankton was larger than 500 microns- mostly Calanus hyperboreus. The baited traps worked to catch scavenging amphipods (Anonyx nugax and Anonyx sarsi - I think) but only on bottom. The island did not move appreciably during our time there (up to 50 m a day maximum). Vertical arrays of traps even a few meters above bottom failed to capture amphipods with deployments of up to eight hours. No ice algae (or eponitic community) was present when we opened the hydroholes with the ice melter. The underside of the ice plugs which we removed to be cut for melting was white with no visible algal layer. However, the edge of the ice around the bottom of the hydrohole developed a 'halo' of brown colour during our work. The light reaching the underside of the ice came from within the red Weatherport tent since the surrounding ice was snow covered and no lateral light entered the hole.

Ponar sediment grabs were sieved through 0.8 mm mesh. No macrofauna were obtained, but the residue was preserved for visual examination. The surfical silt-clay sediment was relatively undisturbed in the grab and polychaete tubes and tracks on the surface showed that fauna was, or had been, present. Large foraminifera were very numerous on the surface but the numbers that could be collected from the few grabs taken would be insufficient for chemical analyses. The upper 1-cm layer was taken for organochlorine determinations.

Our preparations for the work, although rushed, appeared to have considered most necessities. We were self-sufficient for all of our sampling. The winch worked without problems. We had rented a skidoo and kometeck (spp.?) in Resolute which was an absolute necessity for hauling our gear (6500 lbs) from the runway 4 km across the island to our remote site on the seasonal ice. After completion of sampling we moved the tent off the ice and reassembled it on a plywood base on empty oil drums in the Ice Island base camp for the summer. Most of our field gear is stored there except for the pump samplers, plankton nets and a few other items which we brought back with us. All frozen samples were shipped as baggage back to B.C. We will subdivde them later, after some preliminary analyses are carried out to confirm the sample size of various samples was sufficient.

We are now deciding on who will participate in the fall trip. The best dates appear to be the last week of August and first week of September. There will be an interim meeting during July to plan the logistics of the second trip. This will give us the opportunity to improve some aspects of the sample collections. It seems certain now that equipment for collecting sedimenting particulate matter will not be available in time for this trip. I had planned to delploy a multi-cup trap through the ice over the winter months. It would be frozen in and melted out next April. There is not enough time to complete assembly of the new equipment.

PCSP assisted in all aspects of our field work. Accomodation at the Resolute camp and on the island was very comfortable. The meals and menu were excellent and the cooks at both camps are to be complimented for their efforts. The arrangements for air charter to and from the island were handled very efficiently, as was the receiving and handling of boxes of equipment. All of our equipment was transferred without loss or breakage and we appreciate the help in loading and unloading of aircraft to meet our travel schedule.

Barry Hargrave
Marine Ecology Laboratory
Bedford Institute of
Oceanography

Appendix 4: 1989 Field Supplies

Essential

Tarred Marlin
Mops and mop pail (for cleaning deck, etc.)
Scrub brushes (for scrubbing core and deck)
Hammers
Fittings for one-way valve at the top of the small submersible pump (e.g. a reducer)
Assorted pipe fittings (reducers, nipples, etc) from about 3/4 in to 3 in.
Large wall staples (wires to wall)
Set screws for core collars (could not find any spares)
Tap and dye set
Tarring knives
Paint scrapers
Kim towels and wipes (none left now)
Wiper towels (attn. R. Murphy)
Cable clamp for 3/8" cable
Impact wrench
O-rings for piston
Arming tool for piston
Core catchers
Sand for no-slip paint
Small submersible pumps (for meltwater, core cleaning, etc.)(small pump nearly burnt out)
Hydrohole bubble pump
Light bulbs (yes more!)
Pick axe
Handles for sledge hammers (2)
Grease
Core splitting wire
Thick wire (coat hanger type)
Various sizes of U-bolts
Small (1 gal) white buckets and lids
UGR stylus belt
UGR spare springs (note from T. Hearn)
EPC scot sensor 4100
Ice chisels
2-stroke engine oil
Air filter for Kohler motor (Kohler 4508302)
Knives (hunting, pocket)
Oil for generator (HD-X-40)
Cleats (to put around gantry - tie off to)
Oscilloscope
Water heater (like the one up there - very useful)
Heating lamp socket or pigtails with light socket
Staple gun
10 point dividers

To Improve Efficiency/Data Quality

To Improve Efficiency/Data Quality

Dustbuster (to prevent pollution by plastic & wood chips)
Storage containers for nuts, bolts etc.
Guage for measuring hydrohole diameter (to save time during remelting)
Single string hydrophone array
Portable word processer with some graphics capability