Cruise Narrative

EW9009
Port Newark - Port Newark
Nov. 1 - 22,1990

Nov 1 (JD 305) - Departure time of 0900 local was postponed to 1500 hrs to allow for time to drain and replace fantail hydraulic lines that had become contaminated with water during the previous leg. The harbor pilot came aboard at **1330**; we cast off at **1515**. The harbor was cleared and the pilot departed at roughly **1745**. All times for the remainder of this narrative are GMT.

Nov 2 (JD 306) - Way points for the first three MCS lines were entered into Opus for the WayWatch program at roughly **0400** hrs GMT. These lat/lons were also delivered to the bridge and a pre-plotted track chart at 20"=1° was prepared as the basic plotting sheet for both the bridge and the main lab. We arrived at WPO (the NW starting point for our first MCS line. nº 1001) at **0406** hrs. Speed was cut from 12.5 knots to 2.0 and the streamer deployment began.

Deck tests had revealed that nothing beyond the digitizing can nearest the ship/ deepest on the reel was responding, and it was suspected that this can was faulty and in need of replacement before any further testing could be done. Hence the first task was simply to get the entire 1500 m into the water, replace the can, and go from there. The tail buoy was in the water by **0536,** and the experience of previous efforts was confirmed — the tail buoy has two stable configurations: one inverted, the other right-side-up. Bird collars were attached every 100 meters (every eighth group), floats were added at every other can, and the entire cable was out by **~0816.** The suspect can was replaced, but the problem remained. A jumper from this can to the deck connection was successful, so we thought the problem was in either a) the old *(very* old) lead-in that was still on the drum, or b) the slip rings. The latter actually includes two short cables on either side of the slip ring unit. New slip rings were inserted, but nothing changed, so we suspected the cables to be the problem. Rather than continue to spend more time zeroing in on the cause, we decided at **1430** to "hard wire" the streamer to the deck cable, and live with the inconvenience of power up/power down, connect/disconnect during the next phase of deployment. The lead-in from the reel was fed directly to the deck cable, by-passing the slip rings and adjacent cables; it tested out OK. Holes were drilled in the side of the reel to secure the end of the lead-in with tie-wraps, the deck cable was disconnected, and we were ready to begin retrieving the streamer.

Meanwhile we had been heading down pre-plotted line 2D (future Line 1001) at 2+ knots, giving the bridge practice at staying on the line. Seas were calm, winds light, and set variable — drift was 0.5 knots towards both sides of the line. GPS, LORAN and Transit Satellite positions were posted along the pre-plotted track on the CalComp plotter. At **1545** we selected new way points and asked the bridge to break off the line and make for the new one on a reciprocal course, ~1 nmi to the NE, The 180° turn was done conservatively — at 2+ knots we turned 10° rudder every 3 minutes, and completed the turn at an average of 4° per minute. The streamer lay over against the starboard post for about 10 minutes of that 45 minute turn.

After the tail buoy settled to dead astern we decreased to 1 kn and commenced streamer retrieval. Floats were removed as they came in; all proceeded smoothly, and it was noted that Murphy's Law even has corollaries for streamer work: digitizing cans will become spaced on a take-up reel so as to usually overlap those wound underneath; those that do not will lay up tight against the sides of the reel. The last float was landed at **1930.**

We waited until after the fire & boat drill to begin redeploying because ship's engineers as well as technical hands would be needed. One new section was brought up from the hold to replace a collapsed section noted in the streamer during initial deployment. The eel oil pumps were activated at **2100**, and the filling was begun. At about **2145** the bos'n was in the aft lazarette and discovered eel oil dripping from the overhead insulation. It was estimated that 50 or more gallons had leaked from the thru-deck fitting in the eel oil line; the extent of the leak was difficult to determine, but its effect was clear — the insulation was saturated and had dripped over a 10" x 10" area of the lazarette. Additional pumping was curtailed, and the engineers immediately secured the area and halted any work involving fantail hydraulics.

Nov 3 (JD 307) - The saturated insulation was cut away and the bilges pumped. The engineers assessed the damage and by **0130** we were back in business for using hydraulics and resuming the redeployment. Depth transducer calibrations began at **0230**. At **0315** we had returned to ~3 nmi from our intended first shotpoint; we began a looping course that would keep us along the perimeter of a 6 nmi box centered on that starting position. Calibrations continued through the night. Three compass sections were added. Can nº 11 had to be replaced. The DT at can 21 didn't test out on deck but was deployed anyhow. At **1045** we got a "bad can" message for nº 29, despite the fact that all tests for this can checked out OK. This had all the earmarks of the same problem we thought had been overridden by jumpering past the slip rings and their connector cables.

There was enough deck cable to bypass the pedestal can and connect directly to the lead-in that was now fed out of the reel without the slip rings; this hook-up worked, raising the new possibility that the problem all along was not in the slip rings/cables, but instead somewhere between the pedestal can and its short cable to the slip ring connector cable. The gnawing uncertainty lingered.

Calculations showed that in water depths of 100m or less the distance to the nearest trace could result in shallow refractions arriving on top of seafloor reflections. Hence we removed one of the two 100m passive sections. A weary fantail crew headed for breakfast at **1245.**
In the lab we noted that can 29 was at 75 feet; speed was increased to 5 kn to bring it up. The streamer immediately went dead, but it was another few tens of minutes before anyone went aft and discovered that the brake had slipped. About 3 turns had been wound onto the axle of the reel, and that was the cause of the failure. Hindsight advises: 1) don't trust the brake - chain the drum to the pedestal; 2) consider some way of verifying that the brake is functioning properly. At present, the brake kicks in when the reel hydraulic pressure goes down; as I understand it, one has no way of knowing if the brake is firmly set other than to see that it isn't slipping at that moment, and that the brake piston extends on the starboard side axle.

It took 2 hrs to cut out about 5 feet of deck cable and re-splice the 4 wires. Reconnection and testing was successful. At **1525** we were able to talk to the entire streamer, but it was not set up well: the aft 4 or 5 cans were on the surface as were several in the center; the nearest several cans were between 10 and 15 feet. The bridge reported that through binoculars it appeared the tail buoy was diving occasionally; this could explain the shallow aft end for the streamer. It was decided that in all the cable was too light, and that it should be retrieved to remove floats; adding weights was not considered necessary. Retrieval began at **1547** and took precisely two hours. Meanwhile we altered course for deeper water to add a margin of safety during the next deployment. We brought the tail buoy aboard as well to allow for good speed (10.5 kn) to the edge of the continental shelf. This procedure was accomplished by **1805** with a little difficulty. All agree the tail buoy landing and launching needs to be re-thought.

We slowed again to 2.5 kn in 120 m water at **2035**. After bailing out the two compartments in the center hull of the tail buoy (it took on water during the inversion at previous launch or during dives on the previous towing), the buoy was over the side again at **2115;** it was right side up at **2119.** The full steamer was out at **2321.** On the way, birds were added to every odd-numbered can, floats to every other bird. Two DTs that had been reading zero depth were found to have both plugs inserted; one was removed in each. Speed was brought up to 4.5 kn, and

after a little work at the control board, the streamer set up stably with the aft end near 16 feet, and the front end down near 38; the lead-in was shortened up, and most DTs soon were between 14 and 22 ft.

Nov 4 (JD 308) - We had been proceeding along a box around the start of the first dip line (our pre-plot line 3D); at **0016** the bridge brought us around for a point that would place us 4 nm SE of the long hoped-for first shot point. Shortly after the Radio Operator brought in a weather forecast that predicted "gale force winds and rough seas" during the passage of a low on Tues evening/Wed morning, 3 days hence.

At **0245** we were steady on the approach to the first line, about 3.6 nmi to the SE. Gun deployment went without a hitch and took about 30 minutes. The six guns (from port to starboard) were 305, 200, 80, 145, 120 and 500, for a total of 1350 cu. in. Speed was increased to 4.5 kn; the first shot on line 1001 (pre-plot line 3D) was fired at **0345.** Sampling was 1 msec; recording length 3 secs (the minimum). Each tape took 159 shots at this setting. We were firing every 10 secs (nominal 25 m spacing); hence a tape was changed about every 32 mins. The single trace monitor was taken from the oscillograph camera channel 28; this corresponds to streamer channels 109 thru 112 (far trace = n^{o} 1) when the DSS is programmed to scan four groups in sequence. It was decided to start each line with this arrangement to provide a visual check on trace behavior by observing 4 sequential passes (30 traces each). This results in a ragged monitor record (move-out between the 4 traces produces an offset between arrivals), and the DSS was manually set to only one group for the remainder of the line to give a better hard-copy monitor.

At **0430** the bridge notified the lab of a long line string directly across our track; beacons on the floats showed up clearly on radar, and extended for several miles to either side of our track. We got no radio response from the fishing boats, and hence knew nothing of the depths of their gear. We could not avoid them, and there was little to be done with our towed gear. An 18° course change at **0515** at 5°/min bought us through the middle of two beacons which were crossed at **0533** (SP 650) with no noticeable effect. At **0537** the bridge brought us back on a heading that intersected the pre-plot line at **0648**, well ahead of the desired crossing with the Exxon 500 well. Line 1001 was broken off at **1030** (SP 2426); The turn to the next line was delayed because of traffic. We had hoped to bring in each gun to calibrate their DTs, but the air gun crew had been up a long time the night before, and to let them sleep we postponed the calibration until the end of the next line.

Line 1002 began at **1303** (SP 3350). Because this line was to go well out over the shelf edge we opted to record the entire line with a 5 sec window and avoid the risk of losing data during record window changes.

The 500 gun began leaking at **1356** (SP 3669). Retrieval was complicated by the fact that the outboard winches do not line up with their corresponding blocks, and an extra snatch block or some other arrangement must be rigged for underway retrieval to keep the cable winding properly on its winch. The leak was found to be a broken air hose near the solenoid, and the short hose section at the gun was replaced. The gun was back in and firing at **1501** (SP 4055).

We encountered the same long line string as last night at **1745** (SP 5035). Without altering course we sailed between two radar targets. As before, there was no observed effect on either the guns or the streamer. At **2000** the streamer strain meter was working, with low/ high alarms set at 500 and 2000 lbs., respectively. Moderate course corrections had to be made to offset a drift to the north side of the intended line. The water temperature reached its highest value of 18.3° at **2218**, and during the previous hour can 15 shoaled to 10-12 feet. At **2238** a few selected birds were re-set from 30 to 35 feet; by **2300** the entire streamer was 17-23 ft.

Though the original plan was to continue this pre-plot line 2D to the base of the slope, weather forecasts were not favorable for Tues/Wed and the slope was to be surveyed with SCS in another week. Line 1002 ended at **2342** in approximately 1400 m water depth. A non-recording transit to the start of the next dip line (4D) was begun with 4° starboard rudder. The streamer crossed over the guns and chafed against the hose bundles; John Diebold requested that a 2° rudder be used from then on. During the transit to the next line the guns were retrieved to calibrate the DTs. This was successful for only n^{o} 14, the 305 cu. in. gun towed off the starboard boom. It was finally decided that because the other guns were connected to the Bemier DT modules (not Conrad's) that had never been checked out, that the problem was possibly in the wiring between the deck and the modules in the lab. Sorting this out could be a lengthy process, and was postponed. The guns went back in the water.

Nov 5 (JD 309) - Recording on line 1003 began at **0226.** Navigation block errors at the start corrupted the first few tens of MCS files. At about **0400** the first of many, many "acquisition code = 8040" or "...E040" statements appeared. They seemed to come in bunches, sometimes on every shot for several minutes, then none for an hour or more. Joe Stennett was moderately concerned because if this was indicating parity errors originating in the streamer, there was a chance we were getting no data. However, because the wiggle image on the monitor screen, the camera record, and the flat-bed monitor profile were all looking normal, there was a reasonable chance that the problem was either very small (affecting only one can) at worst. We debated running a 15-minute diagnostics procedure that would interrupt the data, with the choices being

to tolerate a data gap, or break off the line and circle during the diagnostics. We chose to do neither, but inadvertently caused a data gap anyhow. The solution was to record a few shots at 1600 BPI for Budhy to examine and display for quality check. In doing this, a few tens of SPs after 9002 on tape 68 were overwritten. After some difficulty, the tape was read, and it appeared to be OK, other than incomplete because at 1600 BPI, 5 sees of 1 mil data cannot be written to tape.

At **0631** the LMF compressor went down for 6 minutes, and shots 9634-73 were lost. Tape 109 finished on the E drive at **1615.** However, E drive did not start immediately, and when D finished its auto-rewind, data began overwriting its previous data. When completed, this tape was removed and labeled nº 109. Tape 111 continued at **1630.**

We had originally requested hourly bearings on the tail buoy, taken from the radar, these had been supplied by the bridge. At **1750** the Mate called to say that the RDF unit was being used, and that it was probably in need of calibration. Hence the bulk of these readings are probably inaccurate.

The landward end of Line 1003 was in the shallowest water of the MCS survey, but included other hazards as well – the approach crossed two shipping lanes, the planned turn swung us within a half mile of the Barnegat light that separates inbound and outbound NY traffic, and several wrecks were charted in the area. Fortunately the seas were calm, the weather clear, we had daylight, and no traffic. To avoid an especially shallow region over a NE-SW sand ridge (we measured 16m under the keel a half mile or so from the northern edge of the 10 fathom contour) we modified the next line (1004) to stay clear of the shoal area. During this turn the 120 and 305 cu. in. guns misfired a number of times. Line 1004 began at **2138.**

Nov 6 (JD 310) - Line 1004 ended at **0058.** During the ~225° turn the system was brought down for diagnostics to search for the problems leading to the "acquisition code = E040" message. Nothing out of the ordinary was detected, and when re-booted this error message did not re-appear. Problem solved ? Recording on the long dip line 1005 began at **0159.** During this run, visual sighting of the tail buoy, when compared with the RDF, confirmed the latter is off by 14°. Operations were especially smooth for the first quarter of this line. Streamer depth remained steady at or just above 20 ft; typical values were 16 to 20 or 18 to 23. A strain gauge was attached to the tow cable off the reel, and measured typical values near 1200 lbs.; warning alarms were relayed to a read out in the lab, set at 500 and 2000 Ibs. for low and high pulls, respectively. The wind picked up to a steady 30-40 knots during the night as a low moved through, the trough passing at **0900**. Gusts reached 60.

The ship rode surprisingly well, partly because seas did not build to more than 6-8 ft and were from the starboard quarter. Camera records showed low frequency noise, usually concentrated on one trace and dissipating in adjacent traces; either individual birds or, more likely, portions of the streamer near the surface, was the cause. Can depths gradually decreased to an average of 18 ft, with occasional readings near 14. Ship speed had to be eased back repeatedly to maintain proper streamer depth. At **1343** bird depths were increased to 35 ft to help keep the streamer down. The old "acquisition code = E040" showed up occasionally. At **1428** the near 3/4 of the streamer was at 10 ft., and water temperature reached a high of 18.1° -- edge of the Gulf Stream ? Despite continued diving of the birds, depths of the first half rose to 5-10 ft. At **1457** we payed out 5 turns (about 35 m) on the lead-in cable. We had to totally shut down and disconnect/reconnect the cable because of the slip ring by-pass. By **1520** the streamer steadied up at 20 ft. At **1621** the last 5 cans were showing about 30 ft; they were raised, and in 20 minutes the entire streamer settled to 20 ft. Since the re-start we began getting occasional "acquisition code" errors again. Line 1005 ended at **1718.**

The Captain expressed concern about turning slowly into the troughs, and we agreed to a turn that would take us a little farther downwind from the start of the next line than originally intended just to allow for a more rapid swing around to start the reciprocal heading on the next line. Line 1006 began at **1851.** During the turn much of the streamer rose to the surface and gun 11 (305 cu. in.) misfired for several minutes. Fortunately, the winds dropped over the next several hours, and continued from the NW. The sky was clear.

Nov 7 (JD 311) – The DSS crashed at **0026** *(explanation* ?) Recording was restarted 11 minutes later, and was termed the beginning of line 1006A. The latter was ended at **0142**. The weather was improving, and we decided to go as planned with the strike line. Line 1007 began at **0242**. An "if 077" message appeared during recording on tape 215; we switched drives, and the problem went away (?) The streamer tail was a little deep, and had to be raised. We continued the practice of preparing a camera record of each of the four trace groups at the beginning of a line, and this time found the typical pattern of two dead traces on group "C," and three on all the rest. The problem could be faulty galvanometers in the camera, but clearly the streamer at can #5 is flakey -- only 1 of the four sections it serves is OK. Gun 7 (500 cu. in.) quit firing at **0558**. It was hauled aboard and found to have a chafed and broken air hose; the hose was replaced, the chafing beefed up, and it was back in and firing at **0701**. At **0815** cans 9-11 showed unusually noisy traces. In 5 minutes can 9 was at the surface. The camera record showed something very likely was snagged

on the streamer, and slowly worked its way back and finally disappeared by **0830**. The line was carried around a 90° turn to the left and continued up to the initiating turn on the next line. Hence it ended at **1229.** Line 1008 began at **1251.** The logging computer crashed at **1854**, and seismic data probably lost header info until all was restarted at **1905.** The line ended at **2031**, and during the turn onto the next line, gun 11 quit temporarily. A fishing boat that refused to make way complicated the turn onto line 1009.

Nov 8 (JD 312) - Line 1009 proceeded uneventfully until it was ended at **0131**, partway around the turn to the approach for the next line. We were commencing a series of fairly short (-4 hr) strike lines with short turns/transits between. The bridge brought us off Line 1009 and began lining up with the wrong next line. A series of fairly sharp turns brought us back around to the correct position, and line 1010 began at **0334.** During these maneuvers the guns quit for two minutes and the streamer sank to 35-40 ft. Once steady on 1010, however, the streamer set up at 16-22 ft, and we had no gun problems; line 1010 ended at **0745.** Line 1011 began at **0828** and ended at **1331.** The wind and seas began to pick up during this line, reaching 25-30 knots and 6-8 ft. We were roughly in the troughs, and the streamer showed surprisingly little deterioration. Streamer depths were rather erratic, first shallow on one end, then the other. Things steadied up by **1217.** The line ended at **1331** and we began the turn for the next line. Though the depths were 18-24 ft, streamer tension reached 3500 lbs. Ship's speed was reduced to 2.5 knots; half the streamer rose to 3-4 ft. At this time the bridge lost RDF contact with the tail buoy, and it was presumed to have flipped over. We turned onto and began Line 1012 at **1417,** despite an inverted tail buoy and very shallow streamer, depths soon were 30 ft. at the head, and 6 ft. at the tail. It took until **1453** to steady it out at 19-24 ft. Line 1012 ended at **1805;** Line 1013 began at **1934.** During the turn gun 11 (80 cu. in.) misfired several times; this was a typical pattern in many of the turns. However, number 11 continued to misfire intermittently throughout this line.

Nov 9 (JD 313) - Line 1013 ended at **0146**; 1014 began at **0210.** The haunting ghost of "acquisition code = E040" continued to show up every so often. The weather began to improve slowly. Seas were 3-5 ft., wind about 20 knots out of the west. The line ended at **0532**, and we began a looping turn to put us back onto the landward end of line 1006. At **0651** we began recording on line 1015, the landward continuation of dip line 1006.

At **1100** we made the scheduled radio contact with Capt. Fish of the "After Hours." The seas were calm with a light breeze of 5-10 knots. We

gave him our position, speed and heading and arranged to meet at the planned end of line 1015 with an ETA of 1445. Following ~2 hrs of hauling the guns and streamer we would make the transfer at local noon. The "After Hours" left the dock in Atlantic City at **1300** and maintained frequent radio contact on VHS. We ended line 1015 at **1452** and immediately slowed to 2 knots and began hauling gear. The "After Hours" was in sight by **1500.** Can 5, sections 17-20, came aboard at about **1630** leaking oil and missing its bird. The fact that it was not flooded with sea water suggested it had happened very recently. The "After Hours" was astern of us, but both Capt. Fish and the people aboard who later joined us insisted they had stayed clear of our streamer (which was floating on the surface during retrieval). The leak was patched and taped heavily before I examined the damage closely, but to either side of the repair there was no evidence of propeller damage. A section served by can 10 had come aboard with a puncture from a fish hook (probably the long line snagged at **0815** on Nov 7); it is possible that one of the other long lines were know we crossed also tore off bird 5 and punctured/weakened section 17, and that it leaked only when stressed and hauled from the water. The tail buoy, as suspected, was flipped over; it was landed on the fantail at **1717.**

The personnel/equipment transfer began via Zodiac at **1730.** Ardye, Musser and Sheridan departed; Miller, Christensen, Iltzche and Beck came aboard, as did a reporter and photographer from the Associated Press. The latter two remained aboard for an hour while we made 8 knots towards the position to resume shooting. They transferred back to the "After Hours" at **1915.**

Weather reports warned of gale force winds from the NE shifting to NW and seas 8-14 ft within 24-36 hrs. We debated several alternatives: 1) proceed with our plan of another 5 or so days of MCS on the shelf, and hope the weather does not get any worse than predicted; 2) replace damaged streamer sections, rewind on the reel, head for the slope and do the SCS program; or 3) continue with MCS deployment, but head down to Delaware Bay, arriving in ~12 hrs as the weather gets bad, and go into the relative protection of the Bay for the planned work there. The first option was chosen. Number two had several problems: a) we were several hours from the slope, the guns would have to be re-rigged, that data would be weather-sensitive as well, and until the winds back to the NE, the slope area would have much heavier seas than the inner part of the shelf. Number three had *the* uncertainty of the "protection" afforded in the Bay, as well as the uncertainty of arranging for a pilot on this relatively short notice (12 hrs.)

The old LDGO tail buoy was launched at **1955,** in place of the unstable, heavy and difficult to deploy buoy we had been using. After a little ballasting, the former was astern with both flasher and a radar

reflector. On the way out sections 17-20 and 37-40 were replaced. DTs in 5 of our 6 guns were successfully calibrated.

Nov 10 (JD 314) - All the gear was in at the beginning of line 1016 at **0139.** We were plagued by several small problems: a) can 25 rode very shallow, and though it appeared to respond momentarily to commands to dive, within a few minutes it would rise to less than 10 ft.; b) trace 117 had a DC shift that resulted in clipped signals; c) can 1 did not respond at all. As forecast, the wind freshened out of the SE to about 25-30 knots by **0450**. Hence this and the next several lines rode us in the troughs. The camera records showed relatively good records, nonetheless. We finished line 1016 at **0550.** During the subsequent turn the streamer was shut down and rebuilt, but the DC shift in trace 117 and the dead can 1 remained as before. After numerous attempts to dive can 25 we concluded that its DT was giving wrong info, because there often was unreasonable differences in depth between cans 23, 25 and 27 at any one time *(e.g.* 18, 6 and 22 ft, respectively).

Several ~ 4-hr strike lines running SW-NE were recorded over the next 24 hrs. On/off times and line numbers were:

Line 1017 - JD 314 **0644/1156**
Line 1018 - JD 314 **1225/1632**
Line 1019 - JD 314 **1756/1916**
Line 1020 -JD 314 **2116/JD** 315 **0112**
Line 1021 - JD 315 **0148/0555**
Line 1022 - JD 315 **0643/1138**

The weather during most of these was the worst we had yet encountered. A very deep low pressure system (990 mbars) passed over us at 314/**2100**. Winds held a steady 30 knots from the SE until that low passed by. Afterwards, winds became variable and shifted abruptly to the SW and eventually backed around to the NW. Rain came along with this front, reducing visibility to 1-2 miles. Seas had built to 8-12 feet during the blow from the SE; afterwards they calmed and rebuilt from the NW.

Nov 11 (JD 315) - By **0500** the wind was a steady 40 knots, gusts reaching 55. Seas were hard to judge in the dark, but probably 10-18 feet. Through all this the data quality appeared to hold up. The ship rode exceptionally well in the troughs. She maintained a rather constant 2-5° list to leeward, and rolled about 10° to either side of this, though not with an especially smooth and periodic motion. There was very little slamming of waves against the windward hull. During turns across the wind we occasionally rolled to 25°. It was difficult to maintain the streamer at a given level during turns, but it would settle to an average 20 feet shortly after holding steady on a line. Cans at any one time would show depths

from 14 to 26 feet, but much of this could be attributed to an uneven sea surface, not to an uneven streamer. The oscillograph records showed a remarkably noise-free record so long as the streamer was everywhere deeper than 10 feet. Typical gun depths were 10-18 feet. The major concern was maintaining a consistent gun signature rather than than reducing noise. While the latter was probably fairly low frequency, the composite waveform from the array was probably far short of optimum. We debated breaking off the survey at several points in this inboard grid of strike lines - they are crucial, new lines that will be very important to the goals of our project, and degradation because of weather was clearly a concern. Options discussed were: 1) continue and hope the weather gets no worse; 2) keep shooting inboard strike lines adjacent to this grid but plan on returning to repeat these lines in better weather; 3) go off to another location and collect data that is less important, and return here in better weather. Options 2 and 3 would exercise our option of using as many as 3 "weather days" agreed upon by NSF and LDGO. Option 2 would keep us in the area to resume this important grid as soon as the weather abated. Option 3 would provide either reconnaissance profiles of new areas or allow us to collect less critical lines already in our plans. The Captain expressed concern that if the seas built much more he would be anxious to get us out of the troughs and onto NW-SE lines. We decided this latter would not be worth it for our needs; if we broke off our strike-line grid it would be his choice, not ours. and we would start the "weather days" clock at that time. We stuck with option 1. We began strike Line 1023 at **1158** to tie to the easternmost survey area. We finished at **1917** and turned SE on dip line 1024 at **2046.**

Nov. 12 (JD 316) - The weather deteriorated, and the turn onto line 1025 was especially long and wide **(0151-0326).** The bridge worried about seas over the weather rail: the "garage door" along the starboard side of the wet lab was stove in (again - the previous time was during the Atlantic crossing on the previous leg). An unforecasted front passed through at about **0600,** and winds rose to a steady 50+ knots, with gusts reaching 70. We continued on course (winds 40° relative) through WP69 (Exxon well 684), where the Captain requested we alter course into the wind. We prepared an alternate WP70A to tie into and begin one remaining strike line on the outermost shelf, but soon learned this course was still too far off the wind. We turned into the wind and 10-18 ft. seas, and stopped recording data at **0634**. While the guns were shut off to minimize the risk of blasts damaging adjacent guns should they tangle, the compressor was left on because of a suspected leak - pressure could not be maintained otherwise. We ran in this mode for the next 8 hours. We simply tried to maintain enough speed to keep the streamer above 40 ft., but

not so fast as to kite the birds to near the surface or to strain the streamer above 2000 lbs. As the wind backed around to the NW, our heading changed from 270° to 300°. Recognizing the preference of riding troughs in foul weather (NW winds, therefore strike lines), our options were:

1) return to WP69 and continue on to the HOM well, and then to dip lines 5D and 9D lines to finish the grid, as planned;
2) add inboard strike lines (difficult operating conditions even in good weather, though weather might be better inboard);
3) break off for SCS (not possible since weather prohibits recovery of MCS streamer);
4) head on an oblique strike MCS line to DE Bay (placing us there in foul weather of 5-6" seas in the bay, not a viable option).

We chose to return to where we had stopped recording and finish the grid as planned. At **1452** the wind and seas had moderated enough to allow a large turn back to where we had finished line 1025. We decided not to collect data on the return; this may have been a mistake since we could have crossed the B-2 well. Still, we had a following (rough) sea on our return to WP69, the line would have been oblique, and there are numerous other crossings of B-2.

The weather reports continued to forecast depressingly high winds and seas. We considered recovering the MCS streamer to rig for SCS, but decided not to because:

1) the 400 in^3 water gun was still in its box, and preparing it is a major operation - we needed this gun to do later SCS under these high seas;
2) to recover, we must turn into the wind (1 hr.), recover (2.5 hours in foul weather), and eventually redeploy (total time ~ 6 hrs.);
3) we were unconvinced that SCS is less weather sensitive than MCS. We have collected good MCS data under 10" seas, and even in the 10-18" seas of this AM we were able to collect adequate data. We were only limited by the ability of the ship to sail in troughs, a decision of the Captain. We would be faced with the same ship handling situation on the slope, and the weather there would be worse.

We returned to the break-off point without recording data, turned and resumed recording on line 1026 at **2045** in a moderate-rough trough sea. The 16-hour loss of time was part of our "weather contingency." The DSS-240 crashed for no apparent reason at **2317**; we were up and

recording again at **2329**. Guns 7 and 11 reported intermittent firing throughout much of this line.

Nov 13 (JD 317) - At about **0300** gun 7 (500 cu. in.) was pulled to replace a broken air hose fitting. It was under repair for the rest of line 1026, which ended at **0425;** the gun was back in the water and shooting by the time we began line 1027 at **0606.** During the turn onto this line the streamer strain regularly reached close to 3000 lbs. Gun 11 continued to misfire on occasion. We crossed DSDP 612 and COST B3 on this line and crossed up onto the shelf, ending the line at **1000.** After a long, slow, ~220° mm that brought the seas back around our stem, we began the long dip line 1028 at **1119.** We headed directly into 6-10 ft. seas and 30+ kn winds. Like the night before, we tried to maintain a fairly even strain on the streamer (and keep it under 2000 lbs.) and to keep the birds at about 20 ft. The speed fell to about 4 knots over the ground and the camera records were noisy. Gun misfires continued for most of this line, and a constant streamer depth was impossible to maintain.

Considering the disappointingly noisy data we appeared to be collecting, we considered numerous options regarding the rest of the MCS goals and the planned Delaware Bay shoot. The Captain expressed the desire to arrive at the pilot station in the early morning and do most of our shooting in daylight. Unfortunately, NW winds forecast for Wednesday did not look encouraging for either the Bay or for high-resolution dip lines off the coast. These options (in local time) were :

Option 1 (as originally planned)
finish grid by 0600 Thurs., requiring 6 hours of additional strike lines, perhaps on inboard grid; collect MCS to DE Bay to 0600 Fri.; leave DE Bay 0700 Sat, end MCS; transit back for SCS
disadvantages: must insert "filler" strike lines to keep on schedule, no opportunity to add quality dip lines in good weather

Option 2
interrupt Line 1028 at 1200 Tues; collect MCS to DE Bay, arr. 0800 Wed.; pull gear by 1100 Wed.; shoot DE Bay; leave 1200 Thurs, transit back to grid by 2100 Thurs; redeploy 0000 Fri. collect "box grid" until ~Sat 1000, pull gear by 01300, rig for SCS by 1700
disadvantages: poor weather DE Bay, may not want MCS to Bay

Option 3
interrupt MCS 2000 Tues, (EOL 1028); pull gear by 2300 Tues; transit to DE Bay by 0700 Wed; shoot DE Bay until Thurs 0800;

redeploy MCS 1100 Thurs., collect back to grid until 0700 Fri.; collect box grid until 1700 Sat; pull gear by 2100, rig for SCS by 0100 Sun

disadvantages: poor weather DE Bay, not enough notification for pilots

Option 4

finish grid by -2000 Wed. and pull gear by 2300; transit to DE Bay, arr. pilot station by 0800 Thurs.; transit back out to deploy, then shoot into Bay; leave DE Bay 0800 Fri.

4A

deploy MCS by 1100 Fri., collect MCS back to grid until 0700 Sat.; collect last dip line (HOM 655-innermost grid) by 1700, pull gear 2000, rig for SCS by 0200 Sun

4B

if data in DE Bay is disappointing, transit back to MCS grid by 1600, re-deploy 2000 Fri., collect several more dip/strike lines

We chose option 4, and left it open as to how we would return to the offshore MCS grid (options 4A or 4B).

The DSS-240 crashed at **1540**. We were recording again at **1554**, but unfortunately the first two minutes of tape #482 were overwritten, for a total data gap of 16 minutes.

The camera records showed noisy traces as expected for heading into fairly rough seas. At **1747** we may have snagged another long line, as it continued for about another 3 minutes and then was gone. This occurred within a few tens of miles from the other two suspected long line entanglements. Guns 11 and 12 (80 and 200 cu. in.) were down for 7 minutes of repairs at **2119.**

Nov 14 (JD 318) - The seas moderated somewhat as we approached the coast; winds, however, continued out of the NW at 30-40 knots. Speed over the ground slowed to less than 4 knots. Line 1028 ended at **0218.** Speed through the water was difficult to keep constant throughout the following butterfly turn. Water depths reached 20 meters, we had ship traffic, and 30-40 knot winds first on the bow, then abeam, astern and finally abeam again. Streamer depths were kept less than 20 feet by asking for as much as 120 RPM on the shaft; as a result we at one time were doing nearly 7 knots through the water, with up to 3100 lbs. of strain on the streamer. We came around to start line 1029 at **0306.** Because of the previous maneuvering, the streamer took awhile to settle to a relatively constant 20 ft. towing depth. We turned off at **0502**, and this time anticipated the effects of turning into the wind and managed to keep the

streamer more nearly at 15-25 ft. We began the long, seaward-running dip line 1030 at **0702**. We had been running two profilers for two days, and both at 30-100 Hz. Shortly after the the beginning of line 1030 profiler #2 was set to 65-150 Hz, and resulted in very much more useful records. Streamer depths were very erratic during this line, perhaps as a result of an offshore current aiding our speed through the water. Speed over the ground averaged more than 5 knots, while the Furuno showed about 4. Gun 7 (500 cu. in.) failed at **1235**; it was repaired and in the water again at **1325.** The weather was relatively good for this line, and we were able to keep the streamer at a steady 18-22 ft. Guns were typically at 16-25 ft.

Line 1030 ended at **2056**, and we began retrieving the gear to make speed for Delaware Bay. Our decision was to collect MCS on the return from the Bay if a) the Bay data looked worthy of tying to anything; b) the weather during the return was OK; and c) by taking the extra time to record that we didn't risk missing a weather window for the last few lines in our top-priority MCS grid. The tail buoy was aboard at **2313** and we got underway. The watchstanders were relieved of duties for the transit; only the 3.5 KHz recorder was left running and annotated once/hr.

Nov 15 (JD 319) - We arranged to pick up the pilot at 8:15 AM (local, **1315** GMT) while recording into the Bay; hence we lay offshore and deployed gear beginning at **1010.** Cans 1 thru 6 were put in the water for a total active length of 300 m. Can 7 was between the fantail and the water, suspended in air. Birds were placed on all cans except nº 4; DTs were placed on 1, 3 and 5. To maintain a uniform depth of 10 ft., the 5 cu. in. air gun was suspended from a float. It began firing without a hitch, and we started line 1031DelBay at **1120.** We used the Price compressor (driven by a very noisy hydraulic motor), and fired every 5 secs. for a 3 sec. recording window, sampled at 1 msec. During deployment we had been circling between traffic lanes; we reached the desired starting point at **1150** and began the ~straight run up into the Bay. The pilot came onboard at **~1315.**

The profile up the Bay was surprisingly "ringy," perhaps because the floor of the channel is dredged very level. Water depths were a fairly uniform 40 ft. Traffic was no problem. We had excellent weather - 10-15 knots from the WNW, clear skies, temperature about 60°. We came in on a flood tide that made our speed over the ground slightly more than that in the water, but this changed through the day as the tides reversed. Water temperature dropped from 14° to 10°, but according to the pilot, we were in salt water the entire way. We had little difficulty in maintaining streamer depths of 7-12 feet. We reached a wide anchorage at **2211** where we hauled in all of the gear and turned around.

Line 1032DelBay began at **2306.** This time we used an 80 cu. in. water gun, also suspended from a float at about 10 ft. The record quality was much as before, only even more reverberent, and will require some work to clean it up. Nonetheless, we could see seaward-dipping reflectors and probable onlapping geometries down to 0.25 - 0.50 sees. Speed over the ground reached 6-7 knots during part of this line due to the outgoing tidal current.

Nov 16 (JD 320) - The pilot stepped off while we were still underway at **0603.** We continued out of the Bay and passed over the 1150 Z starting point. It had been a long day for most, so we continued seaward on this heading until **0900** when the gun/streamer crew was roused out of bed. The line was terminated at **0915,** and the gear was retrieved and re-deployed for the 6-gun MCS set-up. Line 1033 began at **1230,** and ran east to tie to Shell well 273 at the shelf edge, and then turned NE to tie to two more wells within our grid. The seas and wind were calm, and the streamer and gun depths were easily maintained. The geology was, by contrast, quite unspectacular. Fishing boats were common along this outer shelf transect, and had to be maneuvered around on occasion.

Nov 17 (JD 321) - Line 1033 continued without incident until it ended at Exxon well 902 at **1155.** After a butterfly turn to seaward, the well was crossed again 1 nm past the start of line 1034, which began at **1250**. The weather deteriorated significantly along this line, ending in 30-40 kn winds and 8-10 ft seas from the NW. Had we been farther seaward, the added fetch would have made it too rough to retrieve the gear. As it was, we ended at **2346**, a few miles and a few hours sooner than what we would have preferred. But that desired endpoint was in -15 m of water, and carried the risk that when we got there the weather would be even worse. We had intended to disassemble the streamer during retrieval, but this was out of the question under these conditions. The fantail crew was kept to a minimum, and those hoisting birds at the stem were secured with lifelines.

Nov 18 (JD 322) - The tail buoy was on deck at **0145.** We had a transit to the start of the SCS survey at the shelf edge that would get us there at the untimely hour of **0900** or so. The deck crew had put in some tough, cold hours already, and rather than get them out of bed again at local 4 AM, we opted for either of two plans: 1) slow down at **0600** (1 AM local) and put the gun and streamer in, giving the guys a better night's sleep afterwards; or 2) make the transit at a slow pace and arrive at the SCS grid near breakfast time. We chose the former, but by **0600** the weather had gotten even worse, and we kept transiting to the shelf edge. We maintained only a minimal main lab watch.

We decided to make use of the waiting on weather time and practice steering by Hydrosweep. Past seismic surveys have collected dip lines that invariably cut across slope canyons and make it difficult to follow particular reflectors down to the base of the slope. With Hydrosweep, however, we thought it possible to steer dip lines along inter-canyon ridges. Hence, we located a ridge line at the NE edge of our SCS grid using the SeaBeam map collected on the *Atlantis II* last December. Though we were not recording seismics, we spent 2 hrs. following a particular ridge line down the NE flank of Hendrickson Canyon, and found it very easy to do.

We slowed to stream gear at the base of the slope at **1125.** We used the "single channel" streamer and recorded its four traces on the DSS240 at 1 msec for 5 sec records. We did not bother to number any of the SCS lines, so the entire data set is one line with contiguous files. The 400 cu. in. water gun was used, its return air hose vented on deck. The gun is difficult to handle on a rolling deck, as it weighs in excess of 400 lbs. We had been using a single LMF compressor for the 6-gun MCS survey; for the SCS work we began with the Price machine, but found it could not deliver 2000 psi every 10 secs. We switched back to the LMF. Data quality was adequate, but the gun had an unusually long pulse. Ship speed at first was 6 kn or less, owing to the weather.

Nov 19 (JD 323) - The gun stopped Firing abruptly at **0532** due to a broken air hose. Couplings on the gun adjacent to this air hose were pretty well battered as well, probably because of the loose air hose. After replacements and tightenings, the gun was back in the water at **0814** when it fired one shot and quit. The problem and its solution were not readily apparent, so we chose to deploy the more easily handled 80 cu. in. water gun. By **0930** this was in the water and firing. Experience has shown that water guns fail more often when towed directly astern, in the ship's wake. Unfortunately, only one short outboard boom was ready for gun deployment, so switching guns during this cruise was not an especially quick task.

We resumed shooting several miles from the break-off point. The missed track crossed a critical tie to the B3 well, where we wanted top-quality data. We thought this would stand a better chance if we waited for 1) the 400 cu. in. water gun, and 2) the weather to get better. However, the 80 in gun provided very good records, with a sharper pulse than the other. The weather got only marginally better later in the day, but we realized the logistical cost of returning to re-shoot this line if we postponed much longer; hence we filled it in despite the weather.

We noticed increasingly noisy records from the time of the 80 in gun substitution that finally was tracked to a noisy first trace. We eliminated it

from the lead-in to the recorders at **2339**, and the profiles improved immensely.

We continued collecting strike-line profiles for the next two days, trying where possible to: 1) supplement existing seismic data, 2) cross boreholes, 3) cross outcrops sampled by Alvin, and 4) tie to our MCS data set. Most of the survey concentrated on the slope above 1500 m between Hendrickson and Lindenkohl canyons, but one ltine traversed the uppermost rise, and a pair of lines extended SW to Spencer Canyon. The latter was an effort to survey the 1400-1500 m isobaths for lower Neogene outcrops, but yielded unpromising results.

Nov 20 (JD 324) - The strike line grid was completed at **0139,** and to get to the base of the slope to begin the dip lines, we chose to run down the axis of Hendrickson Canyon using Hydrosweep to guide the ship. The hope was that we could collect a profile across the several "plunge pools" that lie down canyon from locally steep stretches in the thalweg. Furthermore, it was hoped that clear images of subcropping strata could be obtained. Unfortunately, steering the thalweg was not as easy as hoped, and either because of the side-swipe of the canyon walls, the rough nature of the thalweg, and/or the highly reflective nature of the seafloor, the profile was of disappointing quality. For the subsequent run up-dip on the inter-canyon ridge, we chose to steer by way points picked off the SeaBeam map. Though measuring and entering these numerous lat/lon positions is tedious and error-prone work that demands a lot of checking and re-checking for accuracy, it was easier and more dependable than driving by Hydrosweep. Because the SeaBeam map a Loran-based map, we asked the bridge to steer by Loran as well; they were able to keep on course to within a tiny fraction of a mile. Often the plotter pen noting the track was so exactly on top of the prescribed course that it was not visible (at a scale of 20° = 1"). Hydrosweep was, however, valuable along the uppermost slope, beyond the SeaBeam map, as we tried to remain between canyons and slump scars. Most dip lines were extended up beyond the 200 m isobath, though acoustic penetration with the single 80 in water gun was minimal in this region.

Nov 21 (JD 325) - An especially clear, buried canyon was crossed on several strike lines on the NE wall of Lindenkohl; we suspect it is the same age as the "Ml" canyon encountered at DSDP 612. We tried to run the last dip line up the thalweg of this one near Lindenkohl; it will take careful examination to see whether or not we were successful. We ended with one last strike line along the 300 m isobath. The gear was hauled at **2350**, the ship turned and headed for Ambrose Light, 100 n mi to the NW. We docked at Port Newark at **1345** the next day, Nov 22 (JD 326).

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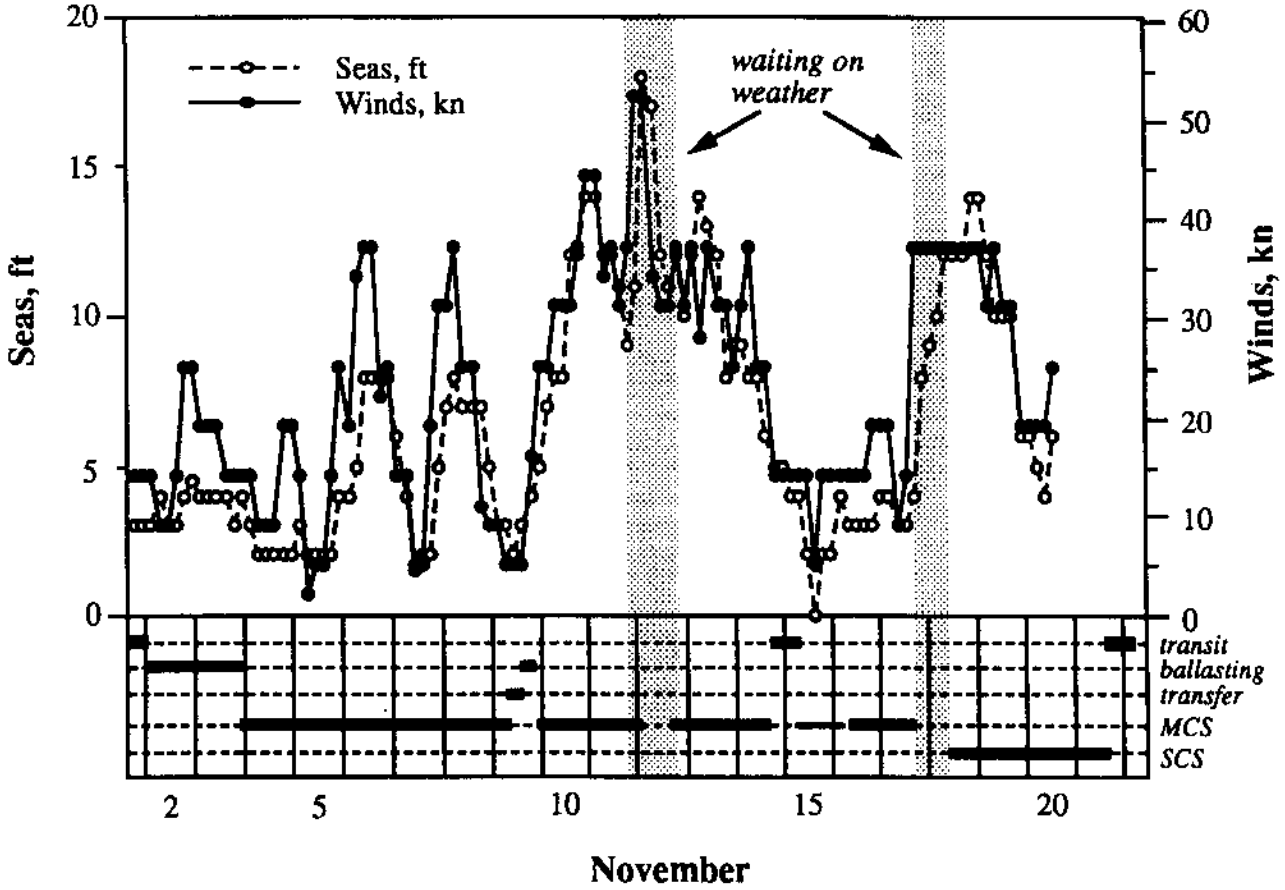
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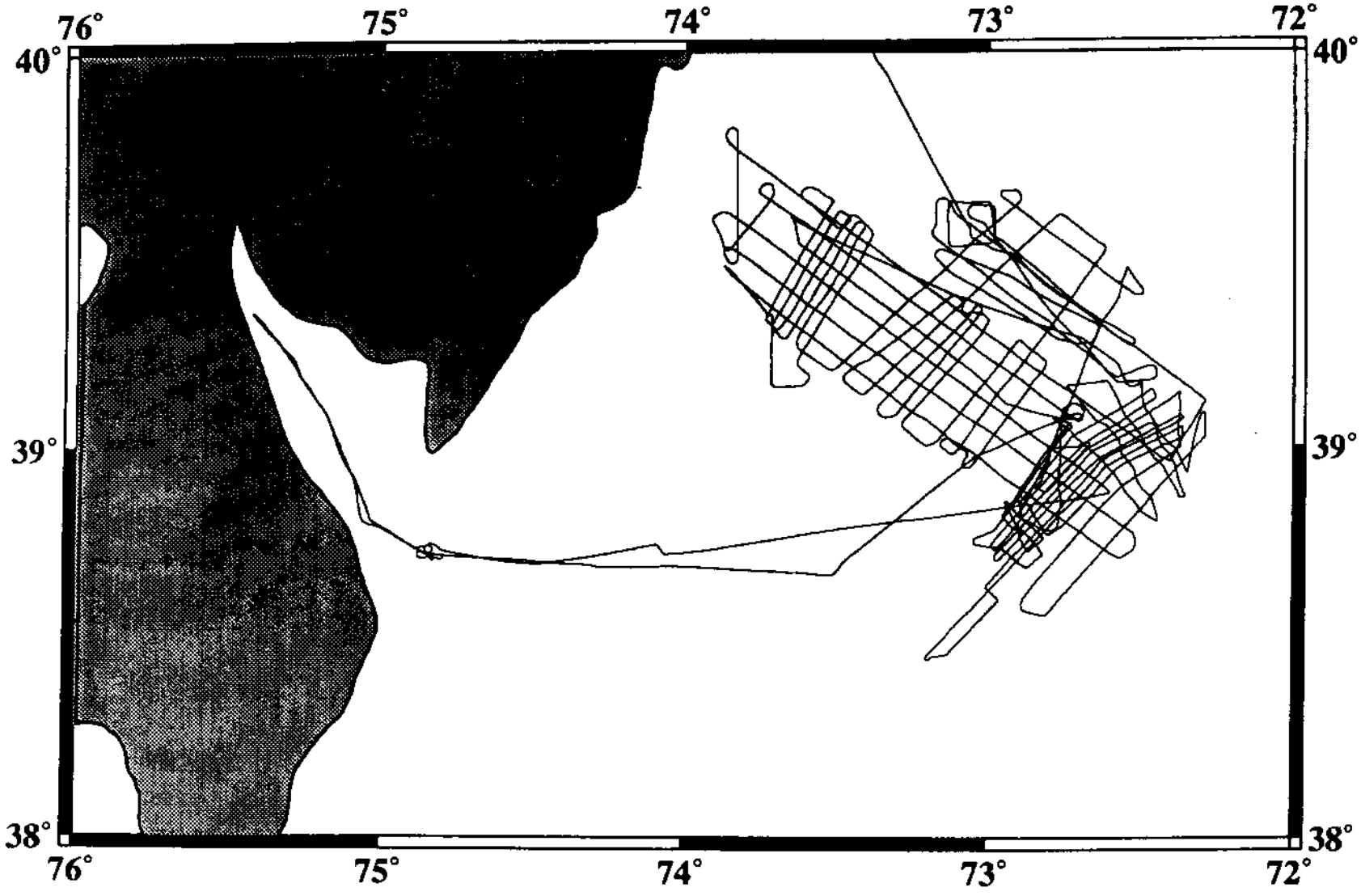
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