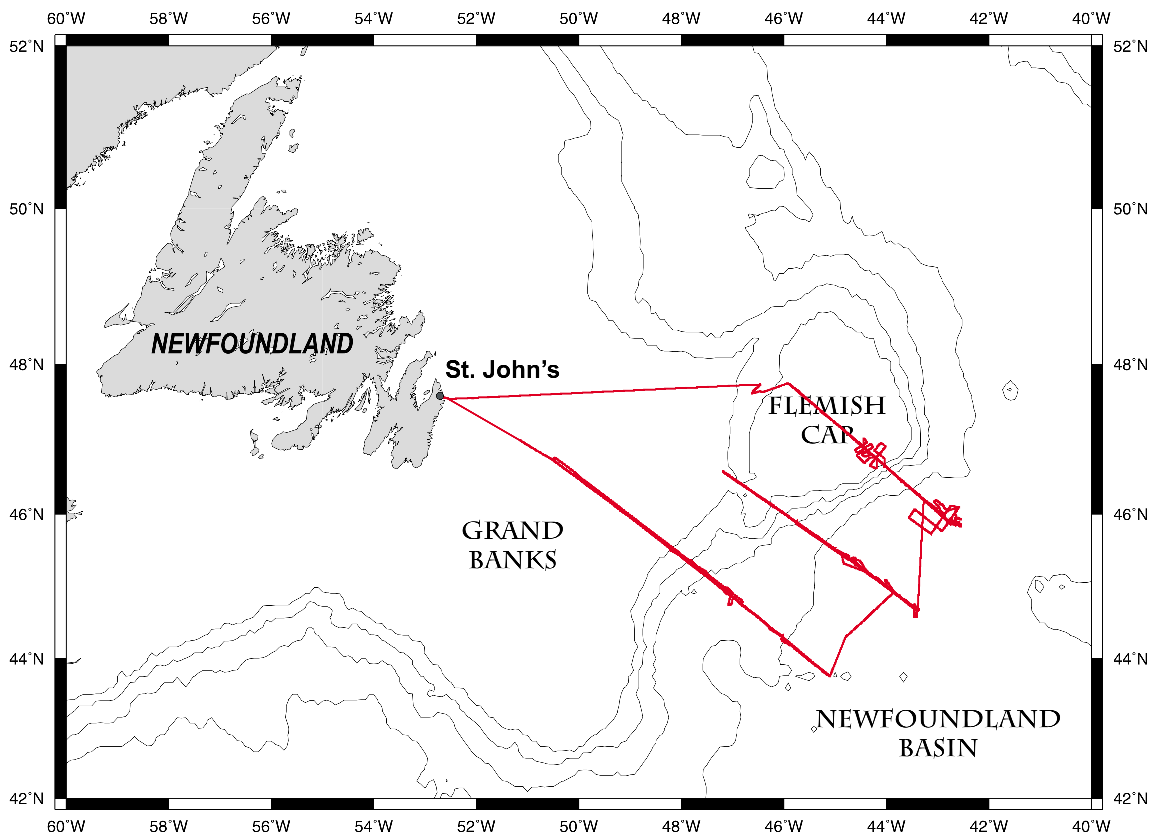
Cruise Report OC359-2
Newfoundland Basin

SCREECH: Study of Continental Rifting
and Extension on the Eastern Canadian Shelf

R/V Oceanus
14 July - 12 August 2000
St John's to St John's



SCREECH: Study of Continental Rifting and Extension on the Eastern Canadian Shelf

Newfoundland Basin, Flemish Cap, and Grand Banks

Cruise Report
OC359-2
R/V Oceanus
St John's to St John's, Newfoundland
14 July to 12 August 2000

Dr. Keith E. Louden, Chief Scientist
Dr. Thomas Funck, Shipboard Scientist
Department of Oceanography
Dalhousie University

SCREECH SURVEY LOCATION

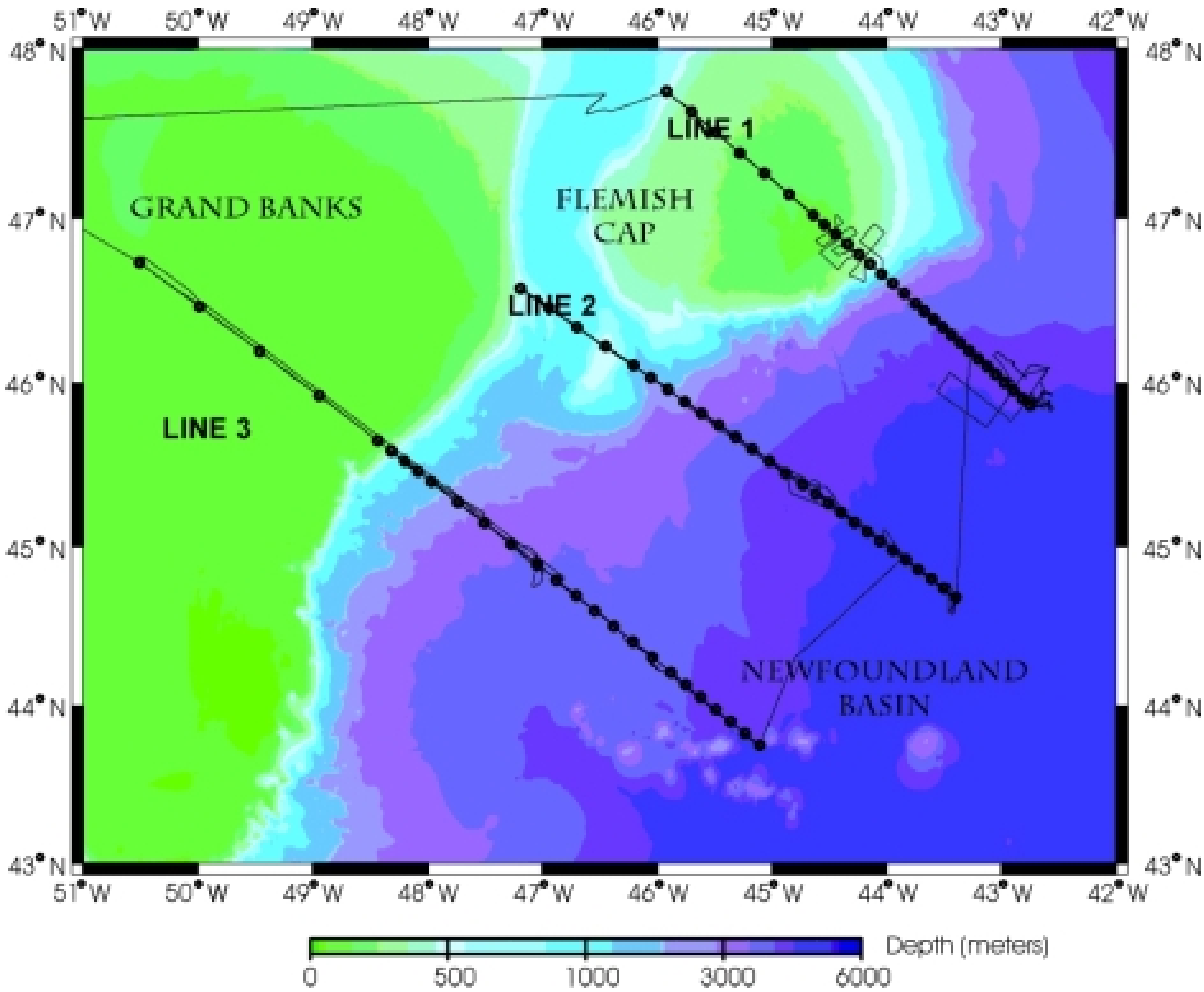


Table of Contents

SCIENTIFIC OBJECTIVES

Deformation and magmatism during continental rifting and eventual breakup are fundamental yet poorly understood processes. To advance our understanding of these processes significantly, we must characterize with unprecedented detail and accuracy the structure and composition of conjugate rifted margins across the full width of the transition from undeformed continental crust to normal oceanic crust. The Newfoundland - Iberia conjugate margins are an excellent natural laboratory for such a study. Their geological characteristics are favorable to address the fundamental scientific questions, logistically the areas are readily accessible, and a large ODP and geophysical database (currently strongly skewed toward the Iberia margin) already exists to focus inquiries on essential scientific questions.

Our field program is on the Newfoundland side of the Newfoundland - Iberia rift, and our results will be integrated with complementary data on the Iberia margin to give an unequaled overview of a complete, mature rift system. The critical characteristics of the Newfoundland margin that need to be understood are tectonic structure, composition, and thickness of crust in four zones: 1) full-thickness, unrifted continental crust beneath the Grand Banks, 2) rifted and thinned crust of known continental origin, generally beneath the continental slope and rise, 3) transitional crust of disputed origin in the deep Newfoundland Basin, and 4) known oceanic crust seaward of the transitional crust. We are studying these zones with state-of-the-art reflection/refraction seismic experiments, using dense arrays of ocean-bottom seismic instruments together with R/V Ewing's large, tuned airgun array and new, 6-km-long hydrophone streamer. Our focus is on three transects that extend from known continental crust on the shelf seaward to known oceanic crust; these transects completely traverse a wide region of thin, transitional crust of enigmatic origin in the deep Newfoundland Basin. Each of these transects is optimally located with respect to detailed geophysical and drilling studies on the conjugate Iberia margin. This maximizes the utility of each Newfoundland transect in terms of interpreting results at existing ODP drill sites on the Iberia margin, improving the siting of proposed Newfoundland-margin drill sites and eventually interpreting their results, and interpreting the development of the full rift. Our Newfoundland transects, combined with existing seismic studies on the Iberia margin, constitute the first complete, densely sampled, wide-angle/vertical-incidence transects across conjugate non-volcanic rifted margins.

Our work will distinguish among competing hypotheses for the origin of crust in the Newfoundland Basin, which propose that the basin may be floored by thin continental crust, slow-spreading (or even normal) oceanic crust, or by a wide zone of serpentinized upper mantle. Specific research goals are to: 1) Characterize the transitional crustal structure of the deep Newfoundland Basin as well as the eastern, unextended edge of the adjacent Grand Banks so as to constrain the origin of the crust in the Newfoundland Basin (continental vs. oceanic) and its tectonic evolution; 2) Determine the position and nature of the boundaries between continental and transitional crust, and between transitional and oceanic crust; 3) Evaluate the amount of igneous material accreted on this "non-volcanic" margin to provide constraints on the volcanic/non-volcanic paradigm for rifted margins; and 4) Compare the crustal structure of the Newfoundland margin directly with that of the conjugate Iberian margin to allow well constrained and systematic evaluation of the mechanisms involved in the rifting process.

Our research is a US-Canadian-Danish cooperative effort that includes the Woods Hole Oceanographic Institution (B.E. Tucholke), the University of Wyoming (W.S. Holbrook), the Danish Lithosphere Centre (H.C. Larsen and J.R.Hopper), Dalhousie University (K. Louden) and Memorial University of Newfoundland (J. Hall and C. Hurich), all of whom bring substantial expertise and resources to the project. Our research will also be coordinated with ongoing studies of the conjugate Iberia margin by researchers including R. Whitmarsh and T. Minshull (Southampton U.), K. Louden (Dalhousie U.), D. Sawyer (Rice U.) and T. Reston (GEOMAR).

OPERATIONAL OBJECTIVES

Our operational plan was to acquire detailed wide-angle OBS/H and vertical incidence MCS seismic data along three main transects across the Newfoundland margin, together with auxiliary MCS data (parallel and crossing lines) along and between transects as geological structure dictated and as time permitted. This was a two-ship program, with R/V Oceanus deploying and recovering the OBS/H, and R/V Ewing shooting to the OBS/H and recording MCS data on its 480-channel, 6-km-long streamer. Wide-angle data were recorded on 29 ocean-bottom instruments: 8 WHOI ORB, 7 WHOI OBH, 8 Geological Survey of Canada -Atlantic Region (GSCA) OBS, and 6 Dalhousie OBS. The 15 WHOI instruments recorded a single-component (hydrophone sensor) while the 14 Canadian OBS recorded 4-components (hydrophone and three orthogonal 4.5 Hz geophone sensors). Shots were fired with R/V Ewing's 20-gun, 8540 cubic inch (131 liter) airgun array.

To minimize transit time and maximize survey time, the transects were surveyed from north to south (Transect 1 to Transect 3).

- Transect 1 extends from the northern margin of Flemish Cap southeast across thick continental crust of the Cap and seaward across thinned continental crust, "transitional" crust of unknown origin, and about 30 km onto known oceanic crust seaward of magnetic anomaly MO.
- Transect 2 extends from continental crust at the western margin of Flemish Pass basin southeast across rifted continental crust, "transitional" crust of unknown origin, and about 60 km onto known oceanic crust seaward of magnetic anomaly MO.
- Transect 3 extends from full thickness continental crust on the central Grand Banks southeast across rift basins and rifted continental crust (Jeanne d'Arc basin, Carson-Bonnition basin), "transitional" crust of unknown origin, and about 30 km onto known oceanic crust seaward of magnetic anomaly MO.

R/V Oceanus deployed the OBS/H instruments along each transect prior to R/V Ewing shooting the transect. Instruments were more closely spaced over thinner crust in deep water (typically 9-12 km) and were more widely spaced (20-50 km) over the thick continental crust of Flemish Cap and the Grand Banks. The OBS line on each transect was shot at 200 meter shot spacing in order to minimize previous-shot noise. After Ewing shot each OBS line, Oceanus retrieved the instruments and moved on to the next transect while Ewing returned along the transect shooting the MCS line at 50 meter shot spacing.

R/V Ewing conducted additional MCS surveys along portions of each transect, in part while waiting for Oceanus to redeploy OBS. These surveys concentrated first on acquiring MCS lines parallel to the main transect, and secondly on obtaining crossing lines. The grid-style survey was most extensive on Transect 2, where ODP drill sites will be proposed. At times when Oceanus was waiting for Ewing, it conducted heat-flow surveys on or near the main transects, or did magnetometer surveys if weather did not permit launching the heat-flow instrumentation.

Primary operational goals for R/V Oceanus are summarized as follows:

- Deploy and recover all available OBS/H along each transect
- Obtain heat flow measurements within transitional crust along each transect during shooting of transect by R/V Ewing
- Obtain magnetometer profiles across M0 anomaly between transects
- Maintain close communications with R/V Ewing to coordinate operations
- Process OBS/H data to Seg-y format using airgun shot times and locations provided by R/V Ewing
- Copy all seismic data to Exabyte tape or CD-ROM for use by participating investigators.

PRELIMINARY CRUISE ASSESSMENT

Although a variety of difficulties were experienced during the cruise, and some data sets may be considered less than perfect, we are optimistic that the data will meet our goals in understanding the crustal structure across the Newfoundland margin, and we judge that our field work has been a notable success. Factors responsible for achieving our goals included: 1) adequate planning to accommodate the vagaries of two-ship operations, and especially inclusion of contingency time to cover unforeseen circumstances, 2) flexibility in survey plans that allowed each of the two ships to accommodate changes or in some cases even to assist one another, 3) generally good weather conditions throughout the cruise, and 4) the highly professional officers and crew of the R/V Oceanus and the supporting scientific technical staff from Woods Hole Oceanographic and Dalhousie University, who did everything possible to help us achieve our goals and ensure a safe cruise.

Notable successes included the following:

- Complete OBS and MCS coverage along all three main transects, plus grid MCS survey and tie lines to address special geological problems of interest and to define ocean drilling objectives.
- High quality of the OBS data. The OBS records were generally of high signal-to-noise and the airgun array produced a strong and clean pulse.
- Processing of most OBS data and combination with shot data to Segy-y format during the cruise.
- Successful use of the new Dalhousie heat flow probe on transects 1 and 3.
- Successful magnetometer profiles across anomaly M0 south of transect 1.

Principal operational difficulties included the following:

- In summary, OBH/S suffered from a higher than normal rate of instrument loss and some additional problems with recovery. These difficulties were exacerbated by the need to maintain coordinated schedules with R/V Ewing. In a total of 82 deployments, we obtained 24 OBS/H records in 29 deployments on Line 1 (plus one additional, poor-quality record); 24 OBS/H records in 27 deployments on Line 2; and 23 OBS/H records in 26 deployments on Line 3 for an overall data recovery rate of 87%.
- Five instruments were lost during recovery (1-WHOI ORB, 1-WHOI OBH, 1-GSCA OBS and 2-DAL OBS) for an overall instrument recovery rate of 94%. Of these, 2 losses of the DAL-GSCA OBS were due to delayed release from the bottom; one WHOI ORB was lost in bad weather and strong currents when it could not be located on the surface; and one DAL OBS and one WHOI OBH were lost when there was no response.
- The Dalhousie and GSC OBS experienced some unpredictable delays in releasing from the bottom. We learned following the cruise that similar difficulties had been encountered during previous deployments of similar OBS within Orphan Basin (north of Flemish Cap). Thus, we believe that this was caused by peculiar characteristics of the bottom sediment within this region. Three OBS with release delays of up to several hours were successfully recovered by returning to the sites following recovery of adjacent instruments. Two OBS (one Dalhousie and one GSCA) with much longer delays (up to ~12 hours) were lost when they had drifted too far away from their deployed position to be located by the time Oceanus could return.
- Four DAL-GSCA OBS had to be retrieved using their backup timed releases. All but one of these occurred for instruments deployed on the continental slope and most likely were due to acoustic interference from near-bottom side echoes. On transect 2, there was an unexpected need to simultaneously recover two OBS on timed release that were far apart. A probable loss of one of these OBS was avoided when R/V Ewing was able to recover one of the OBS during a bad weather break in its operations.
- Four WHOI ORB failed to record. The ORB were often difficult to locate on the surface particularly when they had drifted off site during ascent in strong surface currents or when surface visibility was poor in fog or at night. The need to recover in good daylight conditions sometimes complicated the scheduling of instrument recovery.
- The Dalhousie heat flow pressure case flooded during initial pressure testing. Once the cause of the leak was identified, the instrument worked without fault. However, deployment on deck through the aft A-frame using the modified track system was difficult at best and was restricted to good weather conditions.
- The small size and maneuverability of the R/V Oceanus were particularly well suited to deployment and recovery of the OBS/H. However, some reduction in operations also resulted during marginal weather conditions, and particularly while the R/V Ewing was shooting transect 2. In addition, the need to return for delayed pickup of some OBS due to various difficulties with recovery or to accommodate operations of the R/V Ewing (i.e. need to re-record W-end of transect 1 during MCS shoot), added significantly to the time spent in transit and limited the time available for heat flow and magnetometer measurements.

Preliminary scientific results include:

- OBS record sections with generally high data quality and high signal-to-noise ratio. A number of these sections show evidence for very thin crust within the transition regions.
- Heat flow measurements on oceanic crust at W-end of transect 1 (12 measurements) and in two areas of the transition region on transect 3 (12 plus 8 measurements). These later measurements were the first use of the system with an extended number of thermistors.
- Two crossings of magnetic anomaly M-0 south of transect 1 which show no evidence for a continuous feature.

SCREECH PROJECT INVESTIGATORS

USA

B.E. Tucholke – Woods Hall Oceanographic Institution
W.S. Holbrook – University of Wyoming
H. van Avendonk – University of Wyoming

CANADA

K. Louden – Dalhousie University
T. Funck – Dalhousie University
J. Hall – Memorial University
C. Hurich – Memorial University

DENMARK

J. Hopper – Danish Lithosphere Center
H.C. Larsen – Danish Lithosphere Center

R/V OCEANUS CEW

Anthony D. Mello	Master
Robert S. Bates	Chief Mate
Elizabeth S. McLeod	2nd Mate
Glen R. Loomis	Chief Engineer
Marcel Vieira	Junior Engineer
Mark Williams	Junior Engineer
Jeffrey M. Stolp	Bos'n
Horace Medeiros	A/B
Leonidas Byckovas	A/B
Julia Gidovlenko	O/S
Christopher P. Moody	Steward
Raymond J. Le Valley	M/A

R/V OCEANUS SCIENTIFIC AND TECHNICAL PERSONNEL

Dr. Keith E. Louden, Chief Scientist
Department of Oceanography
Dalhousie University
Halifax, Nova Scotia
Canada B3H 4J1

Dr. Thomas Funck, Shipboard Scientist
Department of Oceanography
Dalhousie University
Halifax, Nova Scotia
Canada B3H 4J1

Mr. Victor H. Bender, Senior research assistant
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 USA

Mr. David L. DuBois, Technician
Dept. Geology & Geophysics
Clark South 272C, MS 24
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 USA

Laura Goeppert, SSSG Technician
c/o R/V Oceanus
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 USA

Mr. Robert E. Handy, Technician
Dept. Geology & Geophysics
Iselin 261, MS 27
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 USA

Mr. Matthew J. Hornbach, Graduate Student
Dept. of Geology and Geophysics
University of Wyoming
P.O. Box 3006
Laramie, WY 82071

Mr. Robert J. Iuliucci, Technician
Department of Oceanography
Dalhousie University
Halifax, Nova Scotia
Canada B3H 4J1

Mr. Walter S. Judge, Technician
Department of Oceanography
Dalhousie University
Halifax, Nova Scotia
Canada B3H 4J

Mr. Kenneth R. Peal, Electronics Engineer
Dept. Applied Ocean Physics and Engineering, MS 10
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 USA

Mr. Llewellyn Pearce, Undergraduate Student
Dept. of Earth Sciences
Dalhousie University
Halifax, Nova Scotia
Canada B3H 4J1

Mr. James R. Ryder, Technician
Dept. Applied Ocean Physics and Engineering
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 USA

CRUISE NARRATIVE

July 14-15 (DN 196-197): Transit to Line 1

Leave St. John's harbor at 1430Z on July 14 (DN196). Port call was very short to have all equipment ready in time. Remarkably clear skies and calm conditions. Steam toward site for test of OBH releases in Flemish Pass. Test proceeded to 1000 m without difficulty. One release failed to communicate and will not be used. Two seismic vessels working close by in Flemish Pass are Veritas Viking II and Geco Triton. Bridge established VHF communication with them but did not discuss their shooting schedule as we will leave this to be coordinated by R/V EWING. Large current to south.

July 15-17 (DN 197-199): Line 1 Deployments (Figs. 1 and 6)

Continued to deployment of OBS at sites 1-29. Weather continues mild and clear. No difficulties but working very hard to have all OBS ready with such short time to prepare. We use mostly OBH in shallow water of Flemish Cap due to concerns about instrument loss on previous cruise possibly due to premature release. Thus we can watch all instruments descend to bottom without taking as long a time as for deeper deployments. We do watch OBH-26 to bottom in deeper water without incident.

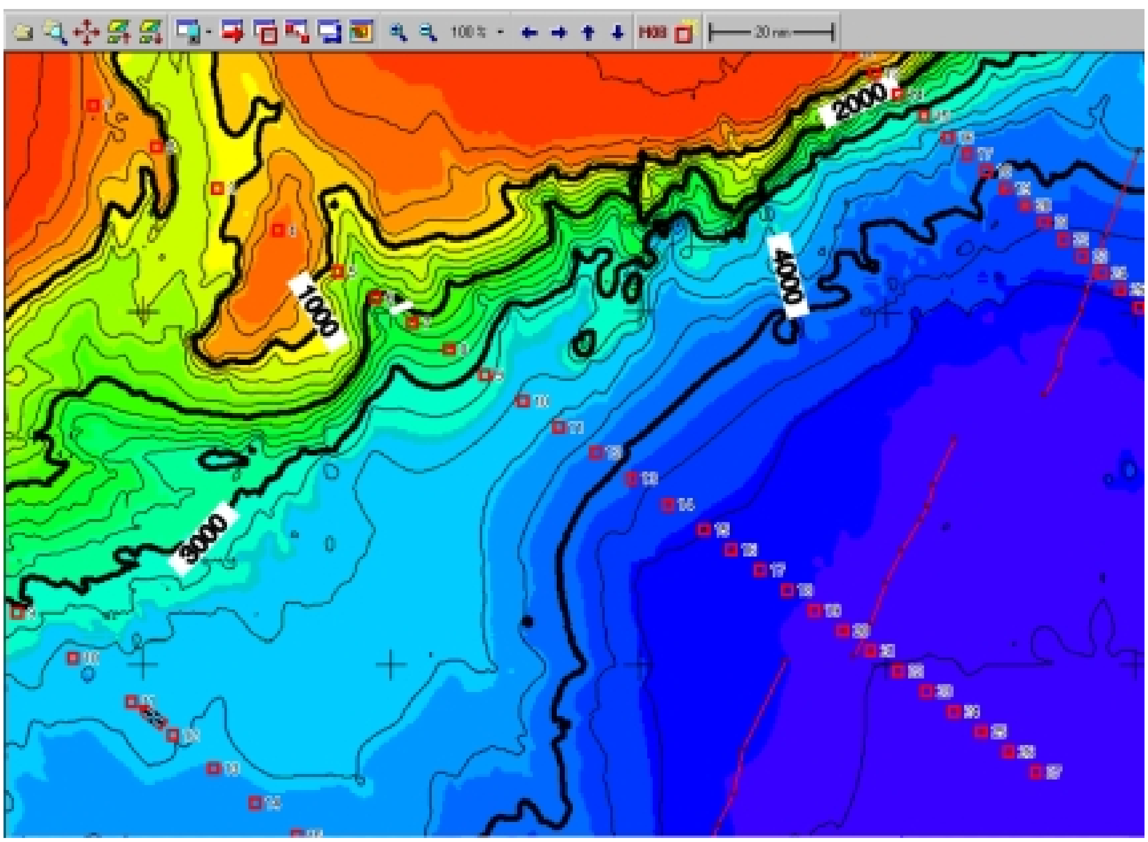


Figure 1. OBS Deployments Line 1

July 17-19 (DN 199-201): Heat Flow I and Magnetometer Survey (Fig. 2)
Following OBS/H/ORB deployments we hove to overnight July17 to rest and prepare for heat flow. We pressure test the two new heat flow systems to 4000m but in each case the same o-ring seal of the 4-pin communication connector (Impulse) failed due to improper machining of the o-ring surface on the end-cap. Fortunately we have a spare connector along from a different unit that has the same thread but larger o-ring surface. This works on similar test the following day (July 18). During the previous overnight on July 18 we conduct a magnetometer survey south of Line 1 with two lines across the proposed M0 anomaly. We find, however, that this is not a continuous feature.

Once pressure test is successful, we conduct heat flow measurements overnight on July 18-19 in very soft sediment as observed on 3.5 kHz sounder. The winch system and meter and tension readout, including the computer display of tension that the ship's ET produced for us, was one of the best systems to aid in measurements that I have seen. A northerly set creates larger wire angles and need to let more wire out during penetrations but generally measurements are good. We solved our previous difficulty with timing system for heat pulse when we discovered that the vertical seismometer used for this purpose was installed upside-down. This greatly reduced its sensitivity. When properly installed the system produced only two stations without heat pulse. This may be due to over sensivity which we can adjust.

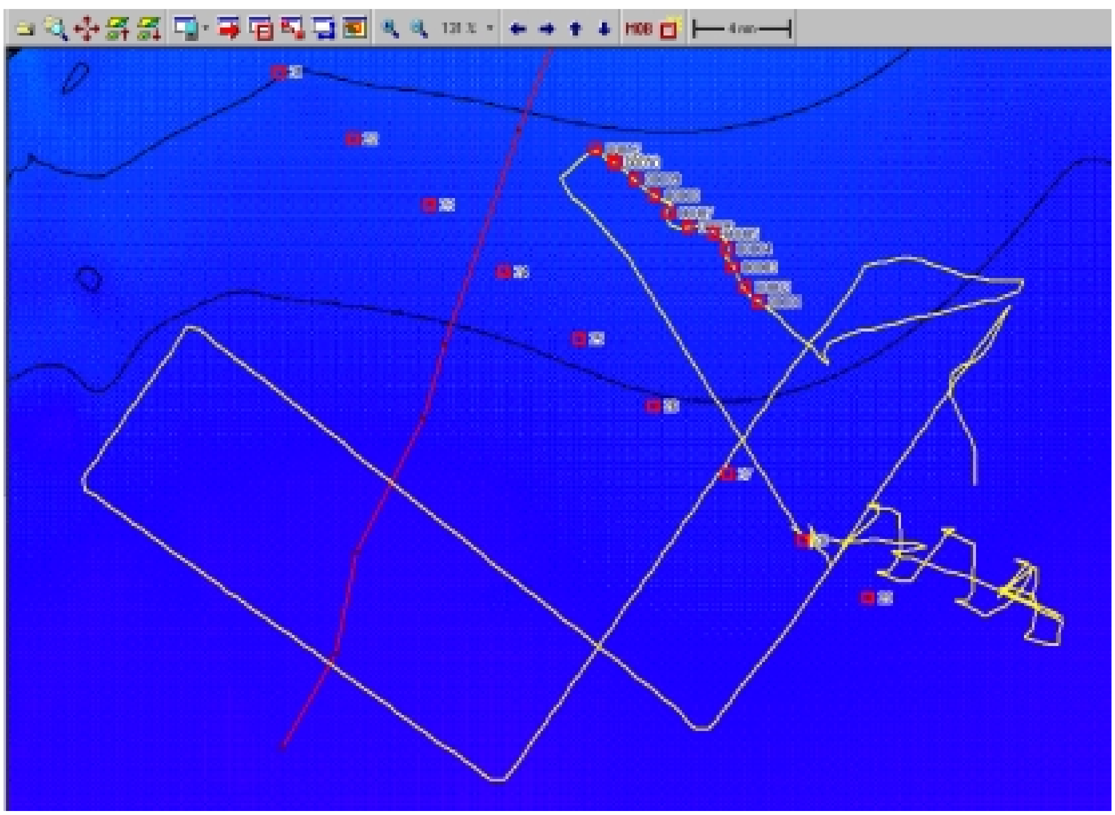


Figure 2. Heat Flow Site 1, Mag Survey 1 and search for ORB-5 at L1-28

July 19-24 (DN 201-206): Line 1 OBS Recovery

Instruments initially were recovered from SE to NW along line 1. It was decided to leave ORB-1 (L1-27) and ORB-6 (L1-29) so they could record the return MCS shots from EWING due to its initial diversion in shooting around the OBS caused by fishing gear. Recovery of ORB-5 (L1-28) was not successful and the ORB was lost in poor visibility and poor transponder communication on the surface. We conducted a fairly extensive search overnight based on expectation of drift but without success (Fig. 2). Because of this problem, additional ORBs at positions L1-22,23,24 were also left in hopes of better conditions in later recovery. It is clear that conditions must be optimal for good recovery of the ORBs in daylight. Visibility of the flashing light is also poor for night recovery but will be improved for future lines. On 20-JUL recovery of remaining OBS continued with various difficulties. GSCA-4 (L1-21) had a long time (2-3.5 hrs) before lifting off bottom. Due to close positioning of instruments, its pinger signal blocked acoustic response from the adjacent instrument GSCA-1 (L1-19), so this instrument could only be retrieved after GSCA-4. This is clearly a problem with the Vemco release system when using instruments in close proximity if one starts pinging but does not release. On 21-JUL, DAL-A (L1-13) did not respond to its release command. We initially thought that this was due to complications from side echos on the slope since the adjacent unit DAL-E (L1-14) took over ten tries to release. GSCA-7 (L1-9) had no liftoff after 4 hrs on site. Recovery of remaining instruments in shallow water on Flemish Cap went without incident, but on 23-JUL there was no sign of GSCA-7 upon return. We believed that it must have come up and there were some faint returns, which we initially thought were coming from its radio beacon. We conducted a detailed search for it during wait for backup release of DAL-A but again there was no contact (Fig. 3). Nearby Russian fishing vessels were communicating on the same frequency as the OBS beacon, so we later thought this caused our original signal that we thought was from the OBS. DAL-A was successfully recovered on its backup timed release. On 24-JUL we returned to recover all remaining ORBs at the SE end of the line on a fine day with perfect conditions. At 2100Z on July 24, after over 4 days of recovering OBS we finally departed for the SE end of Line 2.

July 25-26 (DN 207-208): Line 2 Deployments (Figs. 4 and 7)

Deployment of the remaining 27 OBS went smoothly. The ORBs were deployed primarily at the NW end of the line to allow time for programming of those instruments that had been retrieved at the end of Line 1, and to have more of them located in shallower water so their drift during ascent would be less. GSCA-4 (L2-3) which had a slow release was placed toward the NW-end of the line in case it again gave the same result.

July 27 (DN 209): Transit Line 2

Continuing winds (15-20 kts) and mixed seas make heat flow and magnetic surveys impossible. We continue at slow speed (4-6 kts) toward L2-27.

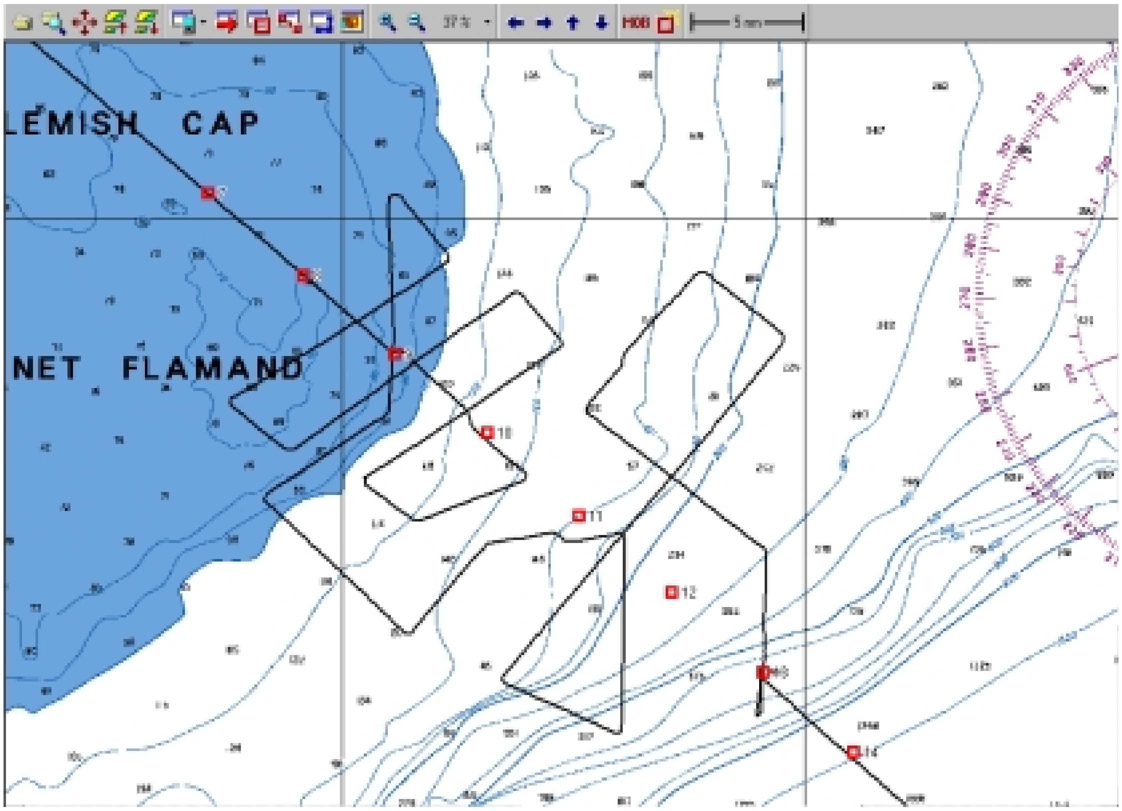


Figure 3. Survey for OBS GSCA-7 at L1-9 and recovery of OBS DAL-A at L1-13

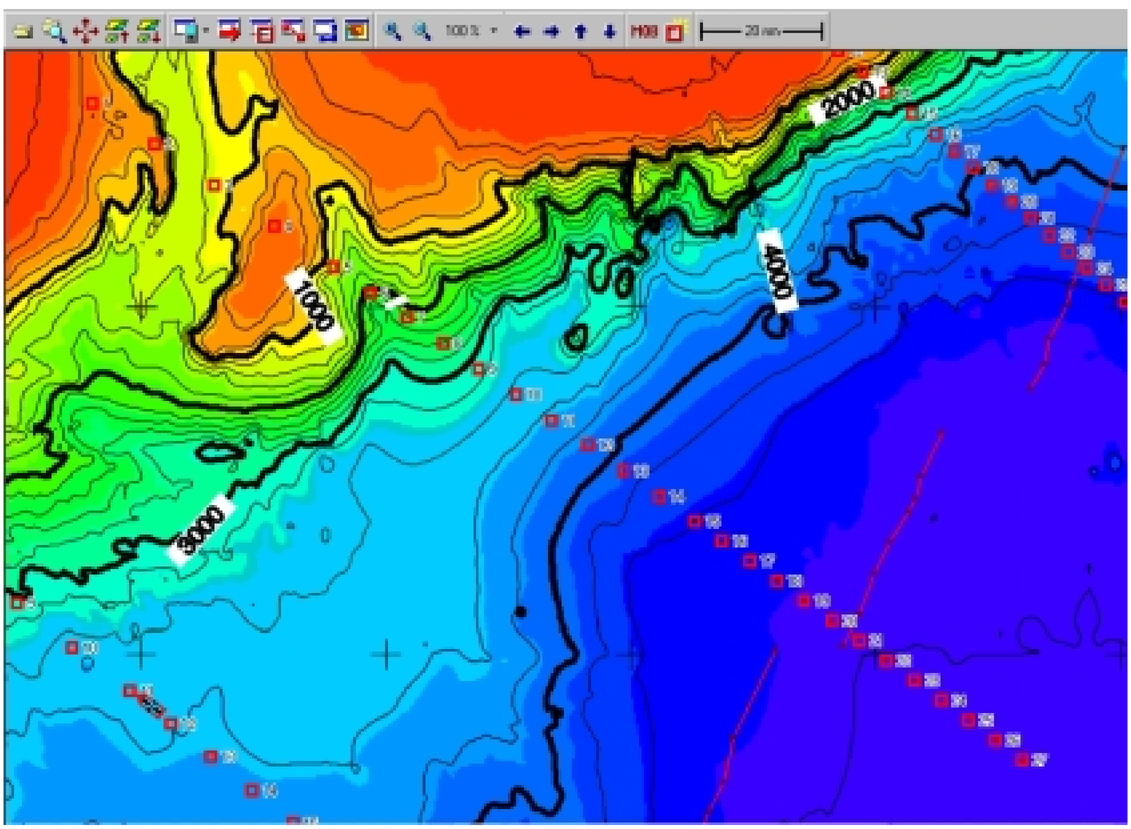


Figure 4. OBS Deployments Line 2

July 28-Aug 2 (DN 210-215): Line 2 OBS Recovery

Recovery of the 27 OBS/H started at position L2-27 at 1000 on 28-JUL. There was no response from the instrument (DAL-A) and it was left for later recovery by backup timed release. This same instrument did not respond to acoustic command on line 1 and it was thought that a fault might exist with its acoustic electronics as this was a new unit and had not been used before. The following three instruments (DAL-B at L2-26; DAL-C at L2-25; and OBH-27 at L2-24) were recovered without difficulty. ORB-7 (L2-23) was left for later recovery due to poor visibility and we proceeded to recover OBH-20 (L2-22). The next instrument on the line, DAL-D (L2-19) did not respond to the acoustic command and was left for its timed release. On 29-JUL, DAL-E (L2-20) was recovered normally. DAL-F (L2-19) responded to the acoustic signal but did not release from the bottom. After waiting for 2 hours, we proceeded to recover OBH-19 (L2-18), ORB-1 (L2-17) and OBH-16 (L2-16). During these recoveries we returned to check twice on DAL-F but it still had not released as of 1330. We proceeded to release GSCA-1 (L2-15) but it again remained on bottom. We recovered GSCA-2 (L2-14) normally and returned to recover GSCA-1, which had released from bottom in the meantime. On 30-JUL, we continued with recovery of instruments from L2-13 to L2-9, all of which proceeded normally. GSCA-6 (L2-8) did not respond to acoustic release. ORB-9 (L2-7, GSCA-8 (L2-6) and ORB-6 (L2-5) were recovered normally. We then proceeded to the NW-end of the line to recover ORB-8 (L2-1) and ORB-3 (L2-2) during daylight. On 31-JUL we proceeded with recovery of GSCA-4 (L2-3) and ORB-2 (L2-4). We then returned back down the line to the SE for recovery of the remaining instruments. We stopped at GSCA-6 (L2-8) and tried acoustic commands from various angles but without success. On 1-AUG 0050 passing by DAL-F (L2-19) no pinger was observed, so it apparently released sometime in the intervening 58 hours. However, there seemed little hope in searching for it after such a potentially long time adrift on the surface. We opted to proceed to DAL-A (L2-27) for its secondary release, but no pinger was observed. On 2-AUG, we successfully recovered GSCA-6 (L2-21), which had surfaced in the meantime on its backup timed release. We finally ended the recovery operation after nearly 5 days with retrieval of ORB-7 (L2-23) at daybreak. In the meantime R/V Ewing, during a bad weather break in its shooting operations, successfully recovered GSCA-6 (L2-8) on its secondary at the other end of the line. We thus ended up loosing two instruments on line 2: DAL-A (L2-27; no communication) and DAL-F (L2-19; late release and drift off site before we could return). Two additional instruments, DAL-D (L2-21) and GSCA-6 (L2-8) did not respond to acoustic command and were recovered on their timed release. One other instrument, GSCA-1 (L2-15), had a late release but was successfully recovered. So the losses could have been worse.

Aug 2-4 (DN 215-217): Line 3 Deployments (Figs. 5 and 8)

We deployed 24 instruments along line 3, beginning at 1836 on 2-AUG with OBH-26 (L3-24) and ending at 14:09 on 4-AUG with DAL-C (L3-1). The DAL and GSCA OBS were placed primarily in shallow water on the shelf because of the various difficulties with their recovery in deep water on the previous lines. In order to avoid returning back down this very long line for backup timed releases of DAL or GSCA OBS, we planned recovery in two groups, with a break in-between for heat flow measurements and with staggered backup release times set accordingly.

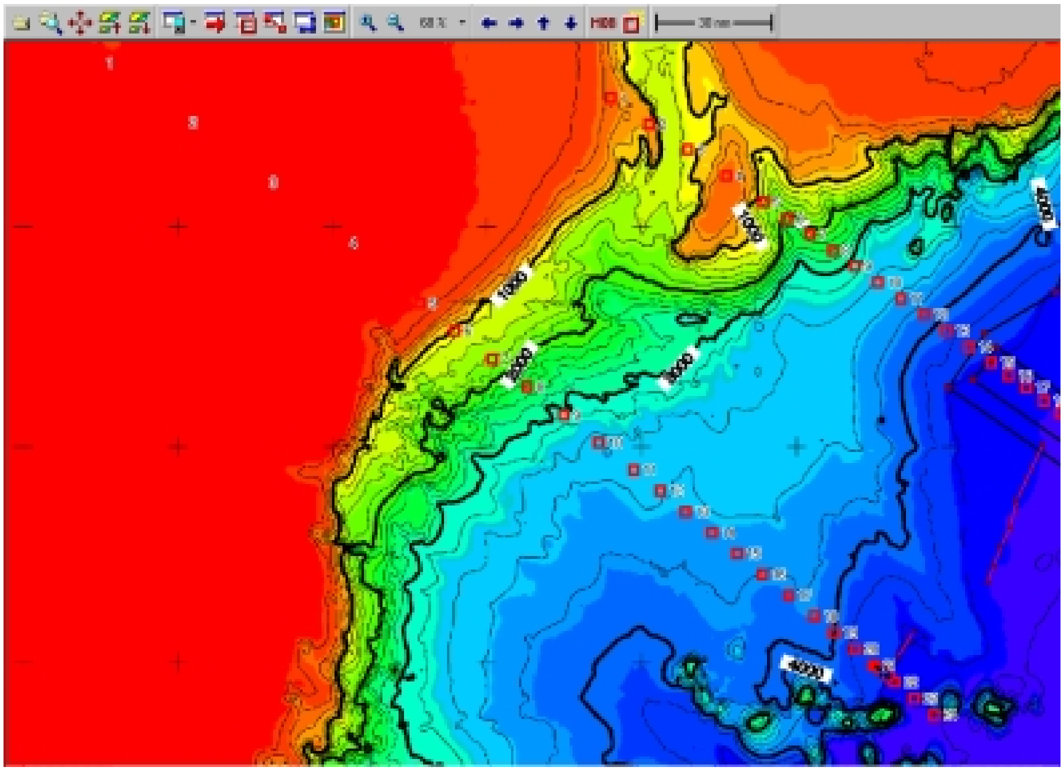


Figure 5. OBS Deployments Line 3

Aug 5-6 (DN 218-219): Heat Flow II

On 5-AUG during transit down the line toward the SE, we passed the R/V Ewing as they were shooting line 3OBS. At about 1200 they launched the OBS (GSCA-6) that they had recovered on line and we recovered it easily. Beginning at about 1800, we began heat flow measurements at site HF-S2 in a region of soft sediment between OBS sites L3-17 toL3-19. A 4-m probe with 32-sensors was used. This was the first use of a marine heat flow probe with such a large number of sensors. Only 24 sensors could be recorded by the probe, because of a malfunction of one of the four 8-sensor multiplexers within the top of the sensor string. Twelve stations were taken until increased winds and seas required the end of operations. On 6-AUG at 1830 following recovery of the probe, we proceeded to the first part of the line 3 OBS recovery.

Aug 7-8 (DN 220-221): Line 3 OBS Recovery Pt 1 and OBS Re-deploy

Recovery of instruments began with OBH-26 (L3-24) on 7-AUG at 0000. No response was received from the instrument and after repeated attempts to communicate with it, we abandoned recovery. Recovery of the other instruments from L3-23 to L3-12 went without incident. However, ORB-8 (L3-21) and ORB-2 (L3-20) had no data recorded because of low battery voltage. Because of the potential loss of data at other ORB sites, we decided to deploy two additional instruments (GSCA-5 and OBH-20) on the slope between sites L3-5 and L3-6. This was accomplished by 2100 on 8-AUG.

Aug 9-10 (DN 222-223): Heat Flow III

Eight heat flow measurements using the 32-sensor 4-m thermistor string were made along Line 3 between OBS sites L3-11 and L3-12. The probe was deployed at 1500 on 9-AUG and retrieved at 0400 on 10-AUG after it became difficult to maintain station in a strong surface current.

Aug 10-11 (DN 223-224): Line 3 OBS Recovery Pt 2

Remaining OBS/H at sites L3-11 to L3-1 and the two additional sites (L3-25/26) ended with complete success. All instruments were successfully recovered. The only difficulty was with DAL-B (L3-9), which did not respond to acoustic command and was recovered later on its timed backup release. Recovery of ORB-7 (L3-6) was very difficult in extremely poor visibility and strong surface current along the edge of the shelf. All instruments successfully recorded, including all the ORBs.

We arrived in the approaches to St. John's harbor at approximately 1000 on 12-AUG.

OCEANUS CRUISE OC359-2
14 JULY - 12 AUGUST
SCIENTIFIC DIARY

DATE (DN)	TIME (UTC)	ACTIVITY	LATITUDE (N)		LONGITUDE (W)		DEPTH (m)
14-JUL(196)	14:30	Leave St. John's harbor	47	33.88	52	42.27	
		Remarkably clear skies and calm conditions					
15-JUL(197)	13:30-17:30	Test of OBH releases in Flemish Pass	47	44	46	27.5	1190
		Test proceeded to 1000 m without difficulty.					
		One release failed to communicate and will not be used					
		Established VHF communication with two seismic vessels working close by:					
		Veritas Viking II and Geco Triton.					
		Weather continues mild and clear. Strong current to south in Flemish Pass.					
		Line 1: Deployment of OBS at sites 1-29					
		see section on OBS Deployment and Recovery for details					
	23:14	L1-1: DAL-B	47	44.99	45	54.93	513
16-JUL(198)	0:35	L1-2: DAL-C	47	37.71	45	42.04	300
	1:53	L1-3: DAL-D	47	30.42	45	29.23	274
	3:14	L1-4: OBH-27	47	23.08	45	16.72	222
	4:55	L1-5: OBH-20	47	15.85	45	3.79	183
	6:19	L1-6: OBH-19	47	8.41	44	51.08	158
	7:45	L1-7: GSCA-2	47	1.06	44	38.52	140
	8:28	L1-8: GSCA-6	46	57.45	44	32.43	133
	9:15	L1-9: GSCA-7	46	53.97	44	26.45	163
	10:02	L1-10: OBH-16	46	50.43	44	20.50	152
	10:50	L1-11: OBH-25	46	46.76	44	14.52	284
	11:33	L1-12: OBH-23	46	43.34	44	8.54	498
	12:16	L1-13: DAL-A	46	39.74	44	2.64	1357
	13:15	L1-14: DAL-E	46	36.22	43	56.75	2613
	14:13	L1-15: DAL-F	46	32.66	43	50.82	3228
	14:57	L1-16:OBH-26	46	29.06	43	44.92	3784
	16:15	L1-17: ORB-7	46	26.25	43	40.30	3937
	16:57	L1-18: ORB-2	46	23.37	43	35.52	4020
	18:06	L1-18: GSCA-1	46	20.52	43	30.75	4109
	18:43	L1-20: GSCA-3	46	17.61	43	26.18	4201
16-JUL(198)	19:41	L1-21: GSCA-4	46	14.82	43	21.54	4289
	20:16	L1-22: ORB-3	46	11.87	43	16.90	4388

OCEANUS CRUISE OC359-2
14 JULY - 12 AUGUST
SCIENTIFIC DIARY

DATE (DN)	TIME (UTC)	ACTIVITY	LATITUDE (N)		LONGITUDE (W)		DEPTH (m)
	21:03	L1-23: ORB-8	46	9.06	43	12.23	4484
	21:45	L1-24: ORB-9	46	6.12	43	7.58	4550
	22:38	L1-25: GSCA-5	46	3.27	43	2.93	4615
	23:13	L1-26: GSCA-8	46	0.34	42	58.36	4637
	23:46	L1-27: ORB-1	45	57.50	42	53.63	4634
17-JUL(199)	0:24	L1-28: ORB-5	45	54.63	42	49.09	4657
	1:02	L1-29: ORB-6	45	52.06	42	45.01	4658
	1:30-12:00	Hove-to overnight					
	12:00-22:00	Pressure tests of Heat Flow System to 4000 m depth	45	57.00	42	38.50	4600
		Same connector fails in each of the two instruments due to faulty machining of O-ring seal					
		Deployment and retrieval of system over aft A-frame proves difficult,					
		various small modifications made in rail system and heat flow stand for improvements					
18-JUL(200)	0:20	Start magnetometer survey of proposed M0 boundary overnight	46	4.80	42	36.30	
		recording of 3.5 kHz profile on paper and as sgy file					
	13:00	Finish magnetometer survey	46	6.40	42	45.30	
	13:00-1700	Another pressure test of heat flow probe to 4000m using new connector	46	7.00	42	43.00	
		Success this time! Retrieval somewhat better as well					
		Heat Flow Measurements at Site HF-S1 using Dalhousie HF2 probe 4-m length					
		see Appendix 3: Heat Flow Surveys for details					
		Simultaneous measurements of STD using Seabird19					
		Very soft upper sed layer from 3.5 kHz record					
	22:49	Station HF-S1-1	46	4.90	42	51.89	4606
19-JUL(201)	0:24	Station HF-S1-2	46	5.57	42	52.73	4595
	1:45	Station HF-S1-3	46	6.37	42	53.53	4569
	3:10	Station HF-S1-4	46	7.20	42	53.90	4566
	4:34	Station HF-S1-5	46	7.85	42	54.69	4560
19-JUL(201)	5:59	Station HF-S1-6	46	8.15	42	56.24	4544
	7:18	Station HF-S1-7	46	8.76	42	57.45	4520
	8:43	Station HF-S1-8	46	9.47	42	58.31	4495
	9:55	Station HF-S1-9	46	10.16	42	59.59	4455

OCEANUS CRUISE OC359-2
14 JULY - 12 AUGUST
SCIENTIFIC DIARY

DATE (DN)	TIME (UTC)	ACTIVITY	LATITUDE (N)		LONGITUDE (W)		DEPTH (m)
	11:13	Station HF-S1-10	46	10.90	43	0.80	4448
	11:34	Station HF-S1-11	46	10.95	43	0.87	4448
	12:59	Station HF-S1-12	46	11.50	43	2.02	4420
		Retrieval of Heat Flow Probe. All is well with system.					
		Recovery of OBS/OBH/ORB: Line 1					
		see section on OBS Deployment and Recovery for details					
		Decided to leave L1-29 and L1-27 for return shoot of Ewing due to missing					
		first pass to avoid fishing line					
	18:00	L1-28: ORB-5 released but lost on surface in fog and strong easterly current					
	18:00	Start grid search for OBS but no success.					
20-JUL(202)	13:30	L1-26: GSCA-8					
	16:45	L1-25: GSCA-5					
	23:35	L1-19: GSCA-1. Released out-of-sequence due to problems with L1-21&20					
21-JUL(203)	0:50	L1-21: GSCA-4. Very long burn (2-3.5 hrs) probably due to use of newer burn wire					
	3:10	L1-20: GSCA-3. Initially did not respond to acoustic signal because of					
		pinger signal from L1-21					
	7:49	L1-18: ORB-2					
	10:48	L1-17: ORB-7					
	12:42	L1-16: OBH-26					
	15:00	L1-15: DAL-F					
	17:25	L1-14: DAL-E					
	SOB	L1-13: DAL-A. Did not respond to acoustic signal.					
	20:54	L1-12: OBH-23					
	21:54	L1-11: OBH-25					
22-JUL(204)	0:12	L1-10: OBH-16: after waited approx. 1 hr. for Ewing to shoot over site					
	1:09	L1-9: GSCA-7: Pinging but no release. Leave site at 05:10					
	6:50	L1-8: GSCA-6					
	8:30	L1-7: GSCA-2					
	9:30	L1-9: GSCA-7: Check again. Pinging but no release					
	12:02	L1-6: OBH-19					

OCEANUS CRUISE OC359-2
14 JULY - 12 AUGUST
SCIENTIFIC DIARY

DATE (DN)	TIME (UTC)	ACTIVITY	LATITUDE (N)		LONGITUDE (W)		DEPTH (m)
	13:54	L1-5: OBH-20					
	15:28	L1-4: OBH-27					
	17:19	L1-3: DAL-D					
	19:01	L1-2: DAL-C					
	20:50	L1-1: DAL-B					
23-JUL(205)	4:15	L1-9: GSCA-7: No pinger suggested OBS had released during absence.					
	4:15-20:00	Grid search for OBS around L1-9 while waiting for backup release of L1-13					
		No sign of OBS					
	21:00	L1-13: DAL-A.Retry. Successful recovery with secondary release.					
24-JUL(206)	8:59	L1-29: ORB-6					
	12:14	L1-27: ORB-1					
	15:45	L1-24: ORB-9					
	18:20	L1-23: ORB-8					
	20:54	L1-22: ORB-3					
	21:00	Depart for Line 2					
25-JUL(207)		**Line 2: OBS Deployment at Sites 27-1**					
		see section on OBS Deployment and Recovery for details					
	8:17	L2-27: DAL-A	44	40.91	43	23.84	4750
	9:00	L2-26: DAL-B	44	44.34	43	30.19	4745
	9:45	L2-25: DAL-C	44	47.90	43	36.79	4742
	10:32	L2-24: OBH-27	44	51.40	43	43.53	4753
	11:17	L2-23: ORB-7	44	54.91	43	50.03	4738
	12:17	L2-22: OBH-20	44	58.46	43	56.82	4732
	13:00	L2-21: DAL-D	45	1.87	44	3.48	4710
25-JUL(207)	13:44	L2-20: DAL-E	45	5.37	44	10.11	4685
	14:33	L2-19: DAL-F	45	8.87	44	16.91	4525
	15:25	L2-18: OBH-19	45	12.50	44	23.73	4590
	16:15	L2-17: ORB-1	45	15.91	44	30.39	4562
	17:08	L2-16: OBH-16	45	19.41	44	37.19	4539
	18:22	L2-15: GSCA-1	45	22.87	44	43.91	4538
	19:27	L2-14: GSCA-2	45	27.03	44	52.69	4423
	20:29	L2-13: GSCA-3	45	31.55	45	1.41	4242

OCEANUS CRUISE OC359-2
14 JULY - 12 AUGUST
SCIENTIFIC DIARY

DATE (DN)	TIME (UTC)	ACTIVITY	LATITUDE (N)		LONGITUDE (W)		DEPTH (m)
	21:32	L2-12: OBH-25	45	35.93	45	10.18	4002
	22:27	L2-11: OBH-23	45	40.34	45	19.05	3774
	23:33	L2-10: OBH-26	45	44.67	45	27.79	3538
26-JUL(208)	0:27	L2-9: GSCA-5	45	49.02	45	36.70	3432
	1:30	L2-8: GSCA-6	45	53.37	45	45.49	3178
	4:36	L2-7: ORB-9	45	57.77	45	54.38	2371
	3:15	L2-6: GSCA-8	46	2.07	46	3.32	2148
	6:24	L2-5: ORB-6	46	6.49	46	12.15	1580
	8:02	L2-4: ORB-2	46	13.49	46	26.96	455
	9:35	L2-3: GSCA-4	46	20.52	46	41.75	1152
	11:14	L2-2: ORB-3	46	27.52	46	56.59	720
	12:42	L2-1: ORB-8	46	34.53	47	11.43	502
	13:00	Start back down to SE end of Line 2					
		winds 20-25 kts and seas 10 ft cancel heat flow survey 2					
	21:10	Begin 3.5 kHz profile starting at L2-8	45	53.4	45	44.6	
27-JUL(209)		Continuing winds 15-20 and mixed seas					
		Mag survey not possible because of reduced speed and ship motion in swell					
		continuing at slow speed toward L2-27					
28-JUL(210)		**Recovery of OBS/OBH/ORB: Line 2**					
		see section on OBS Deployment and Recovery for details					
	10:00	L2-27: DAL-A: no response to release same as Line 1. Leave for secondary					
	12:25	L2-26: DAL-B					
28-JUL(210)	14:49	L2-25: DAL-C					
	17:50	L2-24: OBH-27					
		L2-23: ORB-7: leave for later due to reduced visibility because of weather					
	21:05	L2-22: OBH-20					
	22:10	L2-21: DAL-D: no response to release wait for backup					
29-JUL(211)	1:17	L2-20: DAL-E					
	2:07	L2-19: DAL-F: pinging but SOB checked again twice at 0615 and 1330Z					
	5:15	L2-18: OBH-19					
	9:13	L2-17: ORB-1					
	11:27	L2-16: OBH-16					

OCEANUS CRUISE OC359-2
14 JULY - 12 AUGUST
SCIENTIFIC DIARY

DATE (DN)	TIME (UTC)	ACTIVITY	LATITUDE (N)		LONGITUDE (W)		DEPTH (m)
	16:13	L2-15: GSCA-1: pinging but no release					
	19:48	L2-14: GSCA-2					
	20:50	L2-15: GSCA-1: return to recover					
30-JUL(212)	0:10	L2-13: GSCA-3					
	2:38	L2-12: OBH-25					
	5:06	L2-11: OBH-23					
	7:31	L2-10: OBH-26					
	9:48	L2-9: GSCA-5					
	10:42	L2-8: GSCA-6: no response to release					
	13:32	L2-7: ORB-9					
	15:15	L2-6: GSCA-8					
	17:21	L2-5: ORB-6					
	22:28	L2-1: ORB-8					
31-JUL(213)	0:08	L2-2: ORB-3					
	1:53	L2-3: GSCA-4					
	4:02	L2-4: ORB-2					
	8:00	L2-8: GSCA-6: no response again with numerous attempts					
1-AUG(214)	0:50	L2-19: DAL-F: no pinger observed					
	15:00	L2-27: DAL-A: no response to secondary					
	18:00	L2-8: GSCA-6: released on secondary and picked up by EWING					
2-AUG(215)	1:05	L2-21: DAL-D: released on secondary					
	8:54	L2-23: ORB-7					
	9:30	Leave Line 2 and transit to Line 3					
		Line 3: OBS Deployment at Sites 24-1					
		see section on OBS Deployment and Recovery for details					
	18:36	L3-24: OBH-26	43	45.12	45	6.54	4670
	19:35	L3-23: OBH-23	43	49.59	45	14.04	4620
	20:41	L3-22: OBH-25	43	54.18	45	21.73	4566
	21:43	L3-21: ORB-8	43	58.81	45	29.44	4447

OCEANUS CRUISE OC359-2
14 JULY - 12 AUGUST
SCIENTIFIC DIARY

DATE (DN)	TIME (UTC)	ACTIVITY	LATITUDE (N)		LONGITUDE (W)		DEPTH (m)
	22:38	L3-20: ORB-2	44	3.42	45	37.16	4328
	23:37	L3-19: GSCA-3	44	8.06	45	44.90	4094
3-AUG(216)	0:40	L3-18: GSCA-4	44	12.65	45	52.69	3945
	2:00	L3-17: GSCA-5	44	18.43	46	2.57	3970
	6:02	L3-16: OBH-16	44	24.27	46	12.53	3915
	7:17	L3-15: OBH-19	44	30.08	46	22.43	3814
	8:39	L3-14: OBH-20	44	35.85	46	32.49	3845
	10:06	L3-13: ORB-1	44	41.59	46	42.45	3827
	11:33	L3-12: ORB-3	44	47.32	46	52.53	3665
	13:00	L3-11: GSCA-8	44	53.08	47	2.70	3638
	15:00	L3-10: GSCA-1	45	0.82	47	16.31	3568
	17:11	L3-9: DAL-B	45	8.59	47	30.11	3117
	19:15	L3-8: OBH-27	45	16.26	47	43.97	2500
	20:59	L3-7: ORB-9	45	23.86	47	57.87	1694
	23:17	L3-6: ORB-7	45	31.47	48	11.86	1173
4-AUG(217)	0:47	L3-5: ORB-6	45	39.06	48	25.86	127
	4:47	L3-4: DAL-D	45	55.54	48	56.57	72
	8:17	L3-3: GSCA-2	46	11.75	49	27.57	71
	11:12	L3-2: DAL-E	46	27.92	49	58.94	75
	14:09	L3-1: DAL-C	46	43.94	50	30.54	107
5-AUG(218)		**Transit to Heat Flow Site 2**					
	12:00	Recover OBS from R/V Ewing					
		Heat Flow Measurements at Site HF-S2 using Dalhousie HF2 probe 4-m length					
		First use of 32-sensor string with external multiplexer					
		see Appendix 3: Heat Flow Surveys for details					
		Simultaneous measurements of STD using Seabird19					
		Region of soft upper sed layer from 3.5 kHz record between OBS Sites L3-17 to 19					
	20:44	Station HF-S2-1	44	17.35	46	1.39	3937
	21:00	Station HF-S2-2	44	17.26	46	1.54	3937
6-AUG(219)	1:31	Station HF-S2-3	44	16.57	46	3.14	3955
	2:54	Station HF-S2-4	44	15.61	46	2.50	3951
	4:27	Station HF-S2-5	44	15.10	46	1.46	3948

OCEANUS CRUISE OC359-2
14 JULY - 12 AUGUST
SCIENTIFIC DIARY

DATE (DN)	TIME (UTC)	ACTIVITY	LATITUDE (N)		LONGITUDE (W)		DEPTH (m)
	6:36	Station HF-S2-6	44	14.56	45	59.94	3942
	8:43	Station HF-S2-7	44	13.50	45	58.69	3946
	10:37	Station HF-S2-8	44	12.90	45	56.59	3941
	12:29	Station HF-S2-9	44	11.84	45	54.51	3945
	13:54	Station HF-S2-10	44	11.33	45	52.37	3952
	15:23	Station HF-S2-11	44	10.76	45	50.95	3967
	16:56	Station HF-S2-12	44	10.21	45	49.63	3983
	18:30	Retrieve Heat flow early due to increased winds and seas					
		Transit to OBS pickup					
		Recovery of OBS/OBH/ORB: Line 3 Pt 1					
		see section on OBS Deployment and Recovery for details					
7-AUG(220)	0:00	L3-24: OBH-26: No communication.					
	5:26	L3-23: OBH-23					
	6:40	L3-24: OBH-26: Return. Still no communication.					
	10:21	L3-22: OBH-25					
	13:18	L3-21: ORB-8					
	15:42	L3-20: ORB-2					
	18:16	L3-19: GSCA-3					
	20:40	L3-18: GSCA-4					
	23:37	L3-17: GSCA-5					
8-AUG(221)	2:08	L3-16: OBH-16					
	4:41	L3-15: OBH-19					
	7:09	L3-14: OBH-20					
	9:39	L3-13: ORB-1					
	12:04	L3-12: ORB-3					
		Redeploy 2 OBS: Line 3					
		Decide to deploy two additional OBS between ORBs at sites L3-5 and 6					
		due to potential malfunction of ORBs					
	19:19	L3-25: GSCA-5	45	27.66	48	4.80	1459
	20:52	L3-26: OBH-20	45	35.32	48	18.80	417
	21:00	**Transit to heat flow site 3**					
		Delay in heat flow until following day due to poor weather					
9-AUG(222)		**Heat Flow Measurements at Site HF-S3 using Dalhousie HF2 probe 4-m length**					

OCEANUS CRUISE OC359-2
14 JULY - 12 AUGUST
SCIENTIFIC DIARY

DATE (DN)	TIME (UTC)	ACTIVITY	LATITUDE (N)		LONGITUDE (W)		DEPTH (m)
		2nd use of 32-sensor string with external multiplexer					
		see Appendix 3: Heat Flow Surveys for details					
		Simultaneous measurements of STD using Seabird19					
		Region of soft upper sed layer from 3.5 kHz record between OBS Sites L3-11 to 12					
	15:00	Deploy heat flow probe					
	19:46	Station HF-S3-1	44	51.54	47	0.08	3648
	21:12	Station HF-S3-2	44	50.44	46	59.96	3647
	22:37	Station HF-S3-3	44	49.39	47	0.26	3655
	23:02	Station HF-S3-4	44	49.40	47	0.35	3655
10-AUG(223)	0:04	Station HF-S3-5	44	48.18	47	0.33	3665
	0:34	Station HF-S3-6	44	47.77	47	0.39	3666
	1:49	Station HF-S3-7	44	46.48	47	0.98	3682
	2:14	Station HF-S3-8	44	46.34	47	1.22	3687
		Difficult to keep station due to strong current					
	4:00	Retrieve heat flow					
		Recovery of OBS/OBH/ORB: Line 3 Pt 2					
		see section on OBS Deployment and Recovery for details					
	7:58	L3-11: GSCA-8					
	11:39	L3-10: GSCA-1					
	13:15	L3-9: DAL-B: No communication					
	17:35	L3-8: OBH-27					
	19:38	L3-7: ORB-9					
	22:05	L3-9: DAL-B: Return for secondary					
11-AUG(224)	3:09	L3-25: OBH-20					
	5:05	L3-6: ORB-7					
	6:50	L3-26: GSCA-5					
	8:55	L3-5: ORB-6					
	12:03	L3-4: DAL-D					
	14:39	L3-3: GSCA-2					
	17:30	L3-2: DAL-E					
	20:21	L3-1: DAL-C					
		Transit to St. John's					
12-AUG(225)	10:00	Arrive St. John's harbour					

R/V EWING SHOT LOCATIONS

Locations of R/V Ewing shot points on Lines 1-OBS, Line 2-OBS and Line 3-OBS are shown in figures 6-8, respectively. Data recorded by the OBS/H from these shots were processed to segy files as indicated in Appendices 1 and 2. Shot locations for Ewing MCS Lines are given in Figure 9.

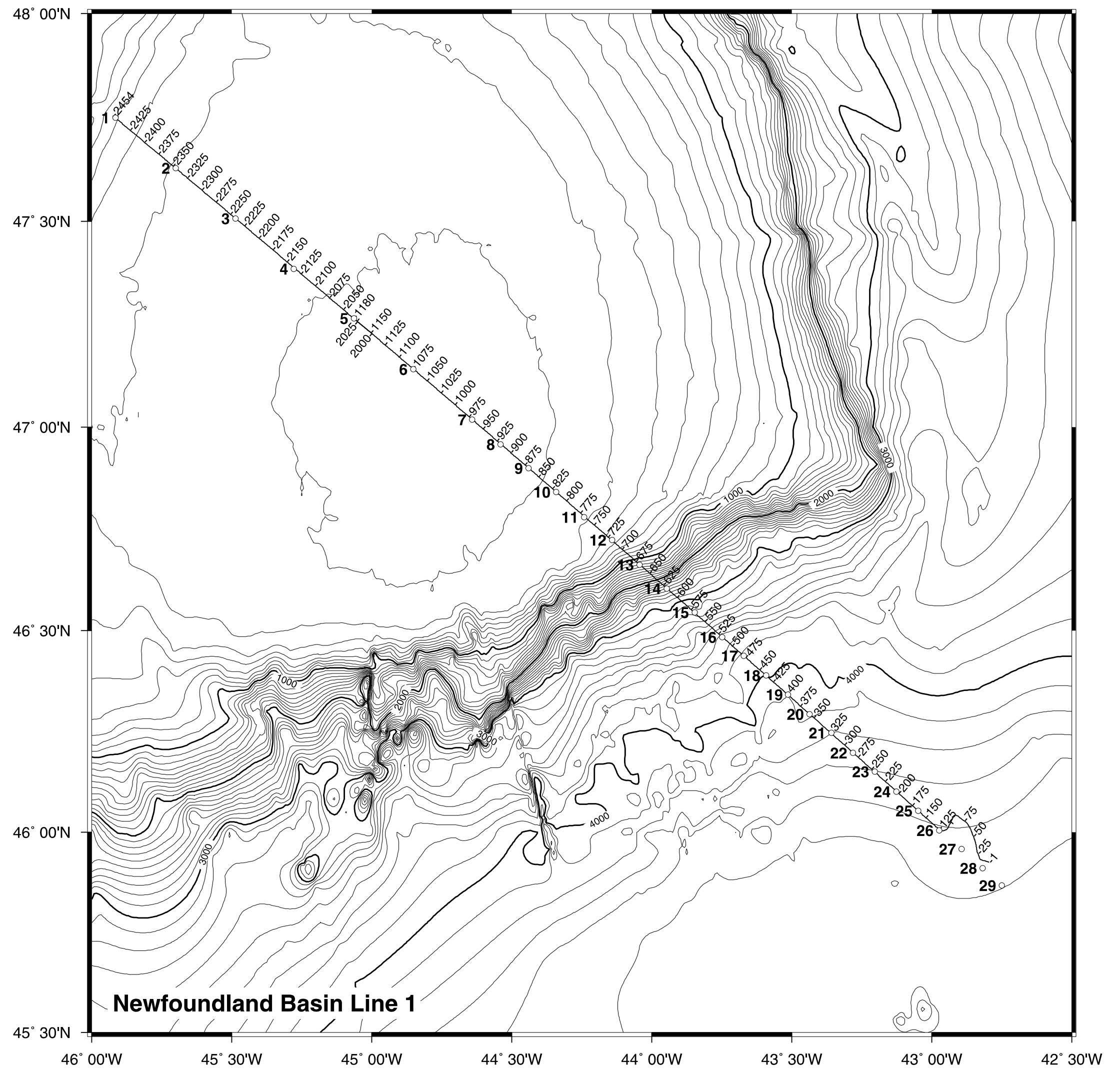


Figure 6. Locations of R/V Ewing shot points on Line 1-OBS

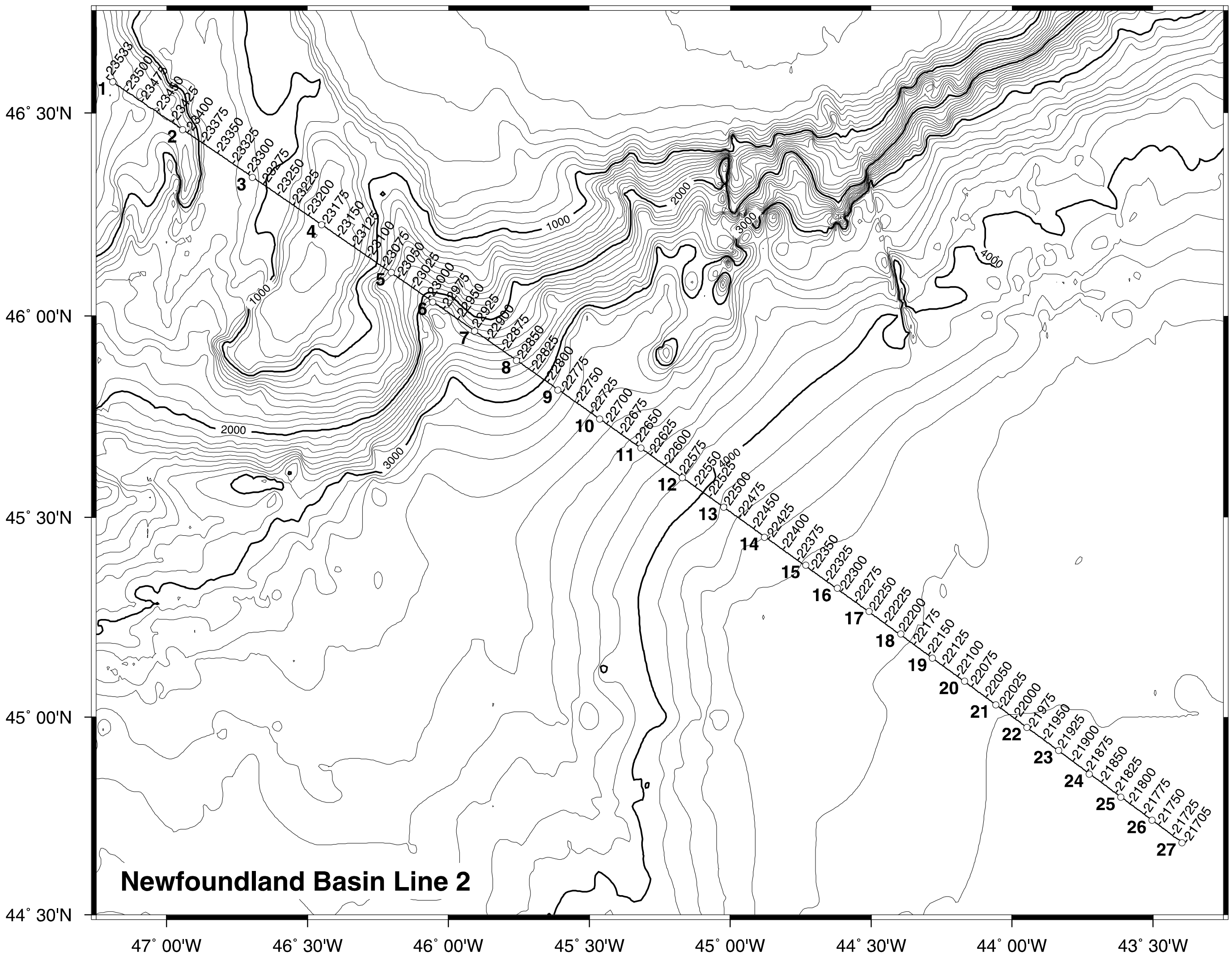


Figure 7. Locations of R/V Ewing shot points on LIne2-OBS

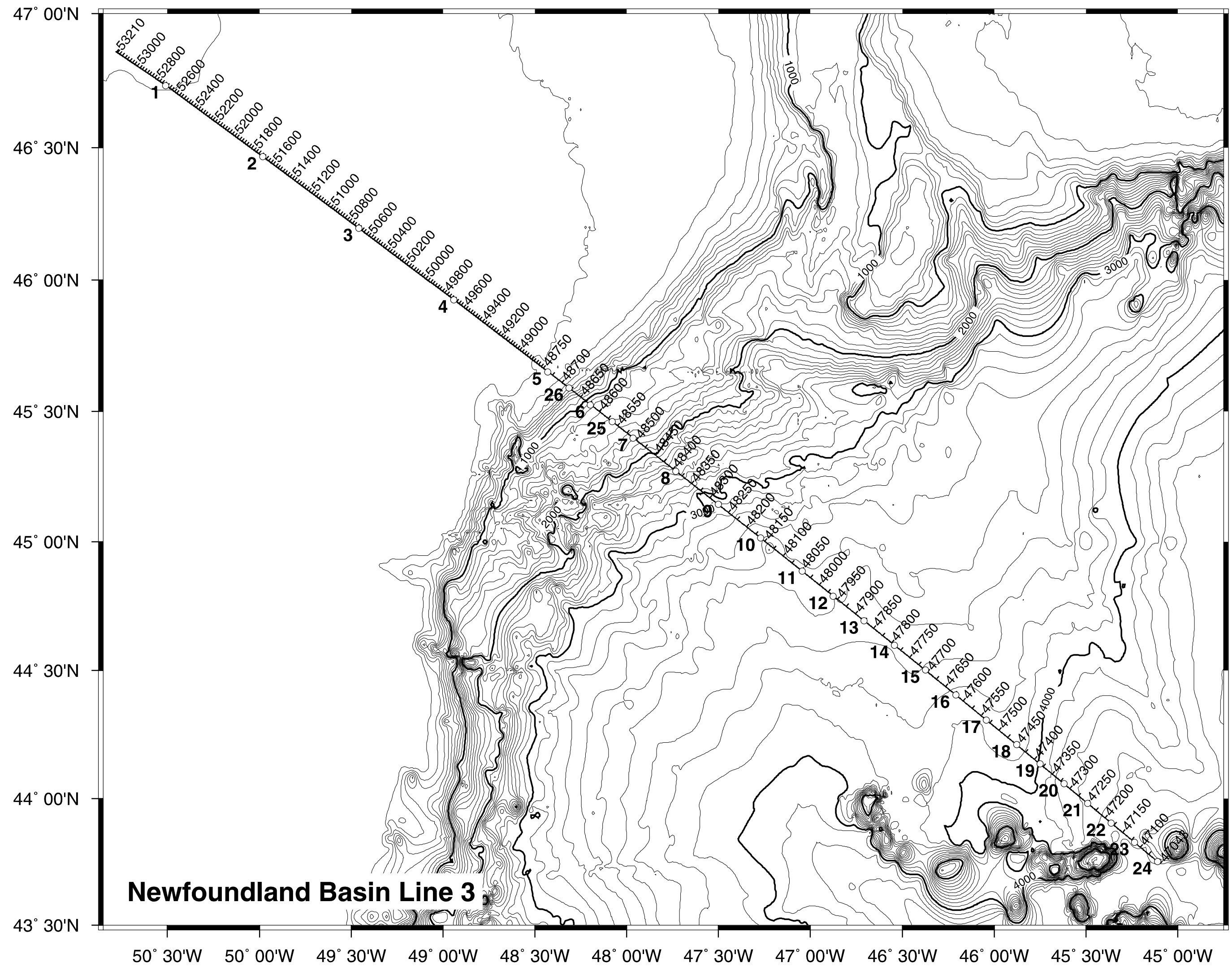


Figure 8. Locations of R/V Ewing shot points on Lines 3_OBS

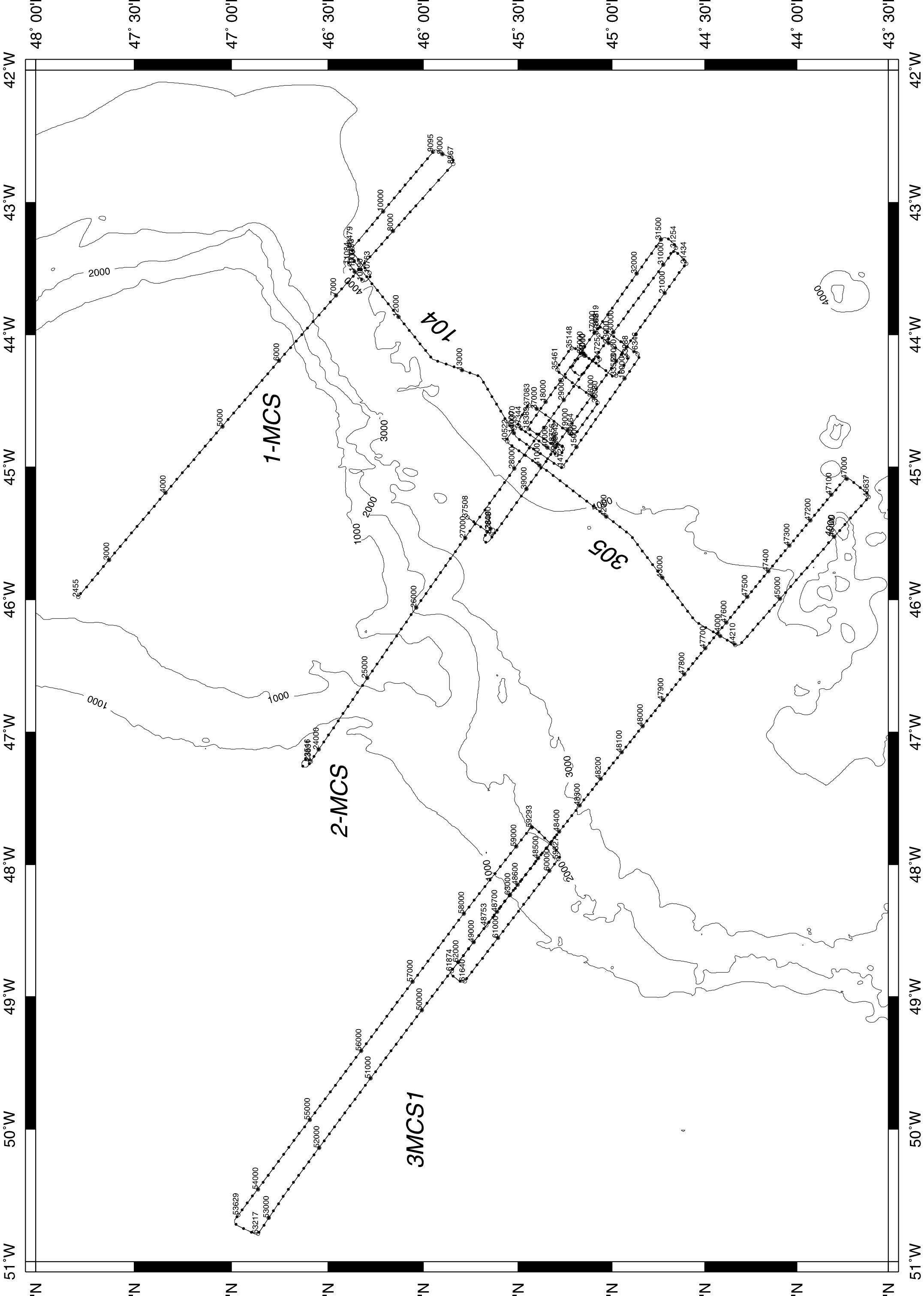


Figure 9. Shot locations for R/V Ewing MCS Lines

OBS DEPLOYMENT AND RECOVERY SUMMARY

<u>OBS DEPLOYMENT LINE 1</u>

Notes: All OBS start recording at 1700Z on July 17

WPT	Lat deg	N min	Long deg	W min	Depth m	Distance nm	OBS	Beacon	Time Deployed UTC
1	47	44.99	45	54.93	513	0.0	DAL-B	B	7/15/00 23:14
2	47	37.71	45	42.04	300	11.3	DAL-C	B	7/16/00 0:35
3	47	30.42	45	29.23	274	22.7	DAL-D	77	7/16/00 1:53
4	47	23.08	45	16.72	222	34.0	OBH-27	B	7/16/00 3:14
5	47	15.85	45	3.79	183	45.3	OBH-20	D	7/16/00 4:55
6	47	8.41	44	51.08	158	56.7	OBH-19	B	7/16/00 6:19
7	47	1.06	44	38.52	140	68.0	GSCA-2	82	7/16/00 7:45
8	46	57.45	44	32.43	133	73.4	GSCA-6	69	7/16/00 8:28
9	46	53.94	44	26.45	163	78.8	GSCA-7	69	7/16/00 9:15
10	46	50.43	44	20.50	152	84.2	OBH-16	D	7/16/00 10:02
11	46	46.76	44	14.52	284	89.6	OBH-25	C	7/16/00 10:50
12	46	43.34	44	8.54	498	95.0	OBH-23	C	7/16/00 11:33
13	46	39.74	44	2.64	1357	100.4	DAL-A	A	7/16/00 12:16
14	46	36.22	43	56.75	2613	105.8	DAL-E	A	7/16/00 13:15
15	46	32.66	43	50.82	3228	111.2	DAL-F	B	7/16/00 14:13
16	46	29.06	43	44.92	3784	116.6	OBH-26	D	7/16/00 14:57
17	46	26.25	43	40.30	3937	120.9	ORB-7		7/16/00 16:15
18	46	23.37	43	35.52	4020	125.2	ORB-2		7/16/00 16:57
19	46	20.52	43	30.75	4109	129.5	GSCA-1	82	7/16/00 18:06
20	46	17.61	43	26.18	4201	133.8	GSCA-3	82	7/16/00 18:43
21	46	14.82	43	21.54	4289	138.2	GSCA-4	71	7/16/00 19:41
22	46	11.87	43	16.90	4388	142.5	ORB-3	22	7/16/00 20:16
23	46	9.06	43	12.23	4484	146.8	ORB-8	23	7/16/00 21:03
24	46	6.12	43	7.58	4550	151.1	ORB-9	24	7/16/00 21:45
25	46	3.27	43	2.93	4615	155.4	GSCA-5	71	7/16/00 22:38
26	46	0.34	42	58.36	4637	159.7	GSCA-8	68	7/16/00 23:13
27	45	57.50	42	53.63	4634	164.1	ORB-1	27	7/16/00 23:46
28	45	54.63	42	49.09	4657	168.4	ORB-5		7/17/00 0:24
29	45	52.06	42	45.01	4658	172.2	ORB-6	29	7/17/00 1:02

OBS RECOVERY LINE 1

WPT	Lat deg	N min	Long deg	W min	Depth m	OBS	Beacon	Retrieval UTC	Notes	Drift nm/deg
28	45	54.63	42	49.09	4657	ORB-5			Adrift At Sea!, Grid search but no contact	
26	46	0.87	42	54.53	4637	GSCA-8	68	7/20/00 13:30		2.9 @ 83
25	46	3.90	43	0.93	4615	GSCA-5	71	7/20/00 16:45		1.6 @ 74
19	46	20.58	43	31.11	4109	GSCA-1	82	7/20/00 23:35		0.3 @ 300
21	46	15.60	43	21.61	4289	GSCA-4	71	7/21/00 0:50	Long release	1.0 @ 000
20	46	17.93	43	26.14	4201	GSCA-3	82	7/21/00 3:10		0.3 @ 018
18	46	22.82	43	36.04	4020	ORB-2		7/21/00 7:49		0.6 @ 200
17	46	25.84	43	41.65	3937	ORB-7		7/21/00 10:48		1.0 @ 250
16	46	28.80	43	45.80	3784	OBH-26	D	7/21/00 12:42		0.7 @ 240
15	46	32.71	43	51.29	3228	DAL-F	B	7/21/00 15:00		0.3 @ 100
14	46	36.01	43	56.96	2613	DAL-E	A	7/21/00 17:25		0.25 @ 025
13	46	39.74	44	2.64	1357	DAL-A	A	SOB	No response	
12	46	43.30	44	8.61	498	OBH-23	C	7/21/00 20:54		
11	46	46.74	44	14.49	284	OBH-25	C	7/21/00 21:54		
10	46	50.15	44	20.54	152	OBH-16	D	7/22/00 0:12	Waited for Ewing to Shoot by	
8	46	57.37	44	32.20	133	GSCA-6	69	7/22/00 6:50		
7	47	0.96	44	38.26	140	GSCA-2	82	7/22/00 8:30		
9	46	53.97	44	26.45	163	GSCA-7	69		Pinging but no release	
6	47	8.43	44	51.16	158	OBH-19	B	7/22/00 12:02		
5	47	15.80	45	3.88	183	OBH-20	D	7/22/00 13:54		
4	47	23.06	45	16.72	222	OBH-27	B	7/22/00 15:28		
3	47	30.48	45	29.08	274	DAL-D	77	7/22/00 17:19		
2	47	37.78	45	41.80	300	DAL-C	B	7/22/00 19:01		
1	47	44.94	45	54.90	513	DAL-B	B	7/22/00 20:50		
9	46	53.97	44	26.45	163	GSCA-7	69	Adrift At Sea!	Return. no pinger Grid search, no contact	
13	46	39.67	44	2.84	1357	DAL-A	A	7/23/00 21:45	Backup release	
29	45	50.88	42	38.71	4658	ORB-6	29	7/24/00 8:59		
27	45	56.88	42	51.62	4634	ORB-1	27	7/24/00 12:14		
24	46	6.17	43	6.55	4550	ORB-9	24	7/24/00 15:45		
23	46	9.17	43	11.57	4484	ORB-8	23	7/24/00 18:20		
22	46	12.16	43	16.85	4388	ORB-3	22	7/24/00 20:54		

OBS DEPLOYMENT LINE 2

Notes: All OBS start recording on 26/7 at 15:00Z

WPT	Lat deg	N min	Long deg	W min	Depth m	Distance nm	OBS	Beacon Freq MHz	Time deployed UTC
27	44	40.908	43	23.837	4750	195.8	DAL-A	154.585	7/25/00 8:17
26	44	44.336	43	30.189	4745	189.9	DAL-B	159.480	7/25/00 9:00
25	44	47.904	43	36.792	4742	184.0	DAL-C	159.480	7/25/00 9:45
24	44	51.399	43	43.530	4753	178.1	OBH-27	159.480	7/25/00 10:32
23	44	54.911	43	50.034	4738	172.3	ORB-7		7/25/00 11:17
22	44	58.464	43	56.819	4732	166.4	OBH-20	160.785	7/25/00 12:17
21	45	1.871	44	3.481	4710	160.5	DAL-D	156.875	7/25/00 13:00
20	45	5.372	44	10.107	4685	154.6	DAL-E	154.585	7/25/00 13:44
19	45	8.867	44	16.911	4525	148.7	DAL-F	159.480	7/25/00 14:33
18	45	12.501	44	23.727	4590	142.8	OBH-19	159.480	7/25/00 15:25
17	45	15.912	44	30.394	4562	137.0	ORB-1		7/25/00 16:15
16	45	19.412	44	37.192	4539	131.1	OBH-16	160.785	7/25/00 17:08
15	45	22.865	44	43.914	4538	125.2	GSCA-1	157.125	7/25/00 18:22
14	45	27.031	44	52.687	4423	117.6	GSCA-2	157.125	7/25/00 19:27
13	45	31.549	45	1.408	4242	110.1	GSCA-3	157.125	7/25/00 20:29
12	45	35.928	45	10.177	4002	102.5	OBH-25	160.725	7/25/00 21:32
11	45	40.338	45	19.053	3774	95.0	OBH-23	160.725	7/25/00 22:27
10	45	44.670	45	27.787	3538	87.4	OBH-26	160.725	7/25/00 23:33
9	45	49.018	45	36.695	3432	79.9	GSCA-5	156.575	7/26/00 0:27
8	45	53.374	45	45.492	3178	72.3	GSCA-6	156.475	7/26/00 1:30
7	45	57.769	45	54.376	2371	64.8	ORB-9		7/26/00 4:36
6	46	2.071	46	3.315	2148	57.2	GSCA-8	156.425	7/26/00 3:15
5	46	6.488	46	12.150	1580	49.6	ORB-6		7/26/00 6:24
4	46	13.491	46	26.962	455	37.2	ORB-2		7/26/00 8:02
3	46	20.518	46	41.748	1152	24.8	GSCA-4	156.575	7/26/00 9:35
2	46	27.520	46	56.590	720	12.4	ORB-3		7/26/00 11:14
1	46	34.525	47	11.427	502	0.0	ORB-8		7/26/00 12:42

OBS RECOVERY LINE 2

WPT	Lat deg	N min	Long deg	W min	Depth m	OBS	Beacon Freq MHz	Retrieval UTC	Notes	drift nm/deg
27	44	40.908	43	23.837	4750	DAL-A	154.585	7/28/00 10:10	No response wait for backup	
26	44	45.136	43	32.417	4745	DAL-B	159.480	7/28/00 12:25		2.0@300
25	44	48.786	43	38.831	4742	DAL-C	159.480	7/28/00 14:49		1.5@305
24	44	52.358	43	45.360	4753	OBH-27	159.480	7/28/00 17:50		1.6@310
23	44	54.911	43	50.034	4738	ORB-7		Leave for later due to weather		
22	44	59.231	43	57.868	4732	OBH-20	160.785	7/28/00 21:05		1.2@330
21	45	1.871	44	3.481	4710	DAL-D	156.875	7/28/00 22:10	No response wait for backup	
20	45	6.043	44	10.474	4685	DAL-E	154.585	7/29/00 1:17		1.1@338
19	45	8.867	44	16.911	4642	DAL-F	159.480	7/29/00 3:00	Pinging but SOB	
									Checked again twice at 0615 and 1330Z	
18	45	13.280	44	23.626	4590	OBH-19	159.480	7/29/00 5:15		1.0@000
17	45	16.928	44	29.973	4562	ORB-1		7/29/00 9:13		1.2@014
16	45	20.246	44	36.785	4539	OBH-16	160.785	7/29/00 11:27		
15	45	25.345	44	43.555	4538	GSCA-1	157.125	7/29/00 20:50	Slow release	2.7@006
14	45	27.509	44	53.110	4423	GSCA-2	157.125	7/29/00 19:48		0.5@322
13	45	31.762	45	1.336	4242	GSCA-3	157.125	7/30/00 0:10		0.25@012
12	45	36.050	45	10.568	4002	OBH-25	160.725	7/30/00 2:38		0.3@114
11	45	40.446	45	19.447	3774	OBH-23	160.725	7/30/00 5:06		0.3@111
10	45	44.535	45	28.369	3538	OBH-26	160.725	7/30/00 7:31		0.4@072
9	45	48.800	45	37.072	3432	GSCA-5	156.575	7/30/00 9:48		0.4@230
8	45	53.374	45	45.492	3178	GSCA-6	156.475	7/30/00 10:42	No response	
7	45	57.786	45	54.414	2371	ORB-9		7/30/00 13:32		
6	46	2.016	46	3.288	2148	GSCA-8	156.425	7/30/00 15:15		
5	46	6.207	46	12.313	1580	ORB-6		7/30/00 17:21		
4	46	13.844	46	27.143	455	ORB-2		7/31/00 4:02		
3	46	20.577	46	41.655	1152	GSCA-4	156.575	7/31/00 1:53		
2	46	27.246	46	56.669	720	ORB-3		7/31/00 0:08		
1	46	34.333	47	11.481	502	ORB-8		7/30/00 22:28		
8	45	53.374	45	45.492	3178	GSCA-6	156.475	7/31/00 8:00	No response at various angles	
19	45	8.867	44	16.911	4642	DAL-F	159.480	8/1/00 0:50	No pinger on sounder	
27	44	40.908	43	23.837	4750	DAL-A	154.585	8/1/00 15:00	Wait for secondary but no response	
21	45	6.090	44	1.320	4710	DAL-D	156.875	8/2/00 1:05	Secondary	4.5@020
8	45	53.374	45	45.492	3178	GSCA-6	156.475	8/1/00 18:00	Secondary pickup by EWING	
23	44	55.620	43	51.210	4738	ORB-7		8/2/00 8:54		

OBS DEPLOYMENT LINE 3

WPT	Lat deg	N min	Long deg	W min	Depth m	Distance nm	OBS	Beacon Freq MHz	Time Deployed UTC
24	43	45.12	45	6.54	4670	0.0	OBH-26	160.725	8/2/00 18:36
23	43	49.59	45	14.04	4620	7.1	OBH-23	160.725	8/2/00 19:35
22	43	54.18	45	21.73	4566	14.3	OBH-25	160.725	8/2/00 20:41
21	43	58.81	45	29.44	4447	21.5	ORB-8		8/2/00 21:43
20	44	3.42	45	37.16	4328	28.8	ORB-2		8/2/00 22:38
19	44	8.06	45	44.90	4094	36.0	GSCA-3	157.125	8/2/00 23:37
18	44	12.65	45	52.69	3945	43.2	GSCA-4	156.575	8/3/00 0:40
17	44	18.43	46	2.57	3970	52.4	GSCA-5	156.575	8/3/00 2:00
16	44	24.27	46	12.53	3915	61.6	OBH-16	160.785	8/3/00 6:02
15	44	30.08	46	22.43	3814	70.8	OBH-19	159.480	8/3/00 7:17
14	44	35.85	46	32.49	3845	79.9	OBH-20	160.785	8/3/00 8:39
13	44	41.59	46	42.45	3827	89.1	ORB-1		8/3/00 10:06
12	44	47.32	46	52.53	3665	98.3	ORB-3		8/3/00 11:33
11	44	53.08	47	2.70	3638	107.4	GSCA-8	156.425	8/3/00 13:00
10	45	0.82	47	16.31	3568	119.9	GSCA-1	157.125	8/3/00 15:00
9	45	8.59	47	30.11	3117	132.3	DAL-B	159.480	8/3/00 17:11
8	45	16.26	47	43.97	2500	144.7	OBH-27	159.480	8/3/00 19:15
7	45	23.86	47	57.87	1694	157.1	ORB-9		8/3/00 20:59
6	45	31.47	48	11.86	1173	169.5	ORB-7		8/3/00 23:17
5	45	39.06	48	25.86	127	181.9	ORB-6		8/4/00 0:47
4	45	55.54	48	56.57	72	208.9	DAL-D	156.875	8/4/00 4:47
3	46	11.75	49	27.57	71	235.9	GSCA-2	157.125	8/4/00 8:17
2	46	27.92	49	58.94	75	262.9	DAL-E	154.585	8/4/00 11:12
1	46	43.94	50	30.54	107	289.9	DAL-C	159.480	8/4/00 14:09
25	45	27.66	48	4.80	1459	163.6	GSCA-5	156.575	8/8/00 19:19
26	45	35.32	48	18.80	417	176.1	OBH-20	160.785	8/8/00 20:52

OBS RECOVERY LINE 3

WPT	Lat deg	N min	Long deg	W min	Depth m	Distance nm	OBS	Beacon Freq MHz	Est. Retrieval UTC(DN)	Backup Release Time (JD) (UTC)	Act. Retrieval UTC	Notes	Drift nm/deg
24	43	45.12	45	6.54	4670	0.0	OBH-26	160.725	8/7/00 4:00	SOB		No communication	
23	43	49.16	45	15.15	4620	7.1	OBH-23	160.725	8/7/00 7:26		8/7/00 5:26		
22	43	53.86	45	22.46	4566	14.3	OBH-25	160.725	8/7/00 10:52		8/7/00 10:21		
21	43	58.36	45	30.46	4447	21.5	ORB-8		8/7/00 14:16		8/7/00 13:18	no data	
20	44	3.21	45	37.90	4328	28.8	ORB-2		8/7/00 17:38		8/7/00 15:42	no data	
19	44	8.06	45	44.90	4094	36.0	GSCA-3	157.125	8/7/00 20:55	06:00 (DN=221)	8/7/00 18:16		0.4@285
18	44	12.84	45	52.94	3945	43.2	GSCA-4	156.575	8/8/00 0:10	06:00 (DN=221)	8/7/00 20:40		0.3@320
17	44	18.84	46	2.57	3970	52.4	GSCA-5	156.575	8/8/00 3:39	06:00 (DN=221)	8/7/00 23:37		0.4@003
16	44	24.47	46	12.37	3915	61.6	OBH-16	160.785	8/8/00 7:06		8/8/00 2:08		
15	44	30.13	46	22.25	3814	70.8	OBH-19	159.480	8/8/00 10:32		8/8/00 4:41		
14	44	35.99	46	32.09	3845	79.9	OBH-20	160.785	8/8/00 13:58		8/8/00 7:09		
13	44	41.56	46	41.96	3827	89.1	ORB-1		8/8/00 17:23		8/8/00 9:39		
12	44	47.20	46	52.26	3665	98.3	ORB-3		8/8/00 20:46		8/8/00 12:04		
BREAK: 1.5 days													
11	44	53.12	47	2.60	3638	107.4	GSCA-8	156.425	8/10/00 12:07	21:00 (DN=223)	8/10/00 7:58		
10	45	0.74	47	15.57	3568	119.9	GSCA-1	157.125	8/10/00 15:27	21:00 (DN=223)	8/10/00 11:39		
9	45	8.59	47	30.11	3117	132.3	DAL-B	159.480	8/10/00 18:35	21:00 (DN=223)	8/10/00 13:15	Pinging but no release	
8	45	16.23	47	44.49	2500	144.7	OBH-27	159.480	8/10/00 21:28		8/10/00 17:35		
7	45	23.78	47	58.34	1694	157.1	ORB-9		8/11/00 0:13		8/10/00 19:38		
9	45	11.91	47	30.57	3117	132.3	DAL-B	159.480	8/10/00 22:54	21:00 (DN=223)	8/10/00 22:05		3.4@355
25	45	27.44	48	5.32	1459	163.6	GSCA-5	156.575		06:00 (DN=224)	8/11/00 6:50	Backup release	
6	45	30.81	48	12.90	1173	169.5	ORB-7		8/11/00 2:38		8/11/00 5:05		
26	45	35.09	48	19.08	417	176.1	OBH-20	160.785			8/11/00 3:09		
5	45	38.87	48	25.70	127	181.9	ORB-6		8/11/00 5:02		8/11/00 8:55		
4	45	55.54	48	56.51	72	208.9	DAL-D	156.875	8/11/00 9:03	19:00 (DN=224)	8/11/00 12:03		
3	46	11.74	49	27.53	71	235.9	GSCA-2	157.125	8/11/00 13:04	19:00 (DN=224)	8/11/00 14:39		
2	46	27.89	49	58.89	75	262.9	DAL-E	154.585	8/11/00 17:06	07:00 (DN=225)	8/11/00 17:30		
1	46	43.90	50	30.51	107	289.9	DAL-C	159.480	8/11/00 21:06	07:00 (DN=225)	8/11/00 20:21		

SUMMARY OF OBS/H INSTRUMENT PERFORMANCE

Line 1

WPT	ID	Performance
1	**DAL-B**	**Poor data**
2	DAL-C	OK
3	DAL-D	OK
4	OBH-27	OK
5	OBH-20	OK
6	OBH-19	OK
7	GSCA-2	OK
8	GSCA-6	OK
9	**GSCA-7**	**Lost**
10	OBH-16	OK
11	OBH-25	OK
12	OBH-23	OK
13	DAL-A	OK
14	DAL-E	OK
15	DAL-F	OK
16	OBH-26	OK
17	ORB-7	OK
18	ORB-2	OK
19	GSCA-1	OK
20	GSCA-3	OK
21	GSCA-4	OK
22	ORB-3	OK
23	ORB-8	OK
24	**ORB-9**	**No Data**
25	GSCA-5	OK
26	GSCA-8	OK
27	ORB-1	OK
28	**ORB-5**	**lost**
29	**ORB-6**	**No Data**

Line 2

WPT	ID	Performance
1	ORB-8	OK
2	ORB-3	OK
3	GSCA-4	OK
4	ORB-2	OK
5	ORB-6	OK
6	GSCA-8	OK
7	ORB-9	OK
8	GSCA-6	OK
9	GSCA-5	OK
10	OBH-26	OK
11	OBH-23	OK
12	OBH-25	OK
13	GSCA-3	OK
14	GSCA-2	OK
15	GSCA-1	OK
16	OBH-16	OK
17	ORB-1	OK
18	OBH-19	OK
19	**DAL-F**	**Lost**
20	DAL-E	OK Data; Timing offset
21	DAL-D	OK Data; Timing offset
22	OBH-20	OK
23	ORB-7	OK
24	OBH-27	OK
25	DAL-C	OK
26	**DAL-B**	**No Data**
27	**DAL-A**	**Lost**

Line 3

WPT	ID	Performance
1	DAL-C	OK
2	DAL-E	Stopped recording at approx 2000Z/8-AUG
3	GSCA-2	OK
4	DAL-D	OK
5	ORB-6	OK
26	OBH-	OK
6	ORB-7	OK
25	GSCA-5	OK
7	ORB-9	OK
8	OBH-27	OK
9	DAL-B	OK
10	GSCA-1	OK
11	GSCA-8	OK
12	ORB-3	OK
13	ORB-1	OK
14	OBH-20	OK
15	OBH-19	OK
16	OBH-16	OK
17	GSCA-5	OK
18	GSCA-4	OK
19	GSCA-3	OK
20	**ORB-2**	**No Data**
21	**ORB-8**	**No Data**
22	OBH-25	OK
23	OBH-23	OK
24	**OBH-26**	**Lost**

EXAMPLE RECORDS

To view example records see pages 35-41 in "Cruise Report with example records"

APPENDIX 1: WHOI INSTRUMENTS

1.1 ORB OPERATIONS

Summary

All available instruments were deployed on each of three lines located southeast of Newfoundland. The lines also included instruments from Dalhousie University and the Geological Survey of Canada. The three lines consisted of 29, 27 and 24 stations respectively. Instrument loss accounts for the changing number of stations:

line 1
- GSCA-5 station 9 lost after delayed surfacing
- ORB-5, station 28 lost after surfacing

line 2
- GSCA-6, station 8 surfaced on backup timer
    - recovered by Ewing, not available for line 3
- DAL-F, station 19 lost after delayed surfacing
- DAL-A, station 27 no reply, not found on surface

line 3
- OBH-26, station 24 unable to communicate during recovery, lost

Instrument and data recovery for ORBs was incomplete:

- ORB-5 was lost during line 1 pickup.
- ORB-6 recorded no useful data on line 1. It experienced various errors in operation so that it did not dump to disk when the memory filled. It was deployed in constant power mode on lines 2 and 3 with no problem.
- ORB-9 experienced a low pressure leak at the equator that damaged the timebase and took both batteries down during line 1. It was deployed in constant power mode on lines 2 and 3 with no problem.
- ORB-2 and ORB-8 recorded no data during the line 3 deployment due to dead disk batteries.

As is usual in a cruise with many deployments and recoveries, a lot of information is recorded. Tables in other appendices present the technical information. What follows here is a summary of engineering details for future reference.

Loss of ORB-5

The unit was released and tracked to the surface but no ship maneuvers were performed so ranging from the hull transducer was lost at about 1200 meters slant range. Use of the over-the-side transducer failed because we did not request declutching. A surface current of over 3 knots took the unit quickly away from the drop site. Without declutching we conducted what was essentially only a visual search of the expected drift destination. With the poor visibility of the package and no bearing information, this search which extended through the night and was hampered by fog and rain was essentially futile. The unit was not recovered after approximately 16 hours of searching.

ORB-9 leak

A leak possibly caused by improper sealing occurred in ORB-9 during the line 1 deployment. Only minor flooding occurred from the equator near the M-board and the shore grounder board. Both the main and disk batteries were at approximately 3 volts and no data was recovered. The M-board and the grounder board were replaced. Timebase 86 which was flooded was taken out of service. No other problems were evident and the unit was deployed on line 2 (station 7). During debriefing after this second deployment, no SAIL/OC communication was possible.

This was traced to corrosion in the Impulse feedthrough that was not noticed after the original leak. A post-deployment clock check was performed by a temporary lash-up to bypass the feedthrough and no data was lost. The feedthrough was replaced before the line 3 deployment during which the unit returned good data.
Since there was some problem with ORB-9 starting from sleep mode on the bench, we deployed it in continuous power mode for both the line 2 and line 3 deployments.

Failure of ORB-6

ORB-6 recorded only SOH packets and some sensor data in RAM during its line1 deployment. The SOH information showed many problems such as invalid power up sequences (the unit was already powered up), memory errors, instruction errors. Also no SCSI auto-dumps were attempted but the system stopped acquisition when RAM filled. When recovered it showed a SCSI error, however the SOH showed no evidence of any SCSI activity. During debriefing the RAM data was dumped to disk but was of limited utility. It was surmised that this problem was caused by loss of memory during sleep caused by a bad rechargeable battery. Since a replacement was not available, the unit was subsequently deployed in constant power mode for both line 2 and 3 during which it returned good data.

Disk battery failures, ORB-2 and ORB-8

These units both returned from line 3 (stations 20 and 21) with no data. The unit was operating correctly but the disk battery measured approximately 3 volts in both cases. The probable sequence was that at the initial DAS turn-on, the battery was unable to spin up the disk (perhaps caused by one or more bad cells). Apparently the DAS leaves power applied to the SCSI device if it does not come ready during the startup test. This completely depletes the battery but the disk still does not spin up. When DAS RAM is full, the DAS determines that the SCSI device has an error and stops acquisition (to avoid overwriting the contents of RAM).

Battery life is normally calculated on the basis of the DAS memory size and the spinup and data transfer characteristics. It is expressed in terms of the total number of bytes that can be written to disk on this basis – typically 2.8 Gbytes. In operation we change batteries when 1 Gbytes are written. In the present case, the disk batteries in the two ORBs that failed had written 0.35 and 0.44 Gbytes respectively. The disk batteries in the remaining ORBs showed no problems after writing between 0.45 and 0.8 Gbytes. This points to bad cells rather than improper usage, however, burn-down tests of the existing batteries would provide useful information for use.

ORB-2 long burn

ORB-2 took 4 15-minute burn commands to release during recovery after line 1. It is suspected that this resulted not from a long burn but rather by the drop bar binding in the cheeks on the bail. In that case, recovery was fortuitous. Several drop bars were tight enough that the bar returned with the ORB but were judged not tight enough to cause hang up. However, the drop bars were checked and filed down where necessary on all subsequent deployments. The correct drop bar dimensions should be determined.

Acoustic deck unit

Once again the 8011A deck unit displayed an intermittent no-receive problem. During the first deployment of line 1 (OBH-27, station 4), we were unable to communicate with the instrument during its descent. Swapping to the 8011 solved the problem – we communicated with the OBH and disabled its transponder as usual. During deployment of ORB-6 (line 1, station 29) the 8011A was used successfully however, all other over-the-side work on the cruise used the 8011. The 8011A was used for some air acoustics with the ORBs and on one occasion it failed in the same way – observers could hear the transponder reply but the 8011A did not.

The new cable that permitted use of the deck unit with the hull transducer was used almost exclusively and with great success. Ascending units can be tracked to the surface if they are within about 300 meters horizontal range. At greater offsets, it is necessary to use an over-the-side transducer for the last portion of the rise (and also declutch, in the case of R/V Oceanus).

The new over-the-side transducer and cable was used only in the lab.

Edgetech releases

The usual rosette tests of the 8242s were performed, in this case to a depth of only 1100 meters due to schedule and bathymetry. Release 14152 did not respond and was set aside. No other 8242 problems were experienced.

No problems were experienced with the board releases used in ORBs. However, there was some difficulty determining just what ping sequence to expect since we were using three generations of board (20xxx, 22xxx, 25xxx). The actual sequences have been documented but the use of fewer types would be desirable. The newest units (25xxx) give the best user information since they confirm all commands and also give a clear burnwire break time (the once per minute ping sequence changes from 15 to 7). These were borrowed from Edgetech for this year's cruises – unfortunately the lost ORB had one of these boards.

Some last-minute repairs performed by Edgetech before the cruise were only partly successful.

Board 20613
- problem: responds part way through wrong command
- test after repair: OK
- result: spare

Board 22805
- problem: no chirp
- test after repair: ranges OK, but no response to commands
- result: still bad, need to return to Edgetech

Board 22807
- problem: ranges but no response to disable or release
- test after repair: OK
- result: used in ORB-7

Board 22808
- problem: ranges but no response to commands
- test after repair: OK
- result: used in ORB-9

SOH timing error messages

The log files from ORBs 6, 7, and 8 showed many internal clock phase errrors and clock jerks. The phase errors typically come in pairs: first –4.997 milliseconds (always negative) then a few microseconds (either sign). The jerks are of two types: -1 second (always negative) with an "occurred at" time which does not match the current time, and –1 millisecond (always negative) with a valid "occurred at" time but immediately followed by a phase error of approximately +1 millisecond. Note that similar problems occurred during the Galapagos deployments.

Since there is no evidence of 1 second jumps in the data, resolution of this problem has low priority. However, during the cruise some enquiries were made. Information was requested from PASSCAL (Mary Templeton), Reftek (Ian Billings) and Bob Busby. M.Templeton indicated the likely cause was a missing 1 PPS signal leading to the conclusion that all times are probably bad and the DAS is running on its internal clock only. I.Billings suggested that the 1 PPS signal may be too wide (range is 1 to 5 msec). There is some variation in our pulses but it does not explain the problem. Most timebases have a 6.6 msec pulse; the timebase in ORB-7 has a 2.5 msec pulse. However, ORB-7 does not exhibit the problem. B.Busby indicated that the many +- 1 millisecond sifts may be caused by a too-wide 1 PPS signal. He also suggests bench recording of known signals to try to resolve the problem. This needs to be investigated further.

ORB recovery aids

Locating an ORB on the surface is difficult unless the unit is sighted visually soon after surfacing. If not, we suffer from lack of bearing information and low package visibility. The ability to range to the unit when on the surface can aid in locating it, but requires ship maneuvering to determine bearing which is inefficient and time consuming.

The ORB flashers are some help for sighting the package but need better exposure. We removed labels on the glass that blocked the flashers in some balls. We cut additional holes adjacent to the flashers in all hard hats. However a further problem is that the brightest output is seen when the observer actually sees the flasher rather than its reflected light – this happens fairly infrequently and for brief periods. Thus, spotting an ORB at night generally depends on seeing the indirect light that escapes through other holes rather than seeing the flasher itself. Finally due to space limitations inside the ball, it is not possible to position the flashers on opposite sides of the ball. This means that it is possible for both flashers to be pointed away from the observer for long periods of time.

After the first deployments, we added flags (which have been used in the past) and also repainted the exposed hard hat to aid in sighting them.

An additional problem is that the flashers can cause unsolicited pings from the acoustic release boards which effectively disables the surface tracking mode of recovery. Metal shields have been added to prevent this but we found these are not always effective necessitating deployments with only one or both flashers disabled. This is because we believe that acoustic ranging is better than visual at ranges beyond a few hundred meters. For reference, it should be noted that on more than one occasion, no interference was observed until the package was evacuated. Thus full system testing needs to be performed to solve this problem.

If these units are to be used again in this mode, this portion of the system should be redesigned. Other changes are a different power method, better way of disabling the flashers between deployments, use of the better mercury switches that were purchased, and easier assembly and removal.

Other ORB problems

As part of the modification done to the Reftek package, the circuit card holders were removed. It would be advantageous if they could be installed again.

Test points on both the M-board and the release battery board are poorly located and too small. These problems should be corrected if the boards are reworked.

The ground conductor that connects all the grounder boards inside the ball needs to be replaced with a more robust connection.

An important part of the preparation and debrief procedure is to view a small sample of data from the hydrophone. Since the plot of the acquired data using FSC displays only a few millivolts, it shows a flat line (off scale) usually at the negative rail until the preamplifier warms up. On some occasions this condition persists for several minutes whereas at other times valid data appears only a few seconds after power on. This needs to be understood and rectified if possible.

A stronger pickup bail would be desirable to avoid its becoming distorted by heavy loads. At present, this prevents the drop bar from seating fully in the burnwire.

1.2 OBH OPERATIONS

Pre-cruise operations

Seven OBHs were unloaded from the Costa Rica shipment from EW0004 into the mainlab of R/V Oceanus. The instrument rack was located in the lab adjacent to the ORB table within coax reach of a bench containing the programming laptop, test stand, bench trough, and clock rack.

7/1/2000 (183) Saturday - All seven OBHs were powered up after installing analog batteries. All but Electronics ID (EID) #20 responded. Performed battery check, option 2 disk read, and manual clock set to nearest minute.

7/2/2000 (184) Sunday - Swap out WET S/N 173 off piggyback board S/N 3 of EID #20. When pulled out of socket the cover came off. Replace with WET S/N 225. SAIL communication OK now on bench. Return to pressure case.

7/3/2000 (185) Monday - Install ICs, fuses, and WET S/N 176 from piggyback board S/N 14 and install in EID #16. Power LED on grey deck box does not light up. Battery and disk read are OK. Set clock off SAIL clock at 19:22z. Install digital stacks and set clocks on EIDs 23 and 27.

7/4/2000 (186) Tuesday - Install remainder of digital battery stacks. WHOOPs test (DOCK??.DAT) is OK on all instruments except EID #20. WHOOPs voltages on that instrument are lower than the usual 3vP-P.

7/5/2000 (187) Wednesday - Install Model 6 S/N 166 in EID #20. No improvement in WHOOPs test output. Model 6 S/N 168 returned to EID #20. Replace piggyback board S/N 03 in EID #20 with piggyback board S/N 15. Transfer fuses, ICs, and WET S/N 225 into piggyback board S/N 15. WHOOPs test output now looks normal.

Cruise operations

7/14/2000 (196) Friday - Connect digital battery stacks after checking voltages and reset clocks. Successful WHOOPs tests (TEST??.DAT) conducted on all instruments.

7/15/2000 (197) Saturday - Ken Peal makes modifications to piggyback boards S/N 14 and 15 so that grey deck box LEDs light up when shore power is applied to EIDs #16 and 20. Reset clocks. Wireline tests of releases take place.

8/1/2000 (214) Tuesday - While changing the digital battery stack on EID #25 after NFLD02, a leaking cell was found. While changing batteries on EID #20 shore power was not connected to the special deck box before standing the electronics on the floor jig. When the main battery was disconnected power was lost to the instrument. The instrument had to be reset and the clock was set at 16:08z.

Loss of OBH #26 (EID #26)

Beginning on August 6, 2000 (219), OBH #26 failed to respond to acoustic commands sent in an attempt to recover it. The deployment position (Line 3-24) was 43° 45.1203'N, 45° 06.5407'W. The water depth at deployment was 4670m.

Acoustic commands were sent to the 11kHz release (S/N 14157) beginning at 23:45:13z. A rapid series of 6 pings was heard once in response to an interrogate command once before switching to the 9kHz release (S/N 14113). This transponder returned one believable reply of 5568m slant range. The Oceanus was declutched at 0004z on 8/17/2000 (220) while communicating with S/N 14113. We switched to the over-the-side transducer at 0013z and boosted power while attempting to communicate with both releases. Up until this time the 11kHz release was characterized by a rapid series of either 6 or 8 pings. The 9kHz release seemed to give us only two believable replies. With power boosted to high or full levels we got spurious replies from 14113 and a change in character for 14157 to a single ping in response to the enable command. We switched to the 8011A deck unit with the over-the-side 'ducer and tried 14157. The single pings continued in response to the enable command and we failed to get a good reply. At 0026z we hauled in the 'ducer and moved back to the drop site. We declutched and used the hull 'ducer with the 8011 deck unit. We sent a disable command to 14113 followed by an enable and the first attempt at a release (00:44:41z). More release commands followed including attempts with 14157. Releases were sent to 14157 with the over-the-side 'ducer and both deck units. The last command in this series was sent at 00:55:20z

At 0102z we turned off the 3.5kHz profiler and at 0104z we returned to the drop site again. The hull 'ducer was used to interrogate both releases with only spurious slant ranges given in response. At a rise rate of 50m/min and a rough depth of 4700m, a 94 minute rise time from the last attempted release at 0055z, a worst case surface time of 0229z was predicted. At 0235z, nearly three hours after the first attempts at communication, site 24, the most seaward of Line 3, was abandoned.

We moved on to a successful release of one of the WHOI instruments and tested the over-the-side 'ducer with spare releases in the rosette on the fantail. At 0642z, we had returned to Station 24. We attempted to enable and interrogate both releases. No good replies were received. Disable commands were sent and we got underway to Station 22 at approximately 0652z.

As with other OBH losses the precise reason for the failure to communicate with the acoustic releases in unknown, but could fall into one of the following categories (cited in the loss of OBH #17 on Alpha Helix Cruise HX-179 in 1994):

1. Complete electronic failure of both releases, leaving the instrument intact, but unable to communicate or obey commands.

2. Implosion of a floatation sphere causing damage to other spheres and to both releases, leaving the instrument destroyed on the bottom.

3. Premature release of the OBH caused by mechanical failure or human error.

1.3 DATA LIST

NFLD01

14 Receiver Books - ORBs #1-3 and 6-9, OBHs #16, 19, 20, 23, and 25-27.

14 SONY 112m 8mm tapes, refdump o/p archive copies 1 and 2 (8500 uncompressed density mode), ORBs #1-3 and 6-9; 7/21/2000 and 7/24/2000.

14 SONY 112m 8mm tapes, dd o/p archive copies 1 and 2 (8500 uncompressed density mode), OBHs #16, 19, 20, 23, and 25-27; 7/22/2000.

NFLD02

14 Receiver Books - ORBs #1-3 and 6-9, OBHs #16, 19, 20, 23, and 25-27.

14 SONY 112m 8mm tapes, refdump o/p archive copies 1 and 2 (8500 uncompressed density mode), ORBs #1-3 and 6-9; 7/29/2000 - 7/31/2000 and 8/2/2000.

14 SONY 112m 8mm tapes, dd o/p archive copies 1 and 2 (8500 uncompressed density mode), OBHs #16, 19, 20, 23, and 25-27; 7/29/2000 and 7/30/2000.

NFLD03

14 Receiver Books - ORBs #1-3 and 6-9, OBHs #16, 19, 20, 23, and 25-27.

10 SONY 112m 8mm tapes, refdump o/p archive copies 1 and 2 (8500 uncompressed density mode), ORBs #1, 3, 6, 7, and 9; 8/8/2000 – 8/11/2000.

12 SONY 112m 8mm tapes, dd o/p archive copies 1 and 2 (8500 uncompressed density mode), OBHs #16, 19, 20, 23, 25, and 27; 8/7/2000 - 8/10/2000.

"NFLD04"

1 Receiver Book - OBH #20 (EID #19).

2 SONY 112m 8mm tapes, dd o/p archive copies 1 and 2 (8500 uncompressed density mode), OBH #20 (EID #19); 8/11/2000.

Miscellaneous Cruise Data

2 SONY 112m 8mm tapes, tar format copies 1 and 2 (8500 uncompressed density mode) of NFLD01, OBH *.raw files and ORB *.ref files, 14 files; 8/3/2000.

2 SONY 112m 8mm tapes, tar format copies 1 and 2 (8500 uncompressed density mode) of NFLD02, OBH *.raw files and ORB *.ref files, 14 files; 8/4/2000.

2 SONY 112m 8mm tapes, tar format copies 1 and 2 (8500 uncompressed density mode) of NFLD01, OBH and ORB, ref and mcs, *.segy files, 26 files; 8/5/2000.

2 SONY 112m 8mm tapes, tar format copies 1 and 2 (8500 uncompressed density mode) of NFLD02, ORB, ref and mcs, *.segy files, 14 files; 8/9/2000.

2 SONY 112m 8mm tapes, tar format copies 1 and 2 (8500 uncompressed density mode) of NFLD02, OBH, ref and mcs, *.segy files, 14 files; 8/9/2000.

2 SONY 112m 8mm tapes, tar format copies 1 and 2 (8500 uncompressed density mode) of NFLD03, OBH *.raw files and ORB *.ref files, 16 files; 8/11/2000.

2 SONY 112m 8mm tapes, tar format copies 1 and 2 (8500 uncompressed density mode) of NFLD03, OBH and ORB, ref and mcs, *.segy files, 22files; 8/12/2000.

1 Notebook of OBH Datafile Headers (obh_rec_hdrs output).

1 Notebook of obh_to_segy processing notes and input files.

1 DLT tape of xray:/export/disk0/oc359

Assorted IBM format floppy disks with backups of ORB FSC files and PROCOMM log files and OBH WHOOPS data and PROCOMM log files.

1 CD of OC359-2 SSSG underway geophysics data.

1.4 INSTRUMENT CONFIGURATION

NEWFOUNDLAND BASIN
OC359-2 ORB COMPONENT CONFIGURATION

ORB	DAS	Disk Power	Disk	Timebase	Power Board	Benthos Ball	Release	Hydrophone
1	7543	0428	HK031386	121	5	60737	20612	209003
2	7542	0096	HD033603	207	6	61592	25325	209006
3	7566	0521	TBV59723	085	8	60650	20785	209007
5	7724	0850	HK035295	123	4	60609	25324	209005
6	8023	0909	HK035134	124	2	59402	25323	209009
7	7723	0864	JK110792	075	10	61600	22807	290004
8	7721	0907	JD287749	122	9	61566	25322	209001
9	7830	1327	HK035218	086		60615	22808	209010

Notes:

- 1. On 7/25/2000, hydrophone S/N 209003, installed on ORB #1, was replaced by hydrophone S/N 209011.
- 2. Due to salt incursion during NFLD01 in ORB #9, the power board was replaced and timebase S/N 086 was replaced by S/N 079.

NEWFOUNDLAND BASIN
OC359-2 OBH FRAME CONFIGURATION

Frame	9 kHz Release	11 kHz Release	Flasher #1	Flasher #2	Radio	Frequency	Hydrophone	Leads
16	14143	14165	18089	F03009	18058	160.785 (D)	GF-7 (M)	19BB
19	13653	14156	F03013	F03011	G04-001	159.480 (B)	1385 (B)	18BB
20	14737	14148	F03010	F03012	18060	160.785 (D)	1140 (M)	37BM
23	14738	14147	18067	1811	18046	160.725 (C)	GF-15 (M)	30BM
25	18332	14150	F03008	F03014	18051	160.725 (C)	001 (M)	14BB
26	14113	14157	18063	18081	18061	160.785 (D)	GF-2 (B)	23BB
27	14744	14160	18071	18117	18038	159.480 (B)	1135 (B)	22BB

For hydrophone leads BB is Burton to OBH, Burton to hydrophone;
BM is Burton to OBH, Mecca to hydrophone.
Notes:

- 1. Flasher S/N 18063, on Frame #26 during NFLD01, did not work on recovery. A bad switch was replaced.
- 2. Flasher S/N F03014, on Frame #25 during NFLD01, did not work on recovery. A bad switch was replaced.
- 3. The hydrophone mount on Frame #19 was found bent upon recovery from NFLD01. Hydrophone S/N 1385 was replaced by S/N GF-6 for NFLD02. S/N 1385 was given a capacitance test and gave good values. We don't know when the mount was damaged, but it was simply bent back into shape for NFLD02.
- 4. Radio S/N 18061, on Frame #26 at NFLD02 deployment, was not working. A replacement radio also didn't work. Finally, S/N 18053 was successfully tested and installed for NFLD02. The topmost battery in S/N 18061 was initially stuck. When retrieved it had moisture on the positive contact.
- 5. Radio S/N 18058, on Frame # 16 during NFLD03, did not work on recovery. In lab test on 8/9 it worked OK. May be a sticky switch.
- 6. Flasher S/N F03010, on Frame #20 during it's second deployment on Line 3, did not work on recovery.
- 7. OBH #26 was not recovered after NFLD03.

NEWFOUNDLAND BASIN
OC359-2 OBH ELECTRONICS CONFIGURATION

OBH	Pre-amp	Filter	HG GRA	LG GRA	P. S. I.*	Tattletale	Disk	Kato	Piggy-back	Vectron Oscillator	WET
16	16	5	2	8	5	145 Rev E	26841636G MK1926FCV	81620 Rev B	14	1431329 317Y1322	176
19	19	4	13	9	6	82 Rev C	38513629P MK2104MAV	116 Rev A	7	1218029 317Y1322	238
20	20	15	26	5	4	168 Rev E	56021926P MK1926FCV	76394 Rev B	15	1431330 317Y1322	225
23	23	8	24	14	12	138 Rev E	56021924P MK1926FCV	76395 Rev B	10	1167160 318Y0467	177
25	25	17	12	11	8	165 Rev E	28R37378P MK2104MAV	118 Rev B	12	1167161 318Y0467	203
26	26	13	22	15	9	143 Rev E	26841627G MK1926FCV	117 Rev B	13	1218030 317Y1322	172
27	27	2	21	28	10	167 Rev E	26841613G MK1926FCV	81618 Rev B	4	1167158 318Y0467	174

Notes:
*Power Supply Interface.
Pre-amp gain is +20dB.
Filter cutoff freq./type is 80Hz DEK 6 Pole LP with a gain selection of 0.
High Gain GRA 0 (Channel 1) gain is 35 dB, attenuation is 7, type DEK.
Low Gain GRA 1 (Channel 2) gain is 9 dB, attenuation is 7, type DEK.
Power Supply Interface Type is KRP May 1991 with jumper positions W1 and W2 both set to 'A'.
Piggyback Board Type is KRP May 1991.
Program Version is 28 (1 February 2000).
Threshold value is 16300 A/D # (0-32000), 0.122 volts.
Sample rate is 200 samples/s.

1.5 INSTRUMENT CLOCK CORRECTIONS

NEWFOUNDLAND BASIN
NFLD01 Instrument Clock Corrections

ORB	DAS	Clock	Clock Check	Correction	Clock Check	Correction	Drift Rate
1	7543	121	198:16:42:34	+0.024306	206:12:52:26	+0.027711	+5.026595E-09
2	7542	207	198:11:51:02	+0.009613	203:08:57:25	+0.012775	+7.500365E-09
3	7566	085	198:13:21:11	+0.006614	206:21:23:48	+0.015722	+1.264717E-08
5	7724	123	198:17:13:43	+0.017955	N.A.	N.A.	N.A.
6	8023	124	198:13:55:36	+0.010424	206:09:32:30	+0.012070	+2.436909E-09
7	7723	075	198:11:16:55	+0.004767	203:11:38:42	+0.007624	+6.593683E-09
8	7721	122	198:14:23:38	+0.011437	206:18:53:23	+0.011962	+7.423354E-10
9	7830	086	198:15:51:40	+0.013982	N.A.	N.A.	N.A.
OBH	**EID**	**Clock**	**Clock Check**	**Correction**	**Clock Check**	**Correction**	**Drift Rate**
16	16	1431329	197:21:06:08	+0.007723	204:13:01:09	+0.064369	+9.839483E-08
19	19	1218029	197:14:49:07	+0.003713	204:15:44:07	+0.003736	+3.782273E-11
20	20	1431330	197:16:23:35	+0.006687	204:17:39:19	+0.031400	+4.055673E-08
23	23	1167160	198:00:56:38	-0.003637	204:00:27:50	-0.042154	-7.454826E-08
25	25	1167161	197:23:05:42	-0.002082	204:10:08:05	-0.017367	-2.738545E-08
26	26	1218030	198:11:54:56	-0.026506	203:14:13:29	-0.099524	-1.658320E-07
27	27	1167158	197:18:46:32	+0.004604	204:18:51:51	-0.029956	-5.711273E-08

NEWFOUNDLAND BASIN
NFLD02 Instrument Clock Corrections

ORB	DAS	Clock	Clock Check	Correction	Clock Check	Correction	Drift Rate
1	7543	121	207:00:03:55	+0.028179	211:09:44:41	+0.030796	+6.878773E-09
2	7542	207	207:12:57:55	+0.015298	213:04:29:20	+0.019271	+8.143327E-09
3	7566	085	207:16:48:45	+0.015120	213:00:27:02	+0.019103	+8.668219E-09
6	8023	124	208:01:26:50	+0.013421	212:19:26:43	+0.014441	+2.485603E-09
7	7723	075	207:00:38:35	+0.008019	215:09:34:43	+0.010102	+2.879508E-09
8	7721	122	207:17:32:07	+0.011909	212:22:45:48	+0.012316	+9.027541E-10
9	7830	086	208:00:41:31	+0.006792	212:15:56:07	-0.029380	-9.032260E-08
OBH	**EID**	**Clock**	**Clock Check**	**Correction**	**Clock Check**	**Correction**	**Drift Rate**
16	16	1431329	207:02:09:13	+0.087439	211:15:27:01	+0.126146	+9.837395E-08
19	19	1218029	207:01:13:45	+0.001242	211:07:17:36	+0.000955	-7.810990E-10
20	20	1431330	206:23:56:55	+0.041125	210:23:28:10	+0.053180	+3.505634E-08
23	23	1167160	207:13:28:07	-0.003637	212:06:36:53	-0.095504	-2.255368E-07
25	25	1167161	207:11:39:58	-0.025494	212:05:47:52	-0.036793	-2.749991E-08
26	26	1218030	207:15:45:08	-0.168369	212:12:20:22	-0.241708	-1.747357E-07
27	27	1167158	206:22:55:02	-0.038186	210:21:22:14	-0.057695	-5.737401E-08

NEWFOUNDLAND BASIN
NFLD03 Instrument Clock Corrections

ORB	DAS	Clock	Clock Check	Correction	Clock Check	Correction	Drift Rate
1	7543	121	215:20:57:32	+0.037540	221:09:54:21	+0.041887	+9.082501E-09
3	7566	085	215:20:04:22	+0.018448	221:12:16:38	+0.023099	+9.485231E-09
6	8023	124	216:09:25:43	+0.017674	224:09:11:11	+0.022252	+6.631622E-09
7	7723	075	216:12:34:13	+0.010806	224:05:16:03	+0.013646	+4.271139E-09
9	7830	086	216:08:52:18	-0.049577	223:20:00:53	-0.107164	-8.929398E-08
OBH	**EID**	**Clock**	**Clock Check**	**Correction**	**Clock Check**	**Correction**	**Drift Rate**
16	16	1431329	215:16:54:38	+0.162790	221:05:09:27	+0.209876	+9.890168E-08
19	19	1218029	215:19:16:23	-0.003680	221:08:01:14	-0.003017	+1.387346E-09
20	20	1431330	215:22:40:08	+0.010431	221:16:36:29	-0.001199	-2.342015E-08
23	23	1167160	215:14:27:18	-0.117250	220:07:17:28	-0.146411	-7.178799E-08
25	25	1167161	215:15:44:06	-0.045911	220:13:29:41	-0.057933	-2.835812E-08
26	26	1218030	215:13:07:25	-0.294194	N.A.	N.A.	N.A.
27	27	1167158	216:08:56:43	-0.078123	223:19:57:59	-0.116543	-5.961432E-08
20	19	1218029	221:19:17:26	-0.003578	224:06:22:00	-0.003676	-4.607992E-10

1.6 SEGY FILES SUMMARY

NEWFOUNLAND BASIN
SEGY FILE SUMMARY

FILE NAME	STN	# TRACES	1st TRACE	OFFSET	nth TRACE	OFFSET
orb6n1ref.segy	29	1632	1	7.329	2454	319.888
orb5n1ref.segy	28	Lost!				
orb1n1ref.segy	27	1632	1	8.463	2454	304.874
orb9n1ref.segy	24	No data!				
orb8n1ref.segy	23	1632	1	40.282	2454	272.777
orb3n1ref.segy	22	1632	1	48.229	2454	264.823
orb2n1ref.segy	18	1632	1	80.524	2454	232.570
orb7n1ref.segy	17	1632	1	88.278	2454	224.742
obh26n1ref.segy	16	1632	1	96.027	2454	-216.883
obh23n1ref.segy	12	1632	1	136.148	2454	-176.752
obh25n1ref.segy	11	1632	1	145.927	2454	-166.975
obh16n1ref.segy	10	1632	1	156.159	2454	-156.739
obh19n1ref.segy	6	1632	1	207.195	2454	-105.698
obh20n1ref.segy	5	1632	1	228.321	2454	-84.570
obh27n1ref.segy	4	1632	1	249.368	2454	-63.526
obh27n1mcs.segy	4	2380	2455	-68.811	4834	49.766
obh20n1mcs.segy	5	2379	2455	-89.855	4833	28.669
obh19n1mcs.segy	6	2129	2455	-110.983	4583	-4.949
obh16n1mcs.segy	10	2001	2455	-162.024	4455	-62.366
obh25n1mcs.segy	11	1512	2455	-172.260	3966	-97.004
obh23n1mcs.segy	12	1285	2455	-182.037	3739	-118.093
obh26n1mcs.segy	16	717	2455	-222.167	3171	-186.547
orb7n1mcs.segy	17	6401	2455	230.138	8855	98.239
orb2n1mcs.segy	18	6401	2455	237.966	8855	90.430
orb3n1mcs.segy	22	6401	2455	270.219	8855	58.158
orb8n1mcs.segy	23	6401	2455	278.173	8855	50.204
orb9n1mcs.segy	24	No data!				
orb1n1mcs.segy	27	6401	2455	310.270	8855	18.108
orb5n1mcs.segy	28	Lost!				
orb6n1mcs.segy	29	6401	2455	325.284	8855	3.096
obh27n2ref.segy	24	1827	21705	32.700	23533	-332.219
orb7n2ref.segy	23	1827	21705	45.565	23533	319.460
obh20n2ref.segy	22	1827	21705	54.505	23533	-310.411
obh19n2ref.segy	18	1827	21705	98.277	23533	-266.638
orb1n2ref.segy	17	1827	21705	109.794	23533	255.249
obh16n2ref.segy	16	1827	21705	120.014	23533	-244.901
obh25n2ref.segy	12	1827	21705	172.694	23533	-192.221
obh23n2ref.segy	11	1827	21705	187.336	23533	-177.580
obh26n2ref.segy	10	1827	21705	201.283	23533	-163.634
orb9n2ref.segy	7	1827	21705	242.833	23533	122.192
orb6n2ref.segy	5	1827	21705	270.973	23533	94.052
orb2n2ref.segy	4	1827	21705	294.204	23533	70.822
orb3n2ref.segy	2	1827	21705	339.801	23533	25.224
orb8n2ref.segy	1	1827	21705	362.744	23533	2.281

FILE NAME	STN	# TRACES	1st TRACE	OFFSET	nth TRACE	OFFSET
orb8n2mcs.segy	1	7427	23820	3.430	31250	367.292
orb3n2mcs.segy	2	7427	23820	26.372	31250	344.349
orb2n2mcs.segy	4	7427	23820	71.970	31250	298.753
orb6n2mcs.segy	5	7427	23820	95.200	31250	275.521
orb9n2mcs.segy	7	7427	23820	123.340	31250	247.381
obh26n2mcs.segy	10	3007	23820	-164.672	26827	-14.792
obh23n2mcs.segy	11	2676	23820	-178.618	26496	-45.268
obh25n2mcs.segy	12	2675	23820	-193.259	26495	-59.960
obh16n2mcs.segy	16	1823	23820	-245.939	25643	-155.159
orb1n2mcs.segy	17	7427	23820	256.398	31250	114.350
obh19n2mcs.segy	18	1330	23820	-267.676	25150	-201.469
obh20n2mcs.segy	22	725	23820	-311.449	24545	-275.413
orb7n2mcs.segy	23	7427	23820	320.608	31250	50.114
obh27n2mcs.segy	24	598	23820	-333.256	24418	-303.555
obh26n3ref.segy	24	Lost!				
obh23n3ref.segy	23	1707	47043	13.941	48750	-326.648
obh25n3ref.segy	22	1707	47043	27.287	48750	-313.302
orb8n3ref.segy	21	No data!				
orb2n3ref.segy	20	No data!				
obh16n3ref.segy	16	1707	47043	114.877	48750	-225.712
obh19n3ref.segy	15	1707	47043	131.840	48750	-208.749
obh20n3ref.segy	14	1707	47043	148.643	48750	-191.947
orb1n3ref.segy	13	1707	47043	165.898	48750	174.800
orb3n3ref.segy	12	1707	47043	182.768	48750	157.930
obh27n3ref.segy	8	1707	47043	268.899	48750	-71.690
orb9n3ref.segy	7	1707	47043	291.949	48750	48.749
orb7n3ref.segy	6	1707	47043	314.958	48750	25.739
orb6n3ref.segy	5	1707	47043	337.948	48750	2.750
orb6n3mcs.segy	5	4460	48751	2.800	53210	225.298
orb7n3mcs.segy	6	4460	48751	25.789	53210	248.288
orb9n3mcs.segy	7	4460	48751	48.798	53210	271.297
obh27n3mcs.segy	8	4460	48751	-71.739	53210	-294.238
orb3n3mcs.segy	12	4460	48751	157.980	53210	380.477
orb1n3mcs.segy	13	4460	48751	174.849	53210	397.347
obh20n3mcs.segy	14	3028	48751	-191.997	51778	-343.049
obh19n3mcs.segy	15	2791	48751	-208.798	51541	-348.027
obh16n3mcs.segy	16	2667	48751	-225.761	51417	-358.807
orb2n3mcs.segy	20	No data!				
orb8n3mcs.segy	21	No data!				
obh25n3mcs.segy	22	1596	48751	-313.351	50346	-392.941
obh23n3mcs.segy	23	1478	48751	-326.697	50228	-400.399
obh26n3mcs.segy	24	Lost!				

1.7 SHOT LINE SUMMARY

NEWFOUNDLAND BASIN
SHOT LINE SUMMARY

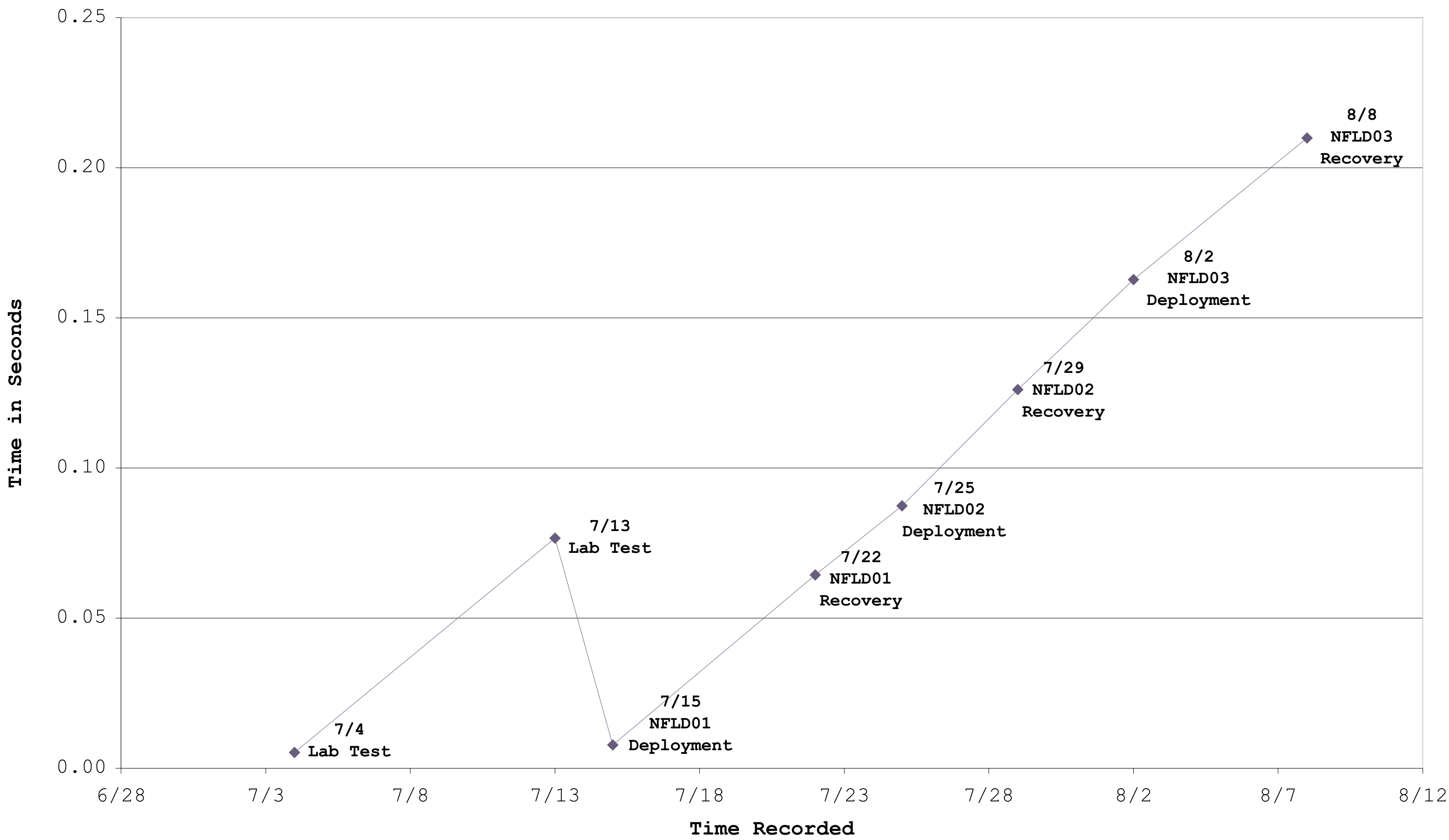
LINE	SHOT NUMBER	DOY	TIME	LATITUDE	LONGITUDE
TEST					
Start	00001	200	09:54:08.125	45° 55.5546'N	042° 37.8992'W
End	00435	200	12:55:50.723	45° 55.4908'N	042° 47.5275'W
LINE1OBS					
Start	00001	200	13:00:00.125	45° 55.5536'N	042° 47.7410'W
	01180	201	19:59:54.087	47° 15.9336'N	045° 03.9174'W
	02000	202	08:59:11.139	47° 13.7441'N	045° 00.0993'W
End	02454	202	19:40:15.464	47° 45.2750'N	045° 55.4908'W
LINE1MCS					
Start	02455	203	03:31:47.129	47° 47.1026'N	045° 58.7476'W
End	08855	204	17:39:34.077	45° 50.8752'N	042° 43.2559'W
LINE2OBS					
Start	21705	208	16:09:37.128	44° 41.0646'N	043° 23.3333'W
End	23533	210	09:19:19.867	46° 35.2215'N	047° 12.9550'W
LINE2MCS					
Start	23820	210	10:57:31.133	46° 35.5033'N	047° 13.6609'W
End	31250	212	08:51:09.491	44° 39.3524'N	043° 20.7198'W
LINE3OBS					
Start	47043	217	15:46:14.125	43° 44.6942'N	45° 06.0652'W
End	48750	219	07:10:40.532	45° 40.0084'N	48° 27.5655'W
LINE3MCS1					
Start	48751	219	07:11:02.132	45° 40.0248'N	48° 27.5956'W
End	53210	220	09:23:53.413	46° 51.5863'N	50° 47.0514'W

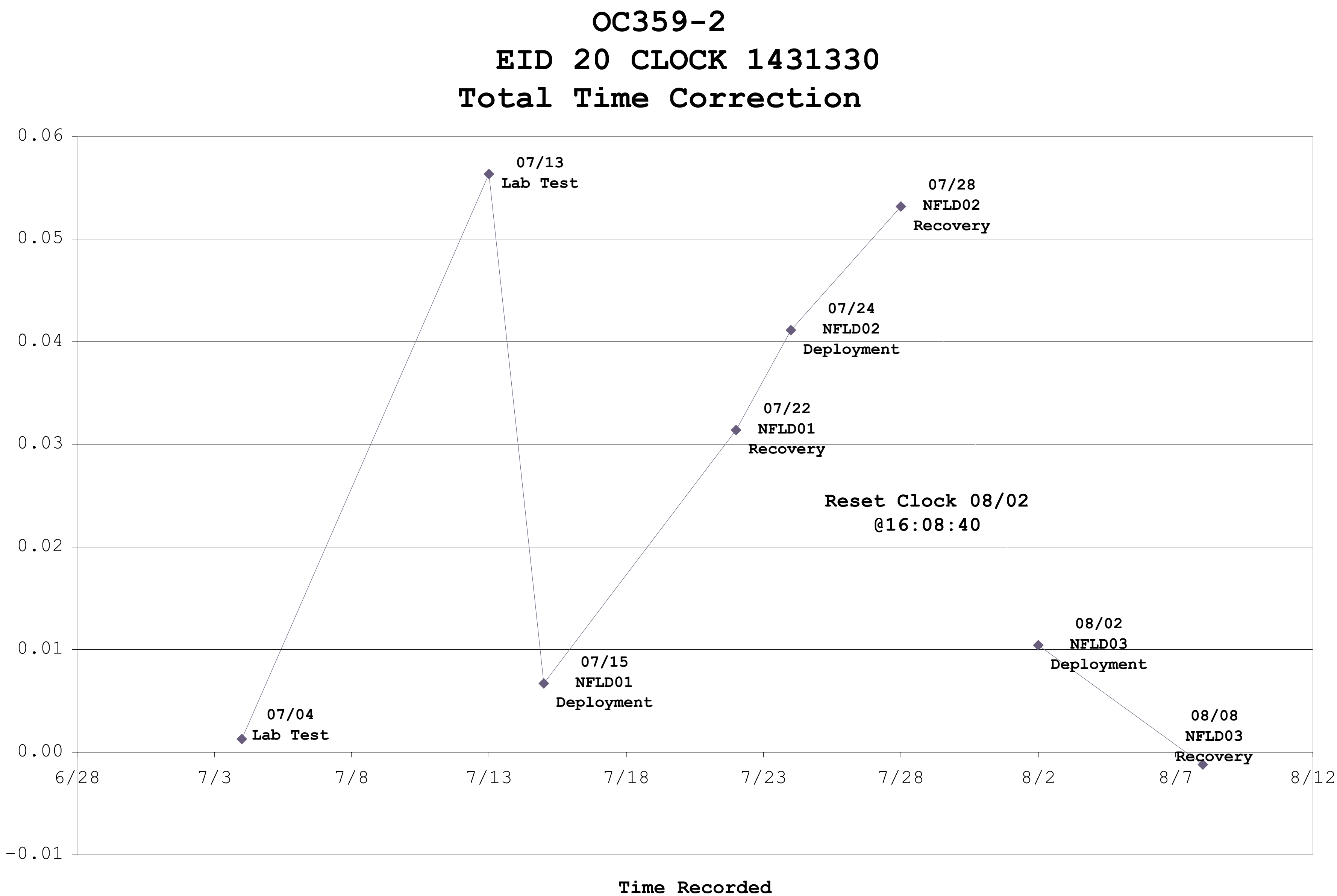
1.8 DATA FROM OBH 01 AND 02 DEPLOYMENTS

EID#	CLOCK #	OBH DATE	OBH TIME	SAILCLOCK SECONDS	OBH CORRECTION	SAILCLOCK CORRECTION	TOTAL CORRECTION	DRIFT
16	1431329	07/04/00	19:24:42	0.005469	0.005469	-0.000184	0.005285	
16	1431329	07/13/00	23:27:55	0.076914	0.076914	-0.000288	0.076626	9.005655E-08
16	1431329	07/15/00	21:06:08	0.008036	0.008036	-0.000311	0.007725	-4.420131E-07
16	1431329	07/22/00	13:01:09	0.064774	0.064774	-0.000405	0.064369	7.654801E-08
16	1431329	07/25/00	2:09:13	0.087877	0.087877	-0.000438	0.087439	1.048255E-07
16	1431329	07/29/00	15:27:01	0.126647	0.126647	-0.000501	0.126146	9.837095E-08
16	1431329	08/02/00	16:54:38	0.163346	0.163346	-0.000556	0.162790	1.044524E-07
16	1431329	08/08/00	5:09:27	0.210507	0.210507	-0.000631	0.209876	9.889939E-08
19	1218029	07/04/00	19:18:09	0.005063	0.005063	-0.000183	0.004880	6.895118E-08
19	1218029	07/13/00	23:25:25	0.995215	-0.004785	-0.000288	-0.005073	-1.256026E-08
19	1218029	07/15/00	14:49:07	0.004023	0.004023	-0.000310	0.003713	6.191684E-08
19	1218029	07/22/00	15:44:07	0.004142	0.004142	-0.000406	0.003736	3.782646E-11
19	1218029	07/25/00	1:13:45	0.001680	0.001680	-0.000438	0.001242	-1.205180E-08
19	1218029	07/29/00	7:17:36	0.001451	0.001451	-0.000496	0.000955	-7.810799E-10
19	1218029	08/02/00	19:16:23	0.996877	-0.003123	-0.000557	-0.003680	-1.192314E-08
19	1218029	08/08/00	8:01:14	0.997616	-0.002384	-0.000633	-0.003017	1.387320E-09
19	1218029	08/08/00	19:17:26	0.997062	-0.002938	-0.000640	-0.003578	-1.383136E-08
19	1218029	08/11/00	6:22:00	0.997000	-0.003000	-0.000676	-0.003676	-4.607428E-10
20	1431330	07/04/00	19:31:56	0.001470	0.001470	-0.000183	0.001287	-1.443065E-09
20	1431330	07/13/00	23:30:32	0.056624	0.056624	-0.000288	0.056336	6.951685E-08
20	1431330	07/15/00	16:23:35	0.006997	0.006997	-0.000310	0.006687	-3.373352E-07
20	1431330	07/22/00	17:39:19	0.031806	0.031806	-0.000406	0.031400	4.055566E-08
20	1431330	07/24/00	23:56:55	0.041562	0.041562	-0.000437	0.041125	4.974933E-08
20	1431330	07/28/00	23:28:10	0.053671	0.053671	-0.000491	0.053180	3.505787E-08
20	1431330	08/02/00	22:40:08	0.010990	0.010990	-0.000559	0.010431	-9.962015E-08
20	1431330	08/08/00	16:36:29	0.999438	-0.000562	-0.000637	-0.001199	-2.342114E-08
23	1167160	07/04/00	18:50:25	0.001776	0.001776	-0.000184	0.001592	-9.254286E-10
23	1167160	07/13/00	23:16:32	0.027910	-0.972090	-0.000288	-0.972378	-1.227343E-06
23	1167160	07/16/00	0:56:38	0.996678	-0.003322	-0.000315	-0.003637	5.419833E-06
23	1167160	07/16/00	0:56:38	0.996678	-0.003322	-0.000315	-0.003637	#DIV/0!
23	1167160	07/22/00	0:27:50	0.958243	-0.041757	-0.000397	-0.042154	-7.454134E-08
23	1167160	07/25/00	13:28:07	0.935139	-0.064861	-0.000445	-0.065306	-7.566013E-08

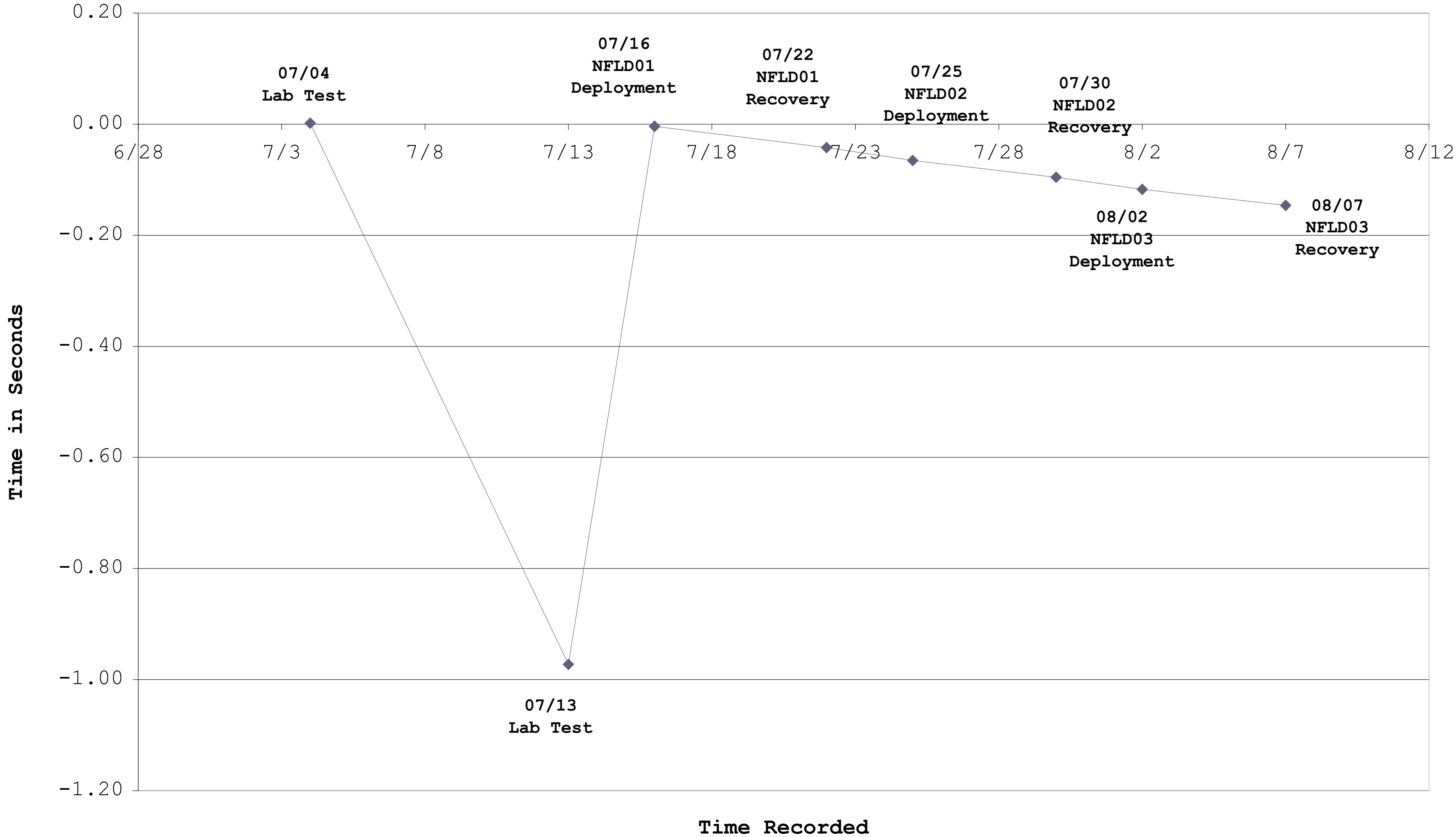
EID#	CLOCK #	OBH DATE	OBH TIME	SAILCLOCK SECONDS	OBH CORRECTION	SAILCLOCK CORRECTION	TOTAL CORRECTION	DRIFT
23	1167160	07/30/00	6:36:53	0.905006	-0.094994	-0.000510	-0.095504	-7.413463E-08
23	1167160	08/02/00	14:27:18	0.883305	-0.116695	-0.000555	-0.117250	-7.566458E-08
23	1167160	08/07/00	7:17:28	0.854208	-0.145792	-0.000619	-0.146411	-7.178976E-08
25	1167161	07/04/00	19:03:17	0.007332	0.007332	-0.000184	0.007148	-5.303844E-08
25	1167161	07/13/00	23:21:27	0.987096	-0.012904	-0.000288	-0.013192	-2.564685E-08
25	1167161	07/15/00	23:05:42	0.998232	-0.001768	-0.000314	-0.002082	6.465317E-08
25	1167161	07/22/00	10:08:05	0.983035	-0.016965	-0.000402	-0.017367	-2.738364E-08
25	1167161	07/25/00	11:39:58	0.974950	-0.025050	-0.000444	-0.025494	-3.070036E-08
25	1167161	07/30/00	5:47:52	0.963717	-0.036283	-0.000510	-0.036793	-2.749951E-08
25	1167161	08/02/00	15:44:06	0.954644	-0.045356	-0.000555	-0.045911	-3.091267E-08
25	1167161	08/07/00	7:29:41	0.942686	-0.057314	-0.000623	-0.057937	-2.836990E-08
26	1218030	07/04/00	19:11:27	0.001895	0.001895	-0.000184	0.001711	-2.044785E-08
26	1218030	07/13/00	23:23:21	0.866931	-0.133069	-0.000288	-0.133357	-1.703855E-07
26	1218030	07/16/00	11:54:56	0.973815	-0.026185	-0.000321	-0.026506	4.903221E-07
26	1218030	07/21/00	14:13:29	0.900869	-0.099131	-0.000393	-0.099524	-1.658445E-07
26	1218030	07/25/00	15:45:08	0.832077	-0.167923	-0.000446	-0.168369	-1.960726E-07
26	1218030	07/30/00	12:20:22	0.758804	-0.241196	-0.000512	-0.241708	-1.747415E-07
26	1218030	08/02/00	13:07:25	0.706360	-0.293640	-0.000554	-0.294194	-2.003130E-07
27	1167158	07/04/00	19:00:21	0.001721	0.001721	-0.000184	0.001537	-1.190342E-07
27	1167158	07/13/00	23:19:13	0.978823	-0.021177	-0.000288	-0.021465	-2.900119E-08
27	1167158	07/15/00	18:46:32	0.004915	0.004915	-0.000311	0.004604	1.666603E-07
27	1167158	07/22/00	18:51:51	0.970452	-0.029548	-0.000408	-0.029956	-5.710886E-08
27	1167158	07/24/00	22:55:02	0.962251	-0.037749	-0.000265	-0.038014	-4.300352E-08
27	1167158	07/28/00	21:22:14	0.942795	-0.057205	-0.000490	-0.057695	-5.788189E-08
27	1167158	08/03/00	8:56:43	0.922441	-0.077559	-0.000580	-0.078139	-4.316358E-08
27	1167158	08/10/00	19:57:59	0.884126	-0.115874	-0.000669	-0.116543	-5.958543E-08

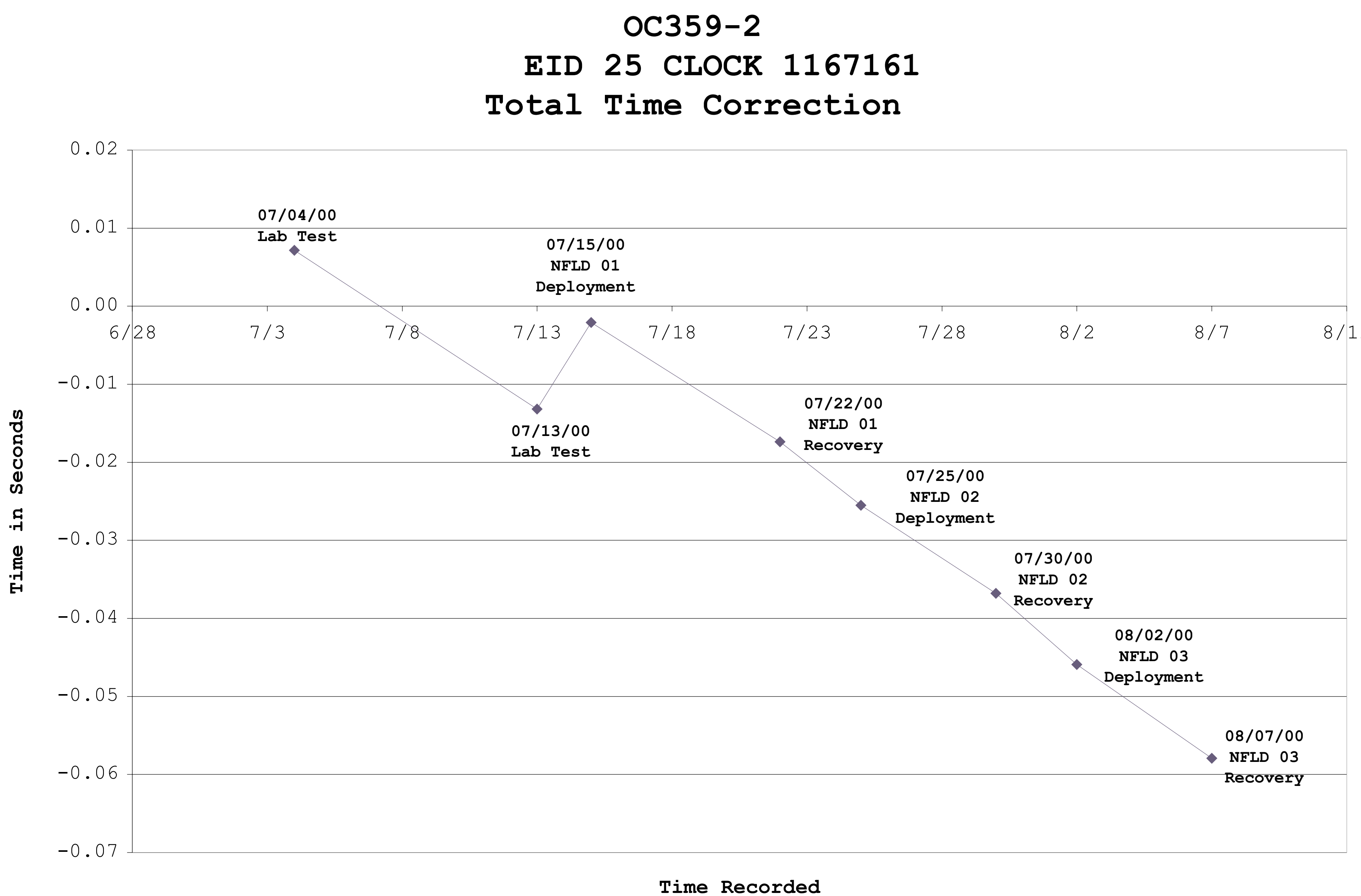
OC359-2
EID 16 CLOCK 1431329
Total Time Correction



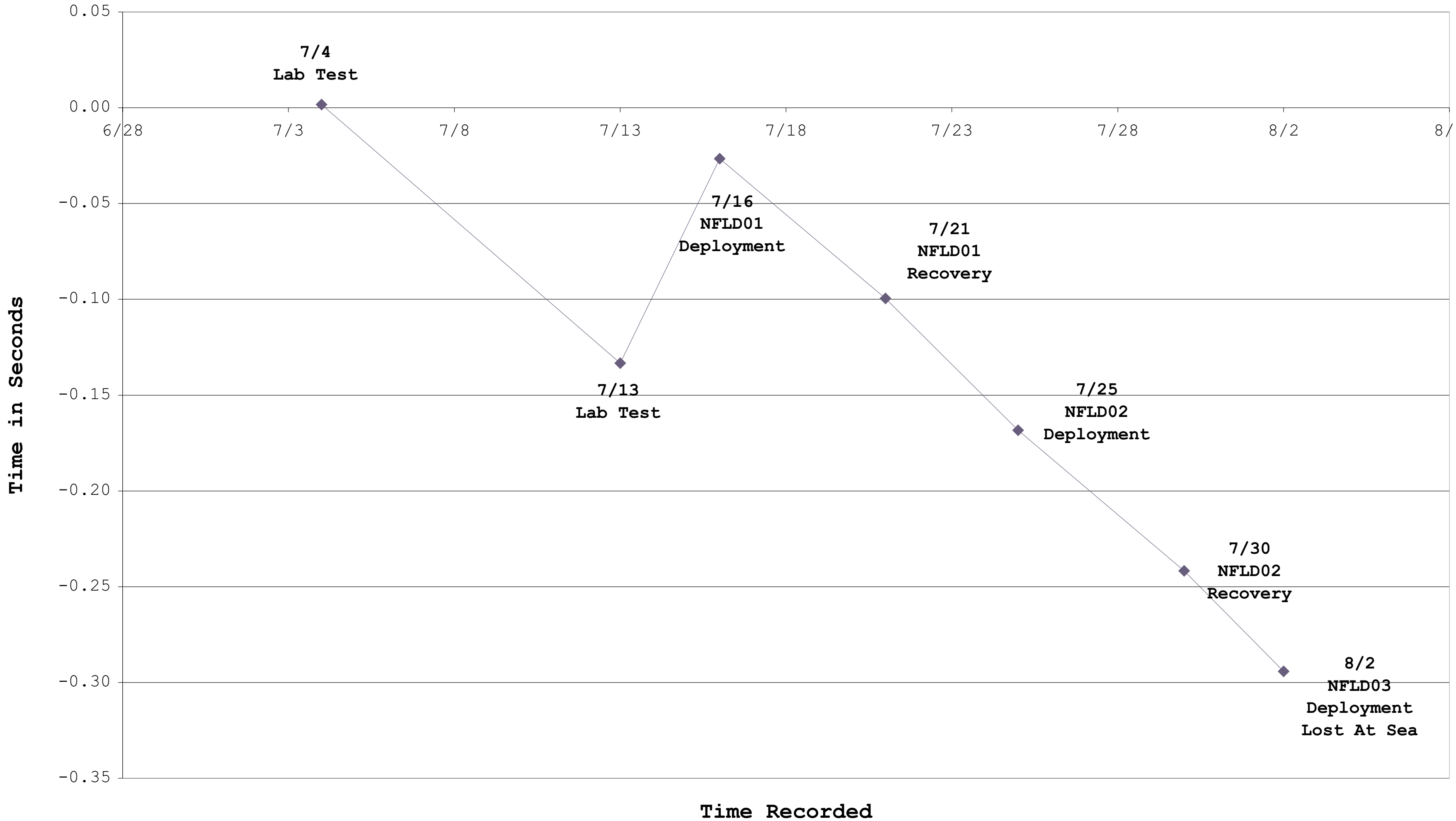

OC359-2
EID 20 CLOCK 1431330
Total Time Correction
Time in Seconds
Time Recorded
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
6/28
7/3
7/8
7/13
7/18
7/23
7/28
8/2
8/7
8/12
07/04 Lab Test
07/13 Lab Test
07/15 NFLD01 Deployment
07/22 NFLD01 Recovery
07/24 NFLD02 Deployment
07/28 NFLD02 Recovery
08/02 NFLD03 Deployment
08/08 NFLD03 Recovery
Reset Clock 08/02 @16:08:40

OC359-2
EID 23 CLOCK 1167160
Total Time Correction

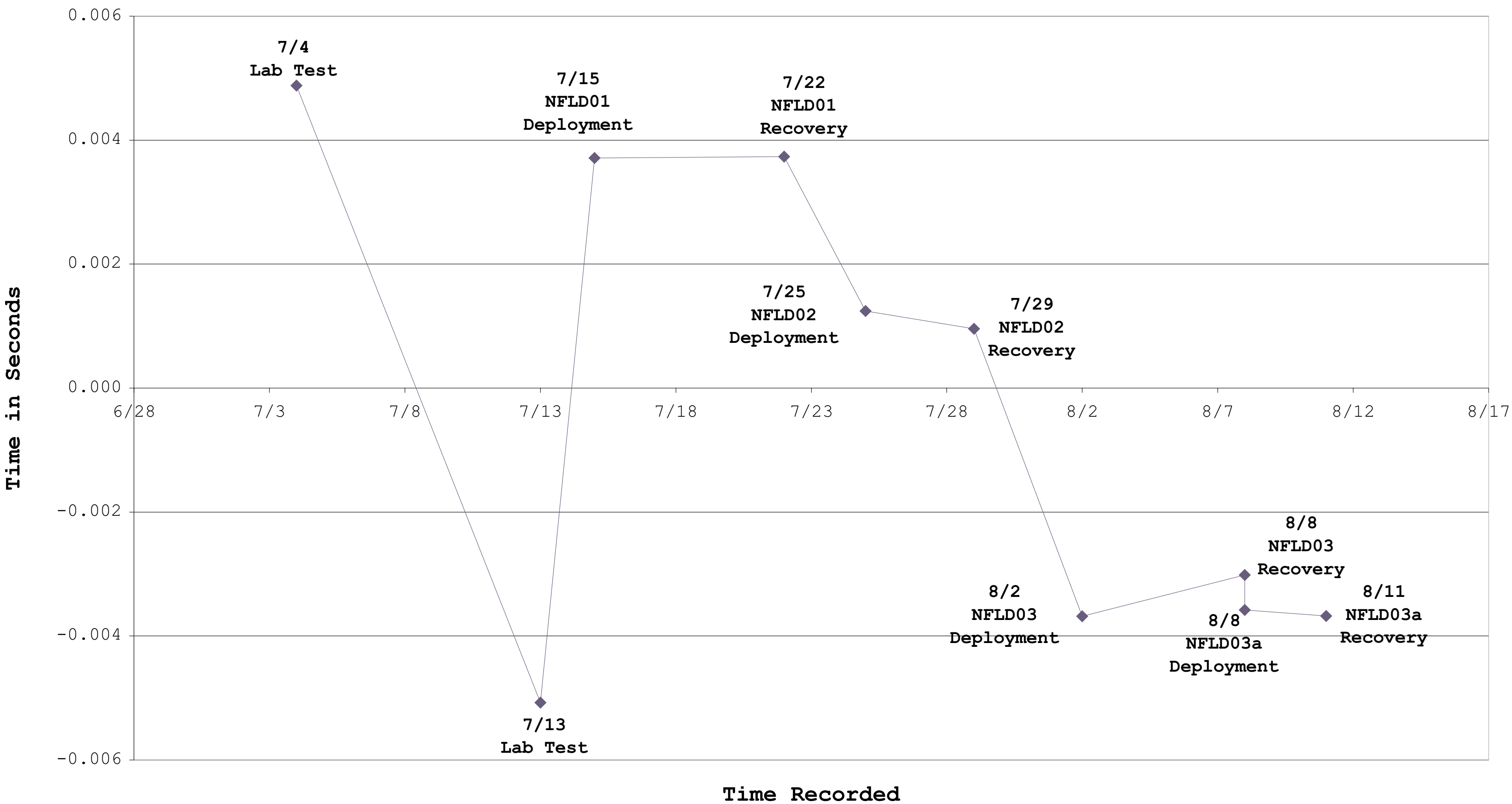


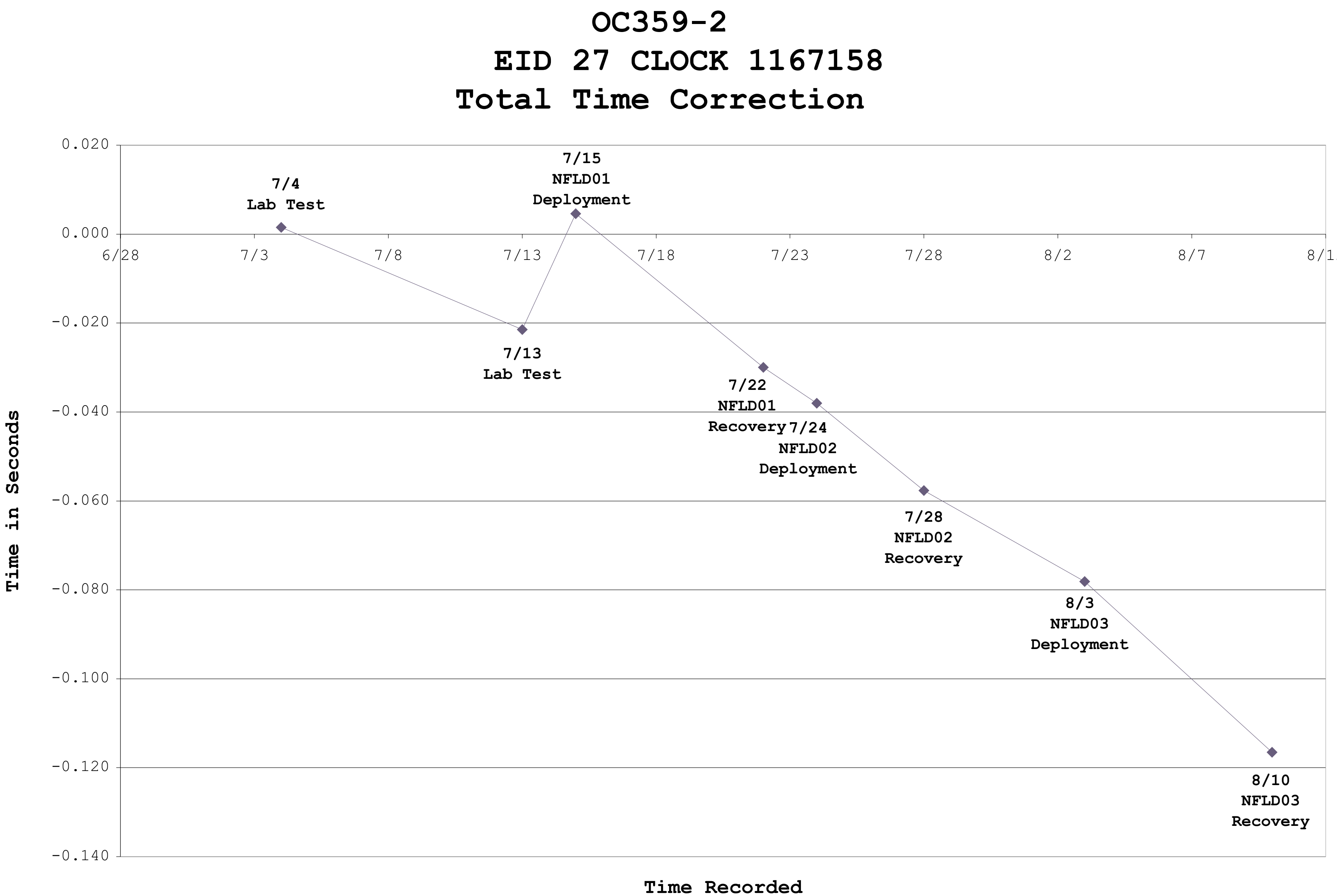

OC359-2
EID 25 CLOCK 1167161
Total Time Correction
Time in Seconds
Time Recorded
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
6/28
7/3
7/8
7/13
7/18
7/23
7/28
8/2
8/7
8/12
07/04/00 Lab Test
07/13/00 Lab Test
07/15/00 NFLD 01 Deployment
07/22/00 NFLD 01 Recovery
07/25/00 NFLD 02 Deployment
07/30/00 NFLD 02 Recovery
08/02/00 NFLD 03 Deployment
08/07/00 NFLD 03 Recovery

OC359-2
EID 26 CLOCK 1218030
Total Time Correction



OC359-2
EID 19 CLOCK 1218029
Total Time Correction

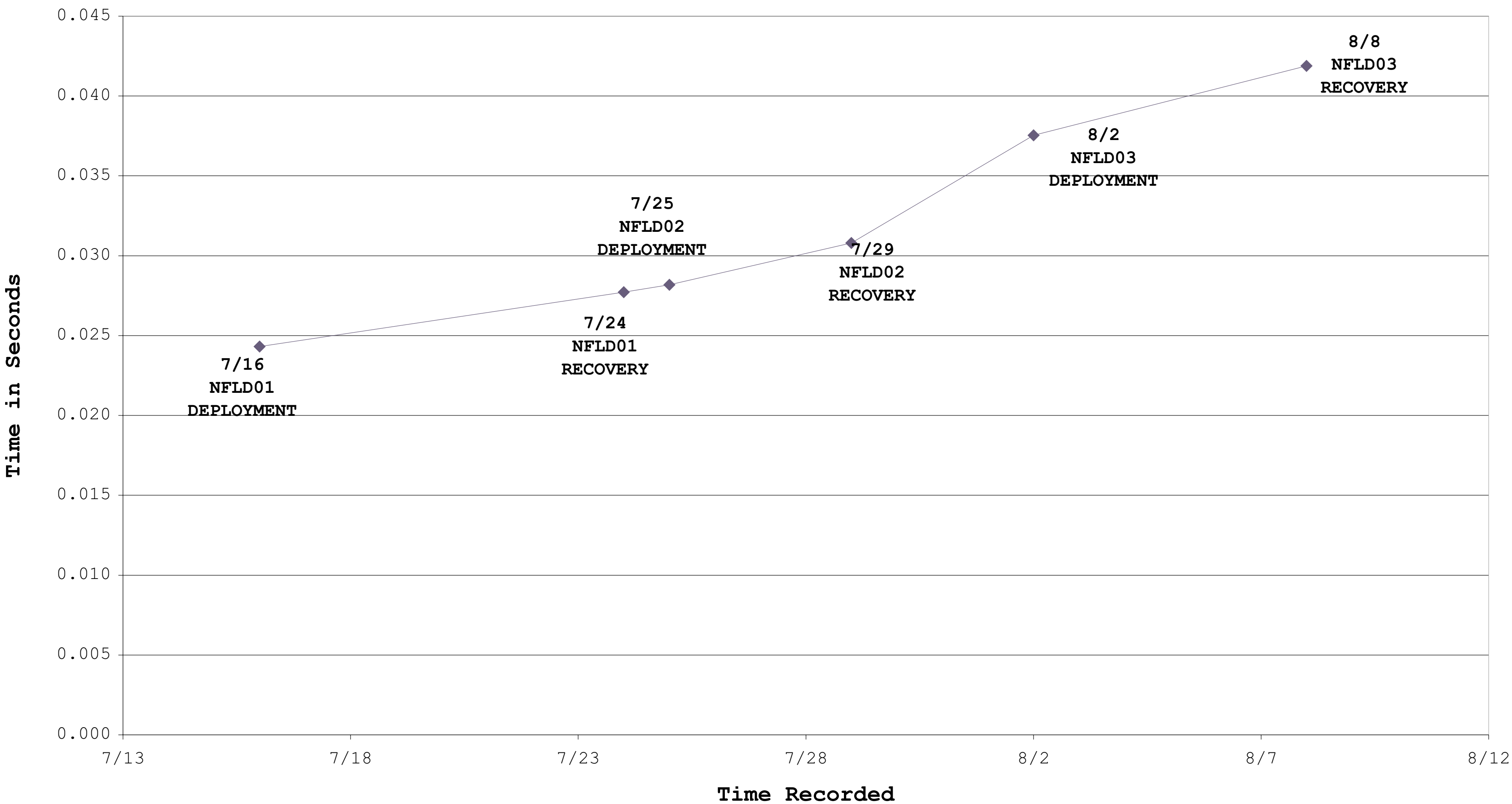



OC359-2
EID 27 CLOCK 1167158
Total Time Correction
0.020
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
-0.120
-0.140
6/28
7/3
7/8
7/13
7/18
7/23
7/28
8/2
8/7
8/12
7/4 Lab Test
7/13 Lab Test
7/15 NFLD01 Deployment
7/22 NFLD01 Recovery
7/24 NFLD02 Deployment
7/28 NFLD02 Recovery
8/3 NFLD03 Deployment
8/10 NFLD03 Recovery
Time in Seconds
Time Recorded

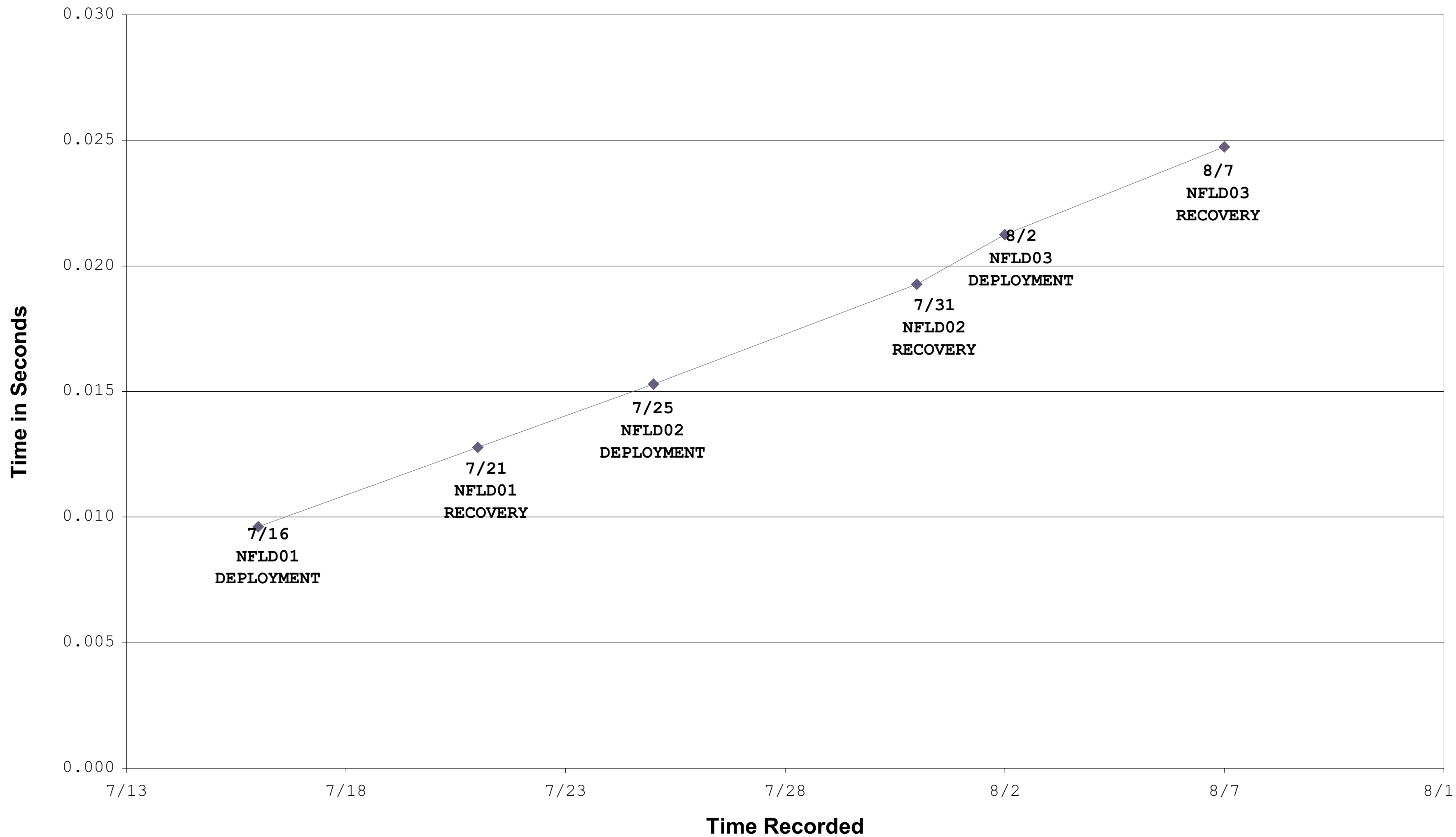
1.9 DATA FROM ORB 01 AND 02 DEPLOYMENTS

ORB#	TIME BASE #	ORB DATE	ORB TIME	SAILCLOCK SECONDS	ORB CORRECTION	SAILCLOCK CORRECTION	TOTAL CORRECTION	DRIFT
1	7543	07/16/00	16:42:34	0.024422	0.024422	-0.000116	0.024306	
1	7543	07/24/00	12:52:26	0.027910	0.02791	-0.000199	0.027711	5.026E-09
1	7543	07/25/00	0:03:55	0.028383	0.028383	-0.000204	0.028179	1.163E-08
1	7543	07/29/00	9:44:41	0.031045	0.0310451	-0.000249	0.030796	6.879E-09
1	7543	08/02/00	20:57:32	0.037836	0.037836	-0.000296	0.037540	1.747E-08
1	7543	08/08/00	9:54:21	0.042241	0.042241	-0.000354	0.041887	9.084E-09
2	7542	07/16/00	11:51:02	0.009726	0.009726	-0.000113	0.009613	
2	7542	07/21/00	8:57:25	0.012941	0.012941	-0.000166	0.012775	7.500E-09
2	7542	07/25/00	12:57:55	0.015507	0.015507	-0.000209	0.015298	7.008E-09
2	7542	07/31/00	4:29:20	0.019539	0.019539	-0.000268	0.019271	8.143E-09
2	7542	08/02/00	15:27:12	0.021541	0.021541	-0.000293	0.021248	9.311E-09
2	7542	08/07/00	15:55:57	0.025089	0.025089	-0.000347	0.024742	8.056E-09
3	7566	07/16/00	13:21:11	0.006728	0.006728	-0.000114	0.006614	
3	7566	07/24/00	21:23:48	0.015924	0.015924	-0.000202	0.015722	1.265E-08
3	7566	07/25/00	16:48:45	0.015331	0.015331	-0.000211	0.015120	-8.613E-09
3	7566	07/31/00	0:27:02	0.019369	0.019369	-0.000266	0.019103	8.668E-09
3	7566	08/02/00	20:04:22	0.018743	0.018743	-0.000295	0.018448	-2.690E-09
3	7566	08/08/00	12:16:38	0.023454	0.023454	-0.000355	0.023099	9.484E-09
6	8023	07/16/00	13:55:36	0.010538	0.010538	-0.000114	0.010424	
6	8023	07/24/00	9:32:30	0.012267	0.012267	-0.000197	0.012070	2.437E-09
6	8023	07/26/00	1:26:50	0.013636	0.013636	-0.000215	0.013421	9.404E-09
6	8023	07/30/00	19:26:43	0.014706	0.014706	-0.000265	0.014441	2.485E-09
6	8023	08/03/00	9:25:43	0.017975	0.017975	-0.000301	0.017674	1.044E-08
6	8023	08/11/00	9:11:11	0.022637	0.022637	-0.000385	0.022252	6.632E-09
7	7723	07/16/00	11:16:55	0.004880	0.00488	-0.000113	0.004767	
7	7723	07/21/00	11:38:42	0.007624	0.007624	-0.000166	0.007458	6.210E-09
7	7723	07/25/00	0:38:35	0.008223	0.008223	-0.000204	0.008019	1.833E-09
7	7723	08/02/00	9:34:43	0.010394	0.010394	-0.000292	0.010102	2.880E-09
7	7723	08/03/00	12:34:13	0.011108	0.011108	-0.000302	0.010806	7.242E-09
7	7723	08/11/00	5:16:03	0.014029	0.014029	-0.000383	0.013646	4.271E-09
8	7721	07/16/00	14:23:38	0.011552	0.011552	-0.000115	0.011437	
8	7721	07/24/00	18:53:23	0.012163	0.012163	-0.000201	0.011962	7.422E-10
8	7721	07/25/00	17:32:07	0.012120	0.01212	-0.000211	0.011909	-6.501E-10
8	7721	07/30/00	22:45:48	0.012582	0.012582	-0.000266	0.012316	9.028E-10
8	7721	08/02/00	14:57:20	0.012876	0.012876	-0.000293	0.012583	1.155E-09
8	7721	08/07/00	13:50:41	0.012350	0.01235	-0.000346	0.012004	-1.353E-09
9	7830	07/16/00	15:51:40	0.014097	0.014097	-0.000115	0.013982	
9	7830	07/26/00	0:41:31	0.007006	0.007006	-0.000214	0.006792	-8.883E-09
9	7830	07/30/00	15:56:06	0.970883	-0.029117	-0.000263	-0.029380	-9.032E-08
9	7830	8/3/2000	8:52:17	0.950724	-0.049276	-0.000301	-0.049577	-6.305E-08
9	7830	#######	20:00:52	0.893215	-0.106785	-0.000379	-0.107164	-8.931E-08

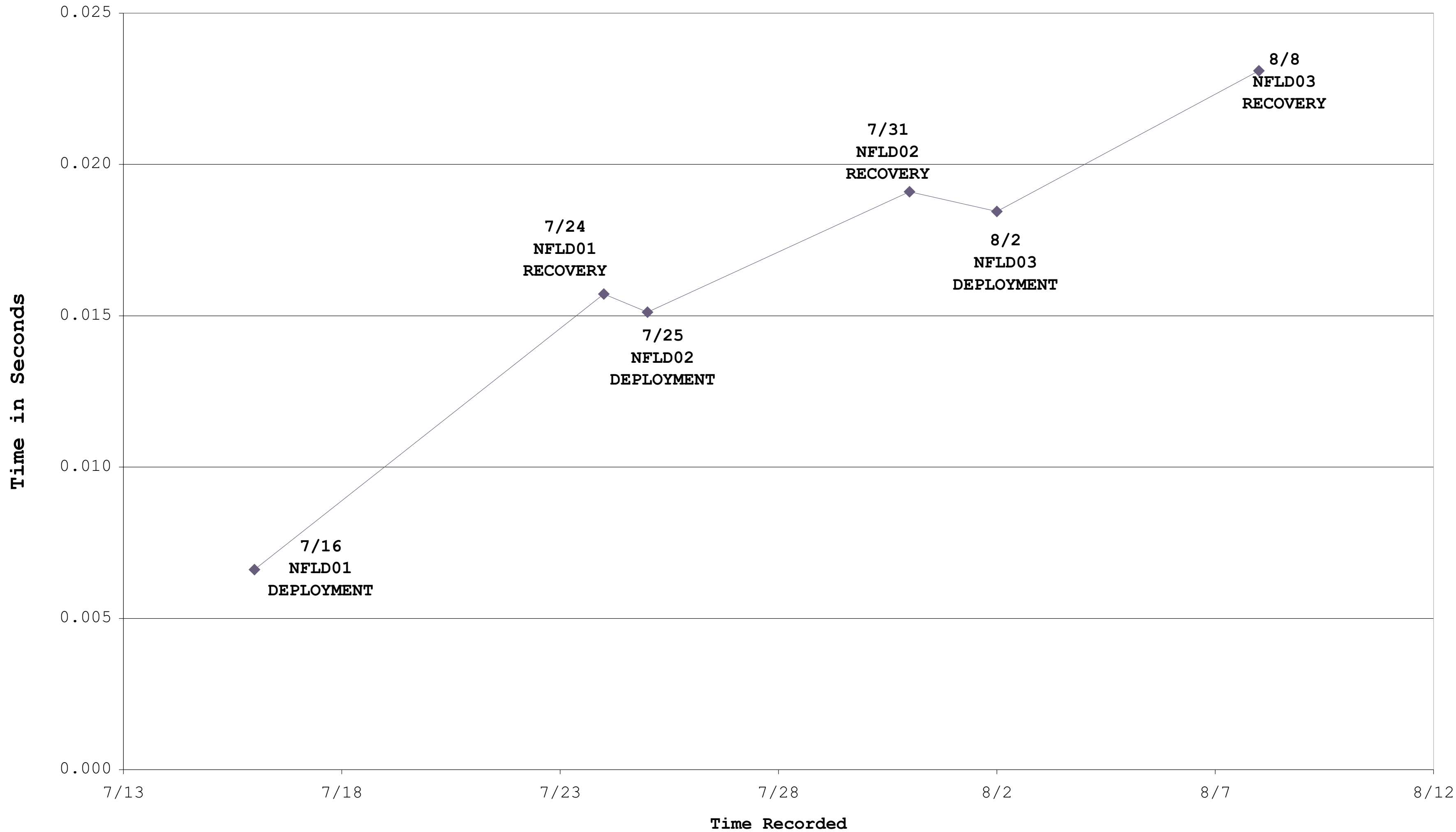
OC359-2
OBR1 TB# 121
Total Time Correction

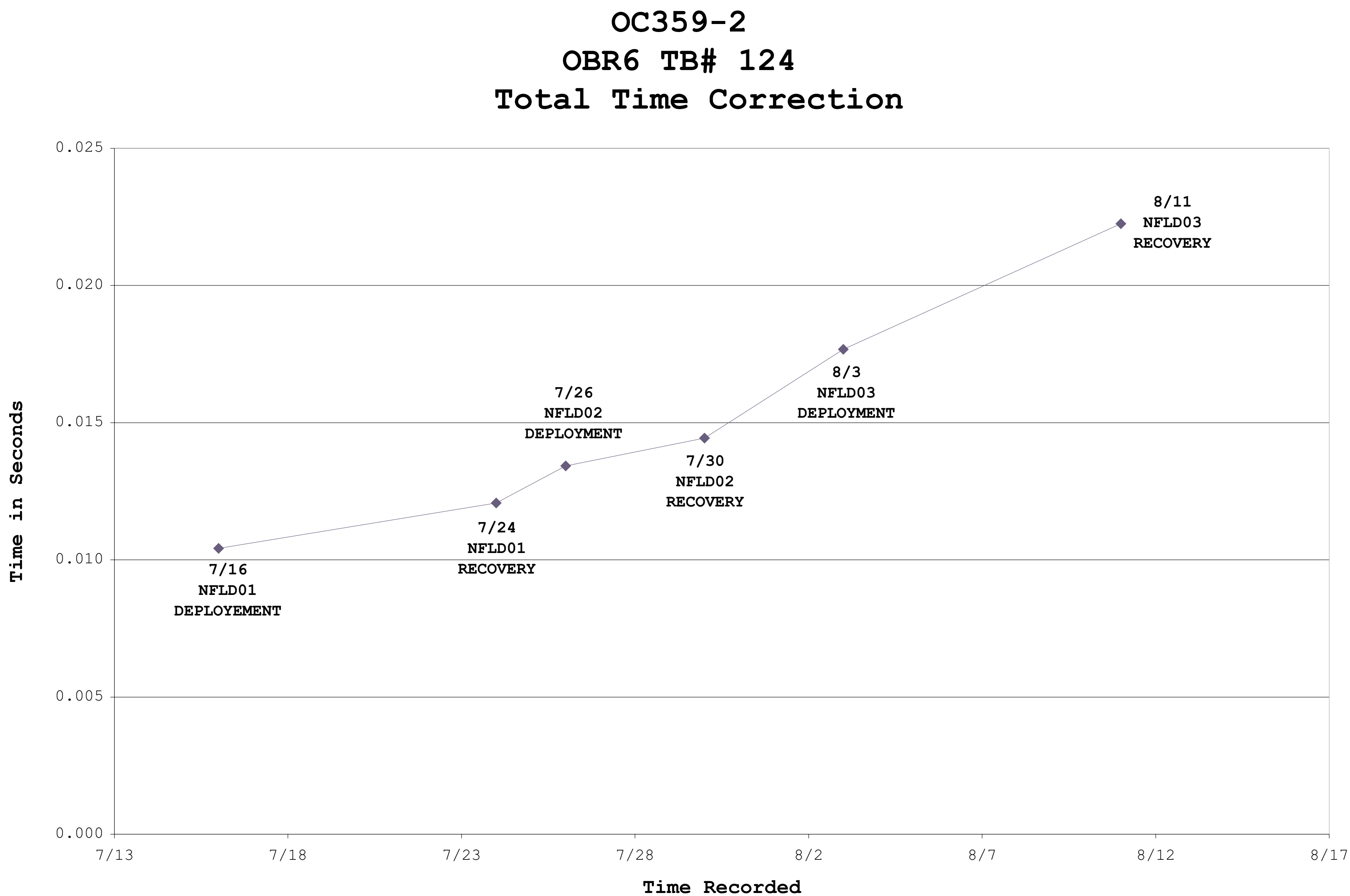


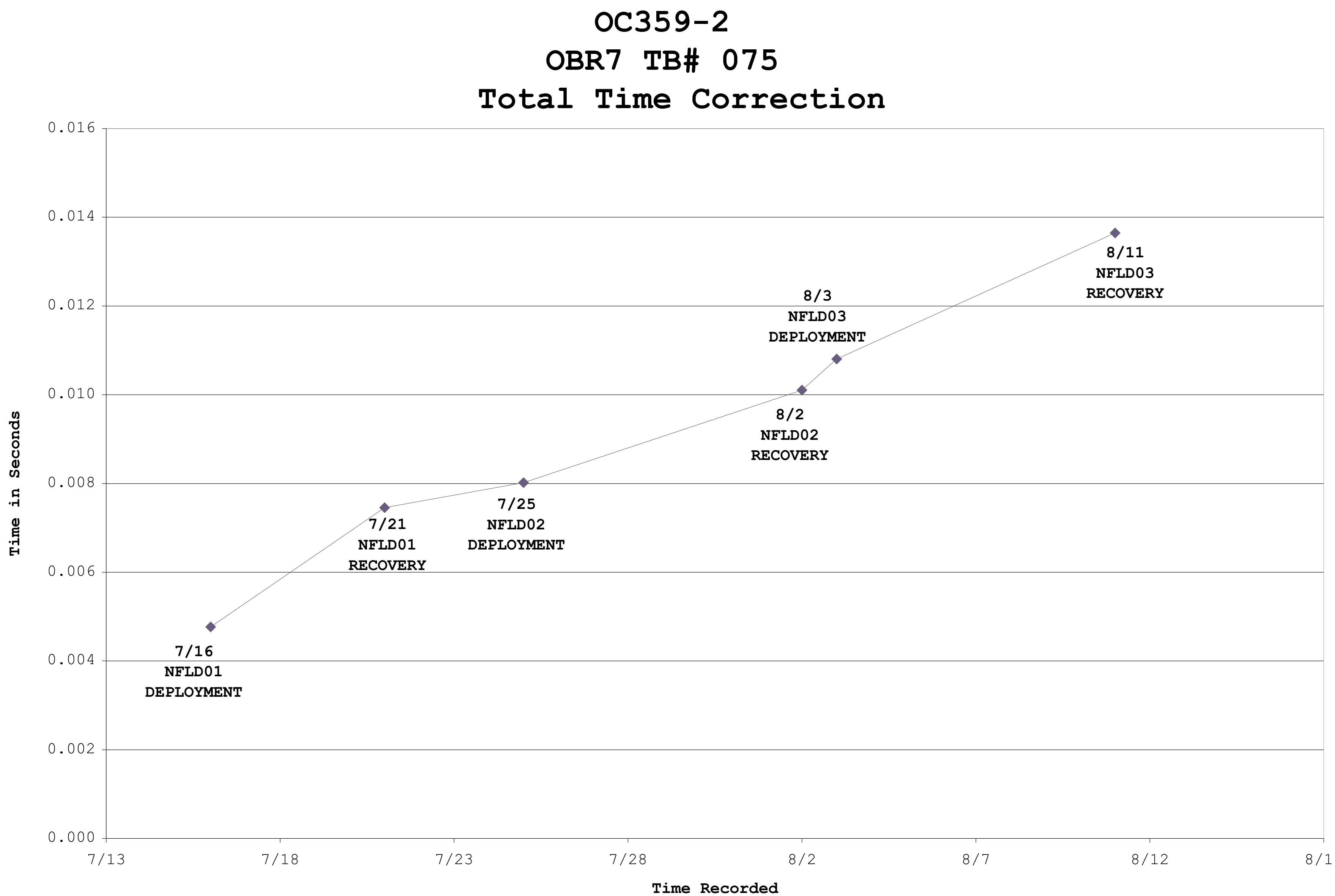
OC359-2
ORB 2 TB# 207
Total Time Correction



OC359-2
OBR3 TB# 085
Total Time Correction

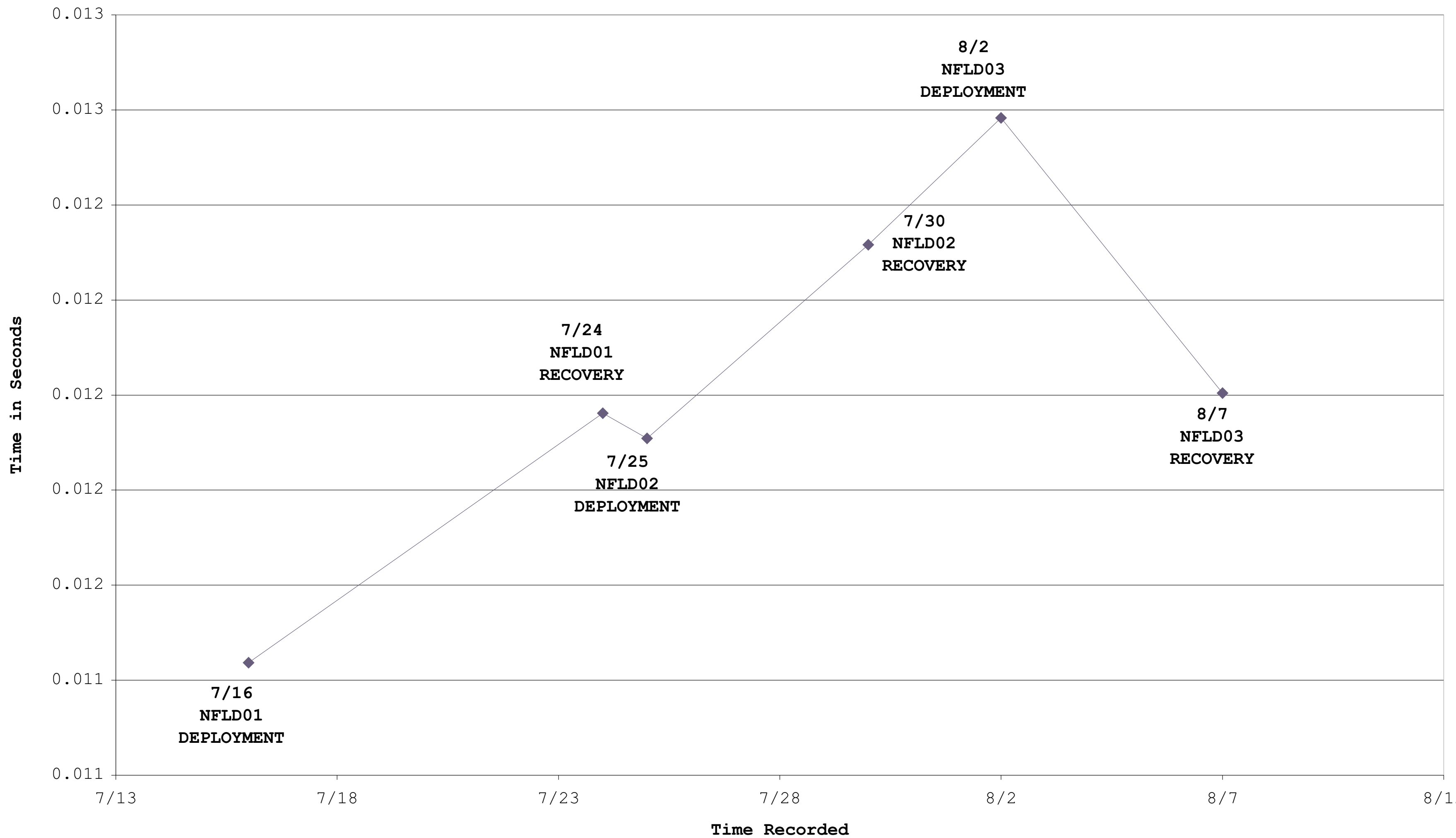



OC359-2
OBR6 TB# 124
Total Time Correction
0.025
0.020
0.015
0.010
0.005
0.000
Time in Seconds
7/13
7/18
7/23
7/28
8/2
8/7
8/12
8/17
Time Recorded
7/16
NFLD01
DEPLOYEMENT
7/24
NFLD01
RECOVERY
7/26
NFLD02
DEPLOYMENT
7/30
NFLD02
RECOVERY
8/3
NFLD03
DEPLOYMENT
8/11
NFLD03
RECOVERY

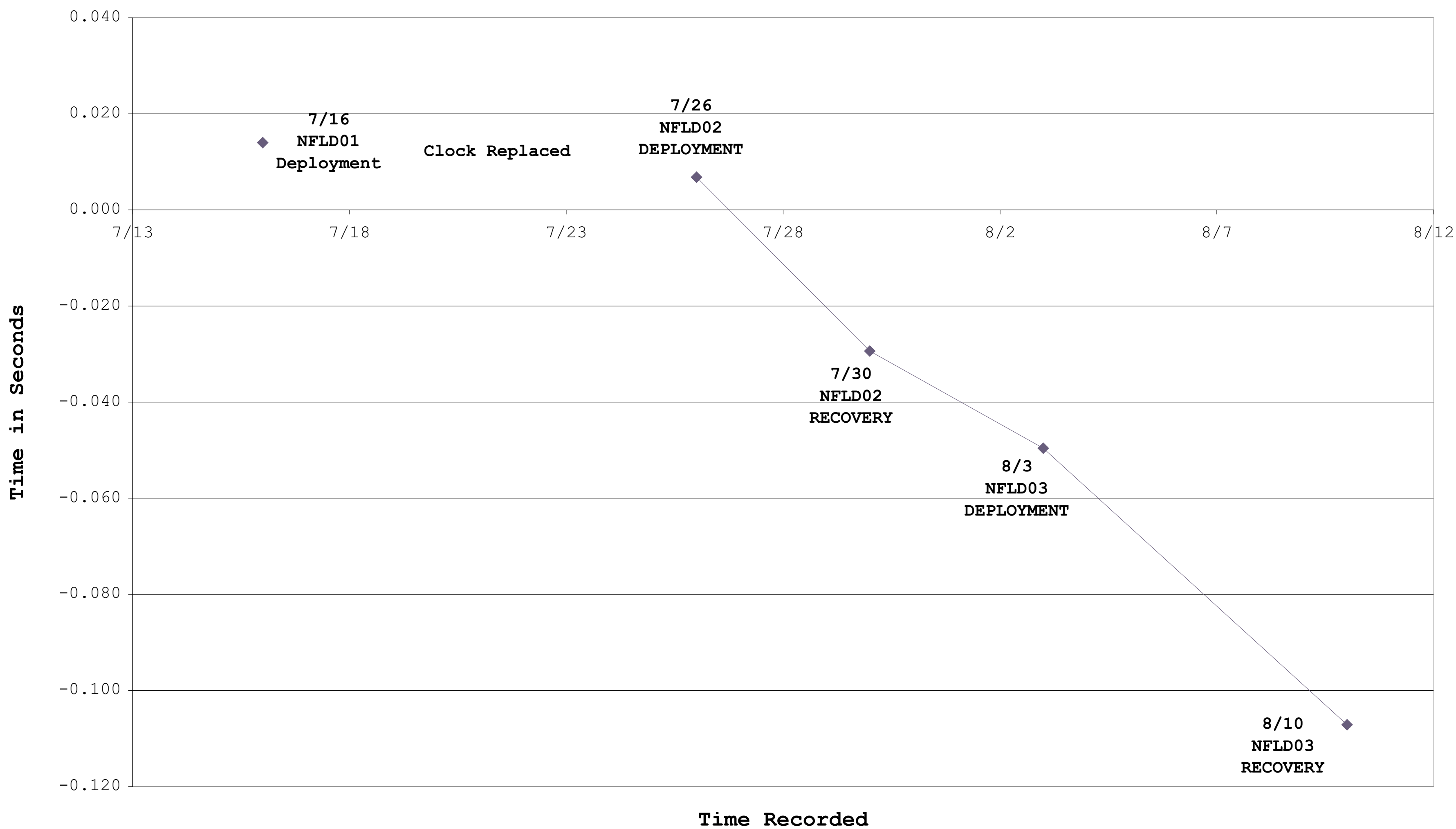


OC359-2
OBR7 TB# 075
Total Time Correction
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Time in Seconds
7/16
NFLD01
DEPLOYMENT
7/21
NFLD01
RECOVERY
7/25
NFLD02
DEPLOYMENT
8/2
NFLD02
RECOVERY
8/3
NFLD03
DEPLOYMENT
8/11
NFLD03
RECOVERY
7/13
7/18
7/23
7/28
8/2
8/7
8/12
8/17
Time Recorded

OC359-2
OBR8 TB# 122
Total Time Correction



OC359-2
OBR9 TB# 086
Total Time Correction



APPENDIX 2: DAL AND GSCA OCEAN BOTTOM SEISMOMETERS

The Ocean Bottom Seismometers used by the team from Dalhousie University are of two types: eight instruments form the Geological Survey of Canada-Atlantic Region (GSCA) and six instruments from Dalhousie University (DAL). All instruments record 4 components: three 4.5-Hz geophone sensors gimbal-mounted in an internal oil-filled container and one external hydrophone. The digital electronics for all instruments are based on essentially the same design and Tattletale-8 data logger; although the GSCA instruments run on a 4-MHz Seascan clock while the DAL instruments use a 5-MHz Austron clock. Since the sampling rates of the 16-bit Sigma-Delta ADC are based on ratios ($\div 2^n$) of the basic clock frequency, they differ for the two instruments with the DAL rate 1.25 times the GSCA rate.

Data is recorded on sequential 2-Mb files until the disks are filled or the acquisition program is aborted. There are small (~10-15 sec) gaps in data when files are written to disk. Some shots may be missed if they occur during these gaps. Time calibrations are made before deployment and following recovery. In most cases clock drifts are not significant over the deployment intervals. However for lines 2 and 3, the GSCA clocks could not be reset in synch with the GPS clock and had to be started manually with arbitrary offsets measured with respect to the GPS standard. In addition, for the DAL instruments clocks sometimes suffered from jumps during deployment caused by interruptions in the clock signal. Generally it is possible to determine if these jumps occurred before of after the shot data were recorded, but in a few cases of several small jumps there might be some inherent uncertainty. In this case, the timing can be verified from arrivals of nearby shots if the position of the OBS is known (shallow water deployments) or assumed (using drifts during descent based on adjacent instruments).

In processing of data to segy-format, timing has been corrected for clock offsets and drifts except where noted. Shot-receiver ranges are calculated from the Ewing's navigation (as supplied) and the Oceanus's position at the time of OBS deployment. Subsequent corrections will need to be applied to these ranges to account for the offset in gun position behind Ewing and the true OBS position on bottom.

2.1. GSCA OCEAN BOTTOM SEISMOMETERS – TECHNICAL REPORT

Introduction

In July and August 2000 the GSCA OBS were used by Dalhousie University in refraction experiment across the Grand Banks, Flemish Cap, and Newfoundland Basin. The Woods Hole Oceanographic Institution ship *RV Oceanus* deployed and recovered OBS and OBH while the Lamont-Doherty Earth Observatory ship *RV Maurice Ewing* did the shooting, and, unexpectedly, recovered one of the GSCA OBS. The *Oceanus* sailed from St. John’s 14 July and returned to St. John’s 12 August 2000. The 8 GSCA OBS were used in conjunction with 6 Dalhousie OBS and 15 WHOI OBH in a program that resulted in a record 80 OBS/H deployments.

Narrative

The GSCA OBS were deployed 22 times in water depths varying from 70 to 4650 meters. There were no problems with the GSCA OBS electronics or with programming, data collection and downloading. The new packaging is clean and easy to work with once the filter and gain settings are configured.

Over-the-side deployments & surface pickup on recovery went smoothly. The release rope canisters were eliminated for this program and all flotation packages were fitted with a stainless-steel hoop to facilitate hooking the OBS when it came alongside.

Releasing the OBS from the seafloor was frustrating, time-consuming, and costly. A number of OBS did not respond to the acoustic release command sent from the Vemco deck unit to the OBS underwater controller and a number of OBS which responded normally to the code were very slow to release from the bottom. Fully 30% of the GSCA and Dalhousie units experienced one or the other of these problems. Prior to this cruise, in approximately 125 deployments of Dalhousie & GSCA OBS using Vemco acoustic releases, there had not been a single failure of an OBS to respond to its release code. On this cruise there were 6 failures in 38 deployments only one of which was the same OBS twice. Other than that OBS all the others responded normally on subsequent deployments. When an OBS responds to its release command the "burn time", the time it takes for the Monel burn-wire loop to disintegrate and the OBS to lift off the bottom, is usually between 5-10 minutes. In the previous 125 deployments of this OBS pool 2 units failed to lift off within 20 minutes of their acknowledged command. On this cruise we experienced 5 burn-times in excess of 2 hours and one of 42 minutes.

Results

The GSCA OBS produced very good data with no timing problems. See Sections 2.2 Seismic Processing Section and 2.3 SEGY files for preliminary notes on the individual instrument's performance.

OBS 7, deployed L1 #9, 163m, was not recovered. It responded to its acoustic release command but failed to lift off the bottom while the *Oceanus* stood by for two hours. When the ship arrived back on location after recovering OBS & OBH at other stations some 20 hours later OBS 7 was no longer on the bottom. A lengthy search pattern failed to yield positive radio contact. The deployment site was in a area of 2 knot highly confused currents, at the confluence of the Labrador Current and the Gulf Stream, so it is likely that the OBS drifted out of radio range during our absence, or less-likely, that the OBS rdf transponder failed. OBS 4, L1#21, 4289m, and OBS 1 L2#15, 4538m, also failed to lift off bottom while the ship was standing-by but were recovered subsequently on the surface on return visits to their locations. Both these instruments were deployed again later with no problems.

OBS 6, L2 #8, 3178m, and OBS 5, L3#25, 3969m, did not respond to their acoustic release commands despite repeated attempts from different angles and compass directions. They both were recovered, OBS 5 by the *RV Ewing*, when they surfaced on schedule on their backup releases. Neither was redeployed after their failures but that was the result of the failures happening late in the cruise and not concern over reliability. OBS 6 had been deployed once and OBS 5 three times prior to their failures. Dalhousie OBS E was deployed twice and OBS D once after early failures to respond with no subsequent problems. Repeated attempts to release OBS 3, L1 #20, 3201m, acoustically failed while OBS 4 L1 #21 was pinging on the seafloor 4.2 nm away (see above). After OBS 4 was surfaced and was recovered OBS 3 responded to the first release code.

Conclusions

The GSCA OBS are proving to be highly dependable and easy to operate field instruments.

The Seascan clocks are extremely reliable and exhibit consistent drifts from one deployment to the next. If a history is maintained clock corrections could be made if an end of deployment clock drift measurement is not possible. As a result of problems with the GSCA GPS Master clock, after the Line 1 the GSCA OBS clocks were set by manually inputting the time and measuring the offset from gps time by time-tagging the 1 pps output of the OBS Seascan using Dalhousie's Odetics GPS Time System. This turned out to be an effective means of setting and getting a microsecond accurate drift measurement at the end of the deployment.

The erratic failure of acoustic communication between the Vemco deck transponders and the OBS controllers is difficult to attribute a specific acoustic, geological (sediment or topography), or oceanographic condition unique to the area. However, given the previously perfect performance of the system, and the erratic nature of the problem this cruise, it most unlikely that the cause is some formerly undetected design flaw. Our inability to release OBS 3 while OBS 4 was pinging a continuous 1 second release acknowledgement 5 miles away, followed by OBS 3's immediate acceptance of the release message once OBS 4 was off, does appear to be an acoustic code design problem requiring corrective action. The GSCA instruments are fairly new and have had few deployments so it is very unlikely that aging components are a factor.

The slow release of an OBS from the bottom after a normal response has been an infrequent occurrence in the past. These instruments are not usually recovered or if we do get them back it is a long time later when someone turns them in so we do not often get to measure the release power supply. During this cruise we had 5 instruments which took in excess of 2 hours to release from the bottom all of which eventually surfaced and 4 of which we recovered. Measured release battery voltages in all cases were consistent with a normal burn cycle. It would appear that the term "long burn" which is often applied to this failure mode is a misnomer and we should instead be using "slow release". The slow bottom releases this cruise were most likely caused by mechanical (frictional) jamming of the flotation brackets in the anchor retainer guides. Gritty oozes and sandy sediment with shell fragments were found adhering to some OBS cylinders and floats and to Heat Flow probes. It is felt that the problem was exacerbated by overweight anchors which caused higher than usual impact disturbance with an increased amount of sediment settling down on top of the anchor plate.

Repairs

The **GSCA Master GPS clock** requires repair of the internal wiring. The clock was jarred causing the internal "C" cell batteries to pop out of their holder. The loose batteries broke some of the wiring connections. Without a wiring diagram and with alternative method to set the OBS clocks it was deemed best to set it aside for repair ashore. Repairs required should be limited to reattaching the wires to their proper locations.

The **GSCA Vemco deck unit** should be sent to Vemco for servicing. The rechargeable battery does not retain a charge and the unit is far less effective than the two Dalhousie deck boxes in communicating with the bottom controllers. Vemco should verify that the output and tuning of the box is up to specifications.

Recommendations

GSCA OBS Electronics package

Redesign the mounting of the WAB/DIB/Tattletale module so that the DIB filter jumpers and WAB gain resistors are more easily accessible. As currently configured these changes require unscrewing and unplugging most of the assembly to make changes.

Add some vertical & horizontal supports to the geophone assembly to improve coupling with the pressure cylinder. At present the geophone assembly is suspended mid-cylinder by a mounting on the endcap some 30 cm from its center of mass.

Vemco Acoustic Release System

More thought and discussion should be directed towards understanding the cause of the communication difficulties between the Vemco deck and bottom units encountered on the Oceanus cruise.

The problem of a continuously pinging OBS interfering with communication with nearby units should be addressed and resolved immediately. A fix that has been discussed with Greg McKinnon of Vemco to add another release code which would stop the pinger after, say, 1 hour.

Mechanical release components

Ensure that the anchor weight is kept to minimum required.

Redesign the flotation package/anchor contact to reduce the potential of mechanical resistance to releasing. Stronger springs, redesign of the bottom bracket profile to reduce the contact surface area, and/or the introduction of an expendable PVC shim between the anchor and the bottom bracket are all possibilities. Raising the cylinder off the anchor by introducing a shim or making a higher bottom bracket, in addition to reducing surface friction, also raises the endcap transducer off the seafloor reducing the likelihood that it could be masked or confused by acoustic bounces from a surrounding sediment mound.

2.2: SEISMIC PROCESSING

The Dalhousie group used a total of 14 ocean bottom seismographs equipped with three-component 4.5-Hz geophones and a hydrophone. Eight of these OBS belong to the Geological Survey of Canada (Atlantic Division) and six are owned by the Dalhousie University. The sampling rate was 139 Hz and 174.38 Hz on the GSCA and Dalhousie instruments, respectively. After retrieval of the instruments, the raw data was downloaded and saved on CD-ROM and 4-mm DAT tape. The raw data consist of 2 MB large data files named *datafile.XYZ* with XYZ starting with 000 and incremented by 1.

The raw data were converted to SEGY-format using Dalhousie software. The shot-receiver offset was computed from the shot locations given by R/V Maurice Ewing (not corrected for offset between guns and GPS antenna) and the deployment position of the OBS. Corrections for the OBS clock drift were applied unless stated otherwise in this report. The record length is 60 seconds. Output files use the following nomenclature.

s[*1/2/3*][*1-29*]ch[*1-4*].sgy

The first identifier [1/2/3] specifies the line number,
the second identifier [1-29] specifies the station number,

and the third identifier [1-4] gives the channel number with

ch1 the hydrophone component,
ch2 the vertical geophone, and
ch3/4 the horizontal geophone components.

Shots recorded during the MCS shooting segment along the lines were stored in separate files, using the name **mcs[1/2/3][1-29]ch[1-4].sgy** with the same nomenclature as above.

Remarks for individual stations

Line 1 Station 1
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 1 to 2454 and 2455 to 8855 (MCS) in SEGY files. The station has a low signal-to-noise ratio, the direct wave is difficult to identify. Some portions show noise from another seismic campaign in the area with a shot interval of ~10 seconds.

Line 1 Station 2
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 1 to 2454 and 2455 to 8855 (MCS) in SEGY files. Data is noisy but direct waves can be easily seen on raw sections. The data need to be debiased before further processing.

Line 1 Station 3
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 1 to 2454 and 2455 to 8736 (MCS) in SEGY files. Data is noisy but direct waves can be easily seen on raw sections. The data need to be debiased before further processing. Low frequency noise on hydrophone component.

Line 1 Station 7
GSC instrument with a sampling rate of 139 Hz. Shots 1 to 2454 and 2455 to 7215 (MCS) in SEGY files. There is some bias in the data. The vertical geophone component was processed on board with a 3-15 Hz bandpass-filter and a coherency mix across 7 traces (velocity range 4.0 to 8.0 km/s). The section shows continental crust to the NW with upper crustal velocities of ~6.0 km/s and a mid-crustal reflection. To the SW, P_n phases can be correlated up to offsets of 185 km.

Line 1 Station 8
GSC instrument with a sampling rate of 139 Hz. Shots 1 to 2454 and 2455 to 6931 (MCS) in SEGY files. Strong low –frequency noise on hydrophone component.

Line 1 Station 9
GSC instrument with a sampling rate of 139 Hz. Instrument not recovered.

Line 1 Station 13
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 1 to 2454 and 2455 to 8855 (MCS) in SEGY files. The OBS clock had a drift of –5246 ms during the survey which is

probably attributed to a jump of the clock during the deployment or close to the beginning of the survey. For this reason, the drift of –5246 ms was applied as a static correction for all shots. The linear clock drift could not be accounted for. Using the static shift, the direct arrivals are at the appropriate position. The hydrophone channel (ch1) has recorded low-frequent noise but otherwise the signal-to-noise ratio is good. The three geophone channels show relative low amplitudes.

Line 1 Station 14
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 1 to 2454 and 2455 to 4572 (MCS) in SEGY files. The OBS clock had a drift of –14295.5 ms during the survey which is probably attributed to a jump of the clock during the recovery of the instrument. Direct waves arrive at the appropriate time without clock corrections. No corrections for the linear clock drift were applied since the drift could not be separated from the time jump. The hydrophone has recorded low-frequency noise. The geophone components (ch2 and ch4) show time intervals with strong 7-Hz signal.

Line 1 Station 15
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 1 to 2454 and 2455 to 4121 (MCS) in SEGY files. The vertical geophone shows 5-Hz noise, which is missing on the two horizontal geophones. The horizontal geophones show a very low background noise level and also the signal appears to be strong only for close shots. The hydrophone has some low-frequent noise but the seismic signal can be well seen for large offsets.

Line 1 Station 19
GSC instrument with a sampling rate of 139 Hz. Shots 1 to 2454 in SEGY files. The station has some low-frequency noise on the hydrophone channel but otherwise the signal-to-noise ratio is very good on all channels. The vertical geophone component was processed on board with a 3-15 Hz bandpass-filter and a coherency mix across 7 traces (velocity range 4.0 to 8.0 km/s). The section shows crustal refractions with a phase velocity of ~6.5 km/s to the SE up to offsets of 30 km, where probably the P_n phase becomes the first arrival. This would indicate oceanic crust. To the NW the seismic phases are influenced by strong basement topography.

Line 1 Station 20
GSC instrument with a sampling rate of 139 Hz. Shots 1 to 2454 in SEGY files. Low-frequency noise is observed on the hydrophone channel. Seismic signals can be seen on the hydrophone and vertical geophone component. The two horizontal geophones show strong clipping in the direct wave field, other seismic phases are less evident.

Line 1 Station 21
GSC instrument with a sampling rate of 139 Hz. Shots 1 to 2454 in SEGY files. For shots 2428 to 2454 the pinger of the instrument was on, but instrument was still on the seafloor. Strong noise on hydrophone channel (0-30 Hz). Geophone components have a better signal-to noise ratio.

Line 1 Station 25
GSC instrument with a sampling rate of 139 Hz. Shots 1 to 2360 in SEGY files. Shots 2254 to 2360 were recorded after the OBS released from the seafloor. The record section for this instrument shows a pattern compatible with oceanic crust, both to the NW and the SE. The record section may show some shear-wave phases to the NW as well. Crustal refractions with velocities of ~6.5 km/s are seen up to offsets of 30 km. For larger offsets the P_n phase becomes the first arrival. Good signal-to-noise ratio on the vertical geophone and the hydrophone (apart from the typical low-frequency noise).

Line 1 Station 26
GSC instrument with a sampling rate of 139 Hz. Shots 1 to 2227 in SEGY files. Shots 2100 to 2227 were recorded after the OBS released from the seafloor. 6.5-Hz noise signal on some traces (shots120 to 260) of the geophone components. Strong low-frequency noise on the hydrophone channel. Seismic signals are visible beneath the noise.

Line 2 Station 3
GSC instrument with a sampling rate of 139 Hz. Shots 21705 to 23533 and 23820 to 31250 (MCS) in SEGY files. Large shot intervals on the geophone components have recorded 5.5 to 6.5-Hz noise.

Line 2 Station 6
GSC instrument with a sampling rate of 139 Hz. Shots 21705 to 23533 and 23820 to 31250 (MCS) in SEGY files. Some shot intervals on the geophone components are spoiled by 6.5-Hz noise. The hydrophone has low-frequency noise.

Line 2 Station 8
GSC instrument with a sampling rate of 139 Hz. Shots 21705 to 23533 and 23820 to 31250 (MCS) in SEGY files. Some shot intervals on the geophone components are spoiled by 6-Hz noise. The hydrophone has extreme low-frequency noise (0-2 Hz).

Line 2 Station 9
GSC instrument with a sampling rate of 139 Hz. Shots 21705 to 23533 and 23820 to 31209 (MCS) in SEGY files. The hydrophone has low-frequency noise (0.5 Hz). The geophone components are biased but have a good signal-noise-ratio (in particular z-component).

Line 2 Station 13
GSC instrument with a sampling rate of 139 Hz. Shots 21705 to 23533 and 23820 to 29709 (MCS) in SEGY files. The hydrophone has low-frequency noise. Refracted phases can be correlated well on the vertical geophone component.

Line 2 Station 14
GSC instrument with a sampling rate of 139 Hz. Shots 21705 to 23533 and 23820 to 29055 (MCS) in SEGY files. The hydrophone has low-frequency noise on traces 21705 to 21783 (0.7 Hz) only. The reason for the disappearance of this otherwise so characteristic noise is unknown. There is also some slight bias on the hydrophone channel. Refracted phases can be correlated well on the vertical geophone component. On the horizontal geophone component (ch 4) some 2

seconds with zero samples follow the direct wave on traces 22490 to 22560 (geophone was saturated).

Line 2 Station 15
GSC instrument with a sampling rate of 139 Hz. Shots 21705 to 23533 and 23820 to 28526 (MCS) in SEGY files. The hydrophone has low-frequency noise. Channels 2 and 4 are slightly biased. Good refracted phases on the vertical geophone. To the NW, the onset of the P_n is at an offset of 13 km only, indicating fairly thin crust and may indicate a serpentinized ridge. This feature is consistent with observations on stations 13 and 14 and with the gravity. The phase velocity of the P_n is 8.3 km/s.

Line 2 Station 20
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 21705 to 23533 and 23820 to 26058 (MCS) in SEGY files. The OBS had clock problems and recorded a clock drift of ~67 minutes after recovery. Many Dalhousie OBS had clock jumps but they occurred either during the deployment or recovery procedures. This OBS clock may have three jumps or more. The OBS recorded its release from the seafloor at 23:06:02 on Julian day 210. The pinger field record shows a time of 23:09 UTC for the release from the seafloor. This time should have an error margin of ±1 minute. This is more than the necessary static time correction to line up the direct wave, which was determined to –1 min 38.391 sec assuming a water depth of 4685 m and a water velocity of 1.5 km/s. This static time correction was applied to all traces. However, great care has to be applied for further analysis of the station. The hydrophone has low-frequency noise. The geophone components have recorded 5.5-Hz noise during several time intervals. Channels 2 and 3 are biased.

Line 2 Station 21
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 21705 to 23533 and 23820 to 31250 (MCS) in SEGY files. The OBS had clock problems and recorded a clock drift of –5.7 sec after recovery. This drift is probably due to clock jumps, possibly both during deployment and recovery. To match the traveltimes of the direct waves (3140 ms for a water depth of 4710 m and a water velocity of 1.5 km/s), a static shift of -1151 ms was applied to the entire data set. All geophone components are biased and show 6.5-Hz noise for large shot segments. The hydrophone component has extreme low-frequency noise (0.5 and 1.5 Hz).

Line 2 Station 25
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 21705 to 23533 and 23820 to 24268 (MCS) in SEGY files. The hydrophone has low-frequency noise. Low amplitudes on channel 4. Vertical geophone shows refracted phases. All channels are biased.

Line 3 Station 1
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 47043 to 48749 and 48750 to 53210 (MCS) in SEGY files. All geophone channels are biased.

Line 3 Station 2
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 47043 to 48749 and 48750 to 53210 (MCS) in SEGY files. The hydrophone component has low-frequency noise. All

geophone channels are biased. The amplification of the signal was reduced by –14 dB compared to other stations.

Line 3 Station 3
GSC instrument with a sampling rate of 139 Hz. Shots 47043 to 48749 and 48750 to 53210 (MCS) in SEGY files. The vertical geophone (channel 2) has recorded low-frequency noise (1-2 Hz). On the MCS data, a strong P_mP reflection can be seen to the SW at offsets > 100 km.

Line 3 Station 4
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 47043 to 48749 and 48750 to 53210 (MCS) in SEGY files. The hydrophone component has low-frequency noise. Channels 2 and 3 are biased, channel 4 is slightly biased.

Line 3 Station 9
Dalhousie instrument with a sampling rate of 174.38 Hz. Shots 47043 to 48749 in SEGY files. All geophone channels are slightly biased with channel 3 showing 6.5-Hz noise. Low-frequency noise is observed on the hydrophone channel.

Line 3 Station 10
GSC instrument with a sampling rate of 139 Hz. Shots 47043 to 48749 in SEGY files. All four channels are biased and the signal-to-noise ratio is high, there is no significant low-frequency noise on the hydrophone channel.

Line 3 Station 11
GSC instrument with a sampling rate of 139 Hz. Shots 47043 to 48749 in SEGY files. Channel 4 has background noise but no seismic signal can be seen (on first inspection). Channels 1 through 3 are saturated behind the direct wave for some close offset shots. The hydrophone has low-frequency noise. Strong mono-frequent 6-Hz noise is recorded on many traces on channels 2 and 3. On channel 3 the noise is often above the clipping level. Channel 4 is biased.

Line 3 Station 17
GSC instrument with a sampling rate of 139 Hz. Shots 47043 to 48749 and 48750 to 53210 (MCS) in SEGY files. The hydrophone has low-frequency noise. The first 500 traces on channel 3 have almost no background noise. Later traces have a strong 5-Hz signal in the background. All channels are biased. Mantle phases with a phase velocity of ~7.7 km/s are observed for offsets >12 km in both directions indicating an extremely thin crust.

Line 3 Station 18
GSC instrument with a sampling rate of 139 Hz. Shots 47043 to 48749 and 48750 to 53210 (MCS) in SEGY files. Signals on channels 2 and 4 are often saturated after the direct wave. All geophone components have recorded strong 6-Hz noise, that is clipped on channels 2 and 4.

Line 3 Station 19
GSC instrument with a sampling rate of 139 Hz. Shots 47043 to 48749 and 48750 to 53210 (MCS) in SEGY files. The hydrophone has low-frequency noise and shows saturation behind the direct wave. Saturation also occurs on channels 2 and 4.

2.2.1 SEISMIC PROCESSING ON BOARD

1. Raw navigation data was obtained from R/V MAURICE EWING
2. Transformation of raw navigation data using the program *raw-nav.for* . Output: *line[line#][mcs].nav*
3. Creating preliminary shot tables with the program *maketab.for* using the input files *mcs[line#][station#].inp* and *s[line#][station#].inp* and the transformed navigation files . Output files: *mcs[line#][station#].sht* and *s[line#][station#].sht*
4. The program *maketab.for* has difficulties with determining the correct sign for the ranges. The output shot tables should be checked manually to determine shot numbers with negative offsets. The program *offset.for* than corrects the signs of the ranges. The program prompts for input and output files and for the minimum and maximum shot point number with negative offsets. After this step, the input shot tables were deleted and the output shot tables were renamed to the name of the input shot table.
5. The shot tables have than to be corrected for the clock drift and any static time corrections. This is done by the program *drift.for* . The input files are the shot tables and files with the name *mcs[line#][station#]tc.inp* and *s[line#][station#]tc.inp* (tc stands for time correction). These .inp files contain six lines of the following format

`s107.sht`	← input shot table
`s107tc.sht`	← output shot table
`-5424`	← static clock correction (msec)
`196,19,12,0`	← clock start (day,hour,minute,second)
`204,8,41,0`	← clock check (day,hour,minyte,second)
`-16`	← clock drift (msec)

6. The output shot tables show the actual OBS clock time of individual shots. The names are *mcs[line#][station#]tc.sht* and *s[line#][station#]tc.sht*
7. Now the SEGY files can be compiled using the program *Dobs2Sgy2000.exe* (please note bugs at the end of this report). Click on the program icon, click okay and browse to the directory with the raw datafiles. Click on the first datafile, move to the last datafile, hold the *SHIFT* key and click on the last datafile. Press *OK*. In the next field browse to the appropriate time corrected shot table, and specify the output filename in the lowermost browse window. Record length is 60 seconds and choose *0* for all channels. The channel number will be added automatically to the SEGY file name.

***Dobs2Sgy2000* bugs**

- The program does not apply corrections for clock drift, gun delay and clock offset – even if specified in the header of the shot table. Individual shot times in the shot table have to be corrected accordingly.
- When choosing just *channel 2* as opposed to all channels (0) for the output, the resulting file will be channel 1 and not channel 2. It has not been tested, if similar errors occur when other single channels are processed.

2.3. SEGY FILES

2.3.1 LINE 1

Pos.	Instrument	Deployment longitude	Deployment latitude	Deployment depth	Recovery longitude	Recovery latitude	Clock reset (JD:hh:mm)	Clock check (JD:hh:mm)	Clock drift (msec)	Drift rate (msec/hour)	Raw data files	Remarks
1	DAL-B	45.91557 W	47.74990 N	513 m	45.91506 W	47.74899 N	197 11.00	204 20.59	+29.5	+0.1657	000-294	
2	DAL-C	45.70065 W	47.62851 N	300 m	45.69670 W	47.62965 N	197 13.13	204 19.10	-3.6	-0.0207	000-290	
3	DAL-D	45.48715 W	47.50693 N	274 m	45.48459 W	47.50793 N	197 11.00	204 17.27	+10.2	+0.0585	000-286	
7	GSC-2	44.64206 W	47.01769 N	140 m	44.63761 W	47.01607 N	196 19.12	204 08.41	-16.0	-0.0882	000-212	
8	GSC-6	44.54057 W	46.95744 N	133 m	44.53673 W	46.95614 N	196 18.39	204 07.09	+32.0	+0.1773	000-209	
9	GSC-7	44.44084 W	46.89900 N	163 m			196 23.34					Not recovered
13	DAL-A	44.04406 W	46.66228 N	1357 m	44.04737 W	46.66121 N	198 09.31	205 22.30	-5246.0	Static shift	000-351	Clock jump @ deployment (?)
14	DAL-E	43.94575 W	46.60371 N	2613 m	43.94878 W	46.60016 N	197 17.57	203 17.40	-14295.5	Not determined	000-229	Clock jump @ recovery
15	DAL-F	43.84699 W	46.54434 N	3228 m	43.85483 W	46.54511 N	196 12.13	203 15.16	+6.6	+0.0386	000-224	
19	GSC-1	43.51242 W	46.34198 N	4109 m	43.51852 W	46.34304 N	197 23.57	202 23.49	+32.0	+0.2670	000-150	
20	GSC-3	43.43631 W	46.29354 N	4201 m	43.43571 W	46.29890 N	197 15.06	203 03.27	0.0	0.0000	000-157	
21	GSC-4	43.35901 W	46.24702 N	4289 m	43.36015 W	46.25999 N	197 12.35	203 01.18	-16.0	-0.1206	000-152	
25	GSC-5	43.04888 W	46.05456 N	4615 m	43.01553 W	46.06495 N	196 18.00	202 16.59	+80.0	+0.5595	000-137	
26	GSC-8	42.97263 W	46.00572 N	4637 m	42.90876 W	46.01457 N	196 18.00	202 13.58	-8.0	-0.0572	000-131	

Sampling rate
GSC instruments 139.00 Hz
Dalhousie instruments 174.38 Hz

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

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

LINE 1 OBS

Pos.	Sampling rate	Clock start JD HH.MM	Clock drift applied (msec/hour)	Static time shift (msec)	Raw datafiles	Shots in SEGY file	SEGY filename	Remarks
1	174.38 Hz	197 11.00	+0.1657		datafile.000 - 294	1-2454	s101ch[*1-4*].sgy	
2	174.38 Hz	197 13.13	-0.0207		datafile.000 – 290	1-2454	s102ch[*1-4*].sgy	
3	174.38 Hz	197 11.00	+0.0585		datafile.000 – 286	1-2454	s103ch[*1-4*].sgy	
7	139.00 Hz	196 19.12	-0.0082		datafile.000 – 212	1-2454	s107ch[*1-4*].sgy	
8	139.00 Hz	196 18.39	+0.1773		datafile.000 – 209	1-2454	s108ch[*1-4*].sgy	
13	174.38 Hz	198 09.31	not determined (0)	-5246	datafile.000 – 351	1-2454	s113ch[*1-4*].sgy	Clock jump, probably at deployment
14	174.38 Hz	197 17.57	not determined (0)	0	datafile.000 – 229	1-2454	s114ch[*1-4*].sgy	Clock jump, probably during recovery
15	174.38 Hz	196 12.13	+0.0386		datafile.000 – 224	1-2454	s115ch[*1-4*].sgy	
19	139.00 Hz	197 23.57	+0.2670		datafile.000 – 150	1-2454	s119ch[*1-4*].sgy	
20	139.00 Hz	197 15.06	+0.0000		datafile.000 – 157	1-2454	s120ch[*1-4*].sgy	
21	139.00 Hz	197 12.35	-0.1206		datafile.000 – 152	1-2454	s121ch[*1-4*].sgy	
25	139.00 Hz	196 18.00	+0.5595		datafile.000 – 137	1-2360	s125ch[*1-4*].sgy	Shots 2254-2360 during ascent of OBS
26	139.00 Hz	196 18.00	-0.0572		datafile.000 – 131	1-2227	s126ch[*1-4*].sgy	Shots 2100-2227 during ascent of OBS

LINE 1 MCS

Pos.	Sampling rate	Clock start JD HH.MM	Clock drift applied (msec/hour)	Static time shift (msec)	Raw datafiles	Shots in SEGY file	SEGY filename	Remarks
1	174.38 Hz	197 11.00	+0.1657		datafile.000 - 294	2455-8855	mcs101ch[*1-4*].sgy	
2	174.38 Hz	197 13.13	-0.0207		datafile.000 – 290	2455-8855	mcs102ch[*1-4*].sgy	
3	174.38 Hz	197 11.00	+0.0585		datafile.000 – 286	2455-8736	mcs103ch[*1-4*].sgy	
7	139.00 Hz	196 19.12	-0.0082		datafile.000 – 212	2455-7215	mcs107ch[*1-4*].sgy	
8	139.00 Hz	196 18.39	+0.1773		datafile.000 – 209	2455-6931	mcs108ch[*1-4*].sgy	
13	174.38 Hz	198 09.31	not determined (0)	-5246	datafile.000 – 351	2455-8855	mcs113ch[*1-4*].sgy	Clock jump, probably at deployment
14	174.38 Hz	197 17.57	not determined (0)	0	datafile.000 – 229	2455-4572	mcs114ch[*1-4*].sgy	Clock jump, probably during recovery
15	174.38 Hz	196 12.13	+0.0386		datafile.000 – 224	2455-4121	mcs115ch[*1-4*].sgy	

ch1 hydrophone
ch2 vertical geophone
ch3 horizontal geophone 1
ch4 horizontal geophone 2

2.3.2 LINE 2

LINE 2

Pos.	Instrument	Deployment longitude	Deployment latitude	Deployment depth	Recovery longitude	Recovery latitude	Clock reset (JD:hh:mm)	Clock check (JD:hh:mm)	Clock drift (msec)	Drift rate (msec/hour)	Raw data files	Remarks
3	GSC-4	46.69580 W	46.34196 N	1152 m	46.69426 W	46.34294 N	207 23.18	213 02.12	-12.3	-0.1001	000-204	Static shift: -362.9 msec
6	GSC-8	46.05525 W	46.03451 N	2148 m	46.05479 W	46.03360 N	207 22.10	212 15.40	-14.4	-0.1269	000-184	Static shift: -353.7 msec
8	GSC-6	45.75819 W	45.88957 N	3178 m	- [1]	- [1]	207 20.50	218 13.44	+47.7	+0.1857	000-281	Static shift: -283.8 msec
9	GSC-5	45.61158 W	45.81697 N	3432 m	45.61763 W	45.81318 N	207 18.45	212 10.00	+58.3	+0.5240	000-173	Static shift: -294.0 msec
13	GSC-3	45.02437 W	45.52581 N	4242 m	45.02240 W	45.52912 N	207 17.40	212 00.25	+0.8	+0.0078	000-155	Static shift: -333.0 msec
14	GSC-2	44.87811 W	45.45052 N	4423 m	44.88475 W	45.45831 N	207 16.50	211 19.57	-8.0	-0.0807	000-146	Static shift: -174.0 msec
15	GSC-1	44.73190 W	45.38108 N	4538 m	44.72589 W	45.42222 N	207 15.45	211 22.13	+26.2	+0.2557	000-150	Static shift: -335.3 msec
19	DAL-F	44.28185 W	45.14778 N	4642 m			207 11.50					Not recovered
20	DAL-E	44.16845 W	45.08953 N	4685 m	44.17456 W	45.10071 N	207 11.30	211 01.32	-4037749.3	Not determined	000-135	Two or more clock jumps
21	DAL-D	44.05082 W	45.03118 N	4710 m	44.02289 W	45.10056 N	207 11.00	215 01.14	-5746.9	Not determined	000-349	Clock jump
25	DAL-C	43.61320 W	44.79840 N	4742 m	43.64718 W	44.81310 N	206 23.17	210 15.18	+2.9	+0.0329	000-114	
26	DAL-B	43.50315 W	44.73893 N	4745 m	43.54029 W	44.75226 N	206 22.00	208 16.08	> 2 days (-)	Not determined	000	Electronic problems
27	DAL-A	43.39728 W	44.68180 N	4750 m			206 22.18					Not recovered

Sampling rate
GSC instruments 139.00 Hz
Dalhousie instruments 174.38 Hz

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

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

[1] OBS was recovered by RV MAURICE EWING and later transferred to RV OCEANUS

LINE 2 OBS

Pos.	Sampling rate	Clock start JD HH.MM	Clock drift applied (msec/hour)	Static time shift (msec)	Raw datafiles	Shots in SEGY file	SEGY filename	Remarks
3	139.00 Hz	207 23.18	-0.1001	-362.9	datafile.000 - 204	21705 – 23533	s203ch[*1-4*].sgy	[1]
6	139.00 Hz	207 22.10	-0.1269	-353.7	datafile.000 - 184	21705 – 23533	s206ch[*1-4*].sgy	[1]
8	139.00 Hz	207 20.50	+0.1857	-283.8	datafile.000 - 280	21705 - 23533	s208ch[*1-4*].sgy	[1]
9	139.00 Hz	207 18.45	+0.5240	-294.0	datafile.000 - 173	21705 – 23533	s209ch[*1-4*].sgy	[1]
13	139.00 Hz	207 17.40	+0.0078	-333.0	datafile.000 - 155	21705 – 23533	s213ch[*1-4*].sgy	[1]
14	139.00 Hz	207 16.50	-0.0807	-174.0	datafile.000 - 146	21705 – 23533	s214ch[*1-4*].sgy	[1]
15	139.00 Hz	207 15.45	+0.2557	-335.3	datafile.000 - 150	21705 – 23533	s215ch[*1-4*].sgy	[1]
19	174.38 Hz	207 11.50						OBS not recovered
20	174.38 Hz	207 11.30	Not determined (0)	-98391.0	datafile.000 - 135	21705 – 23533	s220ch[*1-4*].sgy	2 or 3 clock jumps [2]
21	174.38 Hz	207 11.00	Not determined (0)		datafile.000 - 349	21705 - 23533	s221ch[*1-4*].sgy	Clock jump
25	174.38 Hz	206 23.17	+0.0329		datafile.000 - 114	21705 – 23533	s225ch[*1-4*].sgy	
26	174.38 Hz	206 22.00	Not determined (0)		datafile.000			No data processed
27	174.38 Hz	206 22.18						OBS not recovered

LINE 2 MCS

Pos.	Sampling rate	Clock start JD HH.MM	Clock drift applied (msec/hour)	Static time shift (msec)	Raw datafiles	Shots in SEGY file	SEGY filename	Remarks
3	139.00 Hz	207 23.18	-0.1001	-362.9	datafile.000 - 204	23820 – 31250	mcs203ch[*1-4*].sgy	[1]
6	139.00 Hz	207 22.10	-0.1269	-353.7	datafile.000 - 184	23820 – 31250	mcs206ch[*1-4*].sgy	[1]
8	139.00 Hz	207 20.50	+0.1857	-283.8	datafile.000 - 280	23820 – 31250	mcs208ch[*1-4*].sgy	[1]
9	139.00 Hz	207 18.45	+0.5240	-294.0	datafile.000 - 173	23820 – 31209	mcs209ch[*1-4*].sgy	[1]
13	139.00 Hz	207 17.40	+0.0078	-333.0	datafile.000 - 155	23820 – 29709	mcs213ch[*1-4*].sgy	[1]
14	139.00 Hz	207 16.50	-0.0807	-174.0	datafile.000 - 146	23820 – 29055	mcs214ch[*1-4*].sgy	[1]
15	139.00 Hz	207 15.45	+0.2557	-335.3	datafile.000 - 150	23820 – 28526	mcs215ch[*1-4*].sgy	[1]
19	174.38 Hz	207 11.50						OBS not recovered
20	174.38 Hz	207 11.30	Not determined (0)	-98391.0	datafile.000 - 135	23820 – 26058	mcs220ch[*1-4*].sgy	2 or 3 clock jumps [2]
21	174.38 Hz	207 11.00	Not determined (0)		datafile.000 - 349	23820 – 31250	mcs221ch[*1-4*].sgy	Clock jump
25	174.38 Hz	206 23.17	+0.0329		datafile.000 - 114	23820 – 24268	mcs225ch[*1-4*].sgy	
26	174.38 Hz	206 22.00	Not determined (0)		datafile.000			No data processed
27	174.38 Hz	206 22.18						OBS not recovered

ch1 hydrophone
ch2 vertical geophone
ch3 horizontal geophone 1
ch4 horizontal geophone 2

[1] The static clock shift is due to an initial delay of the OBS clock at the time of the clock reset (caused by manual start of the clock).
[2] The static correction was determined by the position of the direct wave for the closest trace.

2.3.3 LINE 3

Pos.	Instrument	Deployment longitude	Deployment latitude	Deployment depth	Recovery longitude	Recovery latitude	Clock reset (JD:hh:mm)	Clock check (JD:hh:mm)	Clock drift (msec)	Drift rate (msec/hour)	Raw data files	Remarks
1	DAL-C	50.50902 W	46.73229 N	107 m	50.50848 W	46.73167 N	216 14.00	224 20.29	+1.7	+0.0086	000 - 412	
2	DAL-E	49.98229 W	46.46537 N	75 m	49.45882 W	46.19559 N	216 16.30				000 - 266	No clock drift determined, battery failure Lower gain settings compared to other stations (-14 dB)
3	GSC-2	49.45944 W	46.19585 N	71 m	49.45882 W	46.19559 N	216 13.49	224 15.17	-13.7	-0.0708	000 - 319	Static shift: -255.2 msec
4	DAL-D	48.94298 W	45.92566 N	72 m	48.94186 W	45.92564 N	216 13.26	224 09.12	+16.5	+0.0865	000 - 392	
9	DAL-B	47.50217 W	45.14325 N	3120 m	47.50973 W	45.19813 N	215 19.37	223 22.14	+24.0	+0.1233	000 - 356	
10	GSC-1	47.27221 W	45.01395 N	3568 m	47.25944 W	45.01236 N	215 20.45	223 11.51	+51.1	+0.2791	000 - 268	Static shift: -317.1 msec
11	GSC-8	47.04440 W	44.88442 N	3642 m	47.04337 W	44.88442 N	216 00.46	223 08.09	-24.4	-0.1391	000 - 261	Static shift: -66.9 msec
17	GSC-5	46.04299 W	44.30715 N	3969 m	46.04285 W	44.31361 N	215 20.20	220 23.48	+64.8	+0.5248	000 - 190	Static shift: -265.7 msec
18	GSC-4	45.87817 W	44.21087 N	3946 m	45.88262 W	44.21375 N	215 19.42	220 20.53	-12.7	-0.1048	000 - 184	Static shift: -139.3 msec
19	GSC-3	45.74831 W	44.13437 N	4094 m	45.75722 W	44.13407 N	215 18.59	220 18.27	+3.8	+0.0318	000 - 179	Static shift: -352.0 msec
25	GSC-5	48.08011 W	45.46084 N	1459 m	48.08873 W	45.46084 N	221 14.00	224 07.01	+33.7	+0.5183	000 - 109	Static shift: -310.1 msec

<u>Sampling rate</u>
GSC instruments 139.00 Hz
Dalhousie instruments 174.38 Hz

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

<u>Clock drift</u>
+ sign OBS clock is ahead of GPS clock
- sign OBS clock is behind GPS clock

LINE 3 OBS

Pos.	Sampling rate	Clock start JD HH.MM	Clock drift applied (msec/hour)	Static time shift (msec)	Raw datafiles	Shots in SEGY file	SEGY filename	Remarks
1	174.38 Hz	216 14.00	+0.0086		datafile.000 - 412	47403 - 48749	s301ch[*1-4*].sgy	
2	174.38 Hz	216 16.30	0		datafile.000 - 266	47043 - 48749	s302ch[*1-4*].sgy	
3	139.00 Hz	216 13.49	-0.0708	-255.2	datafile.000 - 319	47043 - 48749	s303ch[*1-4*].sgy	1)
4	174.38 Hz	216 13.26	+0.0865		datafile.000 - 392	47043 - 48749	s304ch[*1-4*].sgy	
9	174.38 Hz	215 19.37	+0.1233		datafile.000 - 356	47043 - 48749	s309ch[*1-4*].sgy	
10	139.00 Hz	215 20.45	+0.2791	-317.1	datafile.000 - 268	47043 - 48749	s310ch[*1-4*].sgy	1)
11	139.00 Hz	216 00.46	-0.1391	-66.9	datafile.000 - 261	47043 - 48749	s311ch[*1-4*].sgy	1)
17	139.00 Hz	215 20.20	+0.5248	-265.7	datafile.000 - 191	47043 - 48749	s317ch[*1-4*].sgy	1)
18	139.00 Hz	215 19.42	-0.1048	-139.3	datafile.000 - 184	47043 - 48749	s318ch[*1-4*].sgy	1)
19	139.00 Hz	215 18.59	+0.0318	-352.0	datafile.000 - 179	47043 - 48749	s319ch[*1-4*].sgy	1)
25	139.00 Hz	221 14.00	+0.5183	-310.1	datafile.000 - 109			1)

LINE 3 MCS

Pos.	Sampling rate	Clock start JD HH.MM	Clock drift applied (msec/hour)	Static time shift (msec)	Raw datafiles	Shots in SEGY file	SEGY filename	Remarks
1	174.38 Hz	216 14.00	+0.0086		datafile.000 - 412	48750 - 53210	mcs301ch[*1-4*].sgy	
2	174.38 Hz	216 16.30	0		datafile.000 - 266	48750 - 53210	mcs302ch[*1-4*].sgy	
3	139.00 Hz	216 13.49	-0.0708	-255.2	datafile.000 - 319	48750 - 53210	mcs303ch[*1-4*].sgy	1)
4	174.38 Hz	216 13.26	+0.0865		datafile.000 - 392	48750 - 53210	mcs304ch[*1-4*].sgy	
9	174.38 Hz	215 19.37	+0.1233		datafile.000 - 356			
10	139.00 Hz	215 20.45	+0.2791	-317.1	datafile.000 - 268			1)
11	139.00 Hz	216 00.46	-0.1391	-66.9	datafile.000 - 261			1)
17	139.00 Hz	215 20.20	+0.5248	-265.7	datafile.000 - 191	48750 - 53210	mcs317ch[*1-4*].sgy	1)
18	139.00 Hz	215 19.42	-0.1048	-139.3	datafile.000 - 184	48750 - 53210	mcs318ch[*1-4*].sgy	1)
19	139.00 Hz	215 18.59	+0.0318	-352.0	datafile.000 - 179	48750 - 53210	mcs319ch[*1-4*].sgy	1)
25	139.00 Hz	221 14.00	+0.5183	-310.1	datafile.000 - 109			1)

ch1 hydrophone
ch2 vertical geophone
ch3 horizontal geophone 1
ch4 horizontal geophone 2

1) The static clock shift is due to an initial delay of the OBS clock at the time of the clock reset (caused by manual start of the clock).

APPENDIX 3: HEAT FLOW SURVEYS

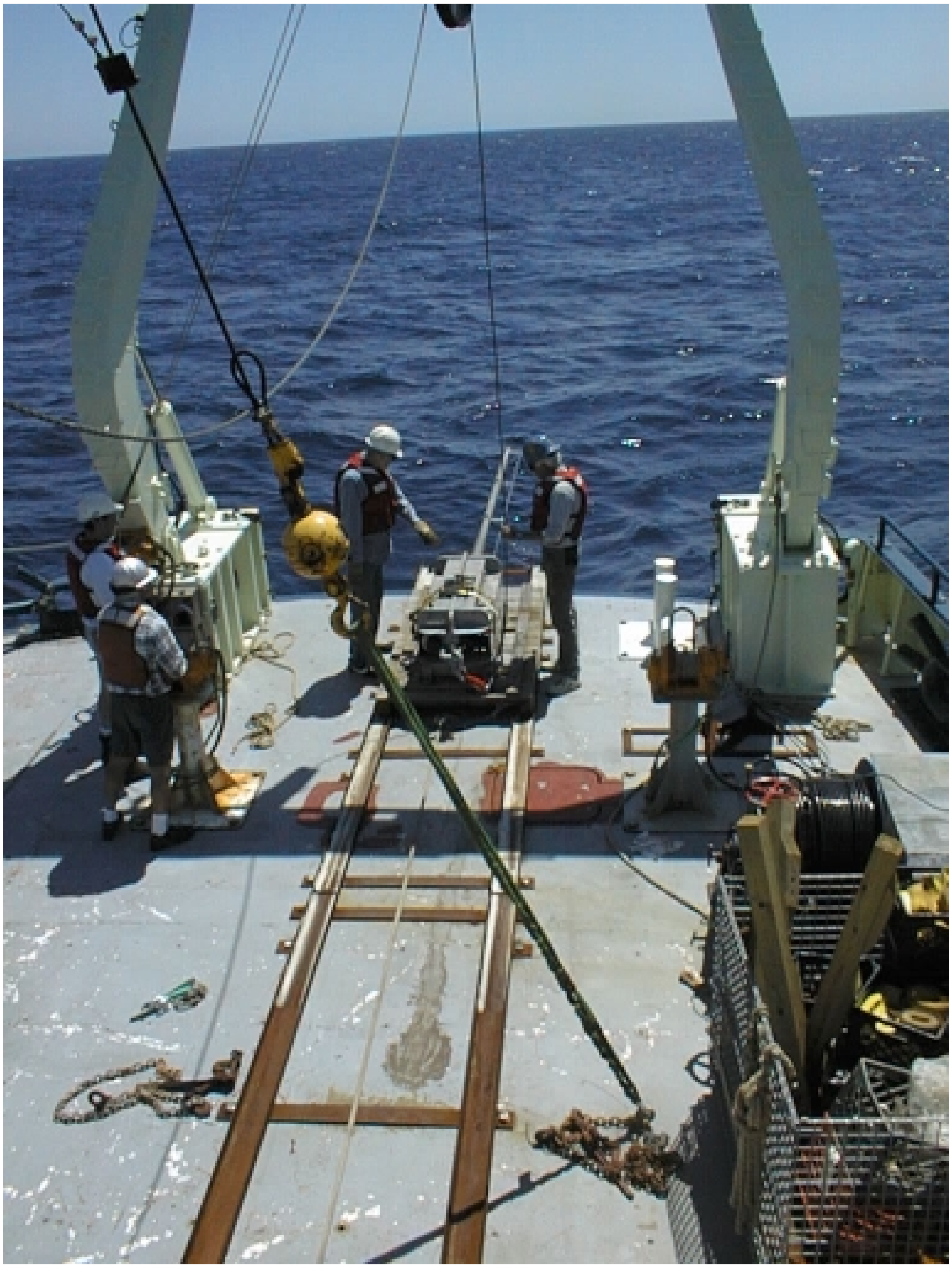


Figure 3.1 Dal heat flow probe on the aft deck of the R/V Oceanus.

Heat Flow Measurements

Heat flow measurements were made during three deployments using a new probe recently built at Dalhousie University. The instrumentation electronics of this system allows an extended number of down-probe temperature measurements up to a maximum of 48. The first deployment on profile 1 used a standard probe 4-m long with 9 thermistors; the subsequent two deployments on profile 3 used a 4-m probe with 32 sensors. The new electronics worked perfectly, although failure of one of the three multiplexers internal to the sensor string reduced to 24 the number of sensors that could be recorded.

Pressure Tests

Because the new system used pressure cases and connectors that had not previously been pressure tested in deep water, we first started with a wire test to a depth of 4000m before installing the electronic packages. Both of the two pressure cases failed. We later determined that the o-ring on the smaller 4-pin connector (used for deck communication with the probe) had been forced under high pressure into the machined o-ring groove on each of the two end-caps. It appeared that this groove had been incorrectly machined on the end-cap. Fortunately, we were able to replace the connector with an alternate connector, which had the same thread but a larger o-ring surface that could avoid the incorrectly machined groove. A further pressure test using this connector was successful. Unfortunately, these necessary tests used up some of the best weather conditions of the entire cruise before we were able to start making measurements on the seaward end of profile 1.

Deployment Procedures.

The deployment of the probe through the aft A-frame was only possible in calm sea conditions. This limited the operations, particularly for profile 2 when weather conditions degenerated following deployments of the OBS. We used an existing Woods Hole rail system, modified for use with the heat flow probe, to stabilize motion of the probe on deck (see Figure 3.1). However, from initial tests in port it was determined that the wooden cradle was not sufficiently robust to rotate the heavy probe from horizontal to vertical over the aft end of the Oceanus, as initially planned. Thus the probe needed to be lifted in a horizontal position by the crane and then slowly rotated into vertical using the main winch wire. With the long bar pointing aft it proved difficult to stabilize the probe with guy lines before it could be rotated. Operations were therefore limited to good weather conditions when vessel motion was restricted.

Underway Operations

Monitoring of the probe during deployments was generally excellent. We utilized the superb digital controls of the main winch system (winch speed, wire-out and tension) which were displayed on a VDU monitor using a web-based program written by the ship's technical officer. Operation of the probe measurements utilized its 12-kHz pinger signal displayed on the ship's PDR recorder (see figure). Navigation of the vessel during deployments was coordinated between lab and bridge. However, it was necessary to have an additional watch on deck to monitor the wire angle. This rather tedious job could be eliminated if there had been more adequate TV monitors of aft deck operations available to the bridge and main lab.

<u>Results</u>

A total of 32 stations were made during three deployments: 12 on the seaward end of profile 1; 12 on the seaward end of profile 3; and 8 on the central portion of profile 3. Locations of measurement stations are given in the accompanying tables. Subsequent processing of results will be undertaken at Dalhousie University.

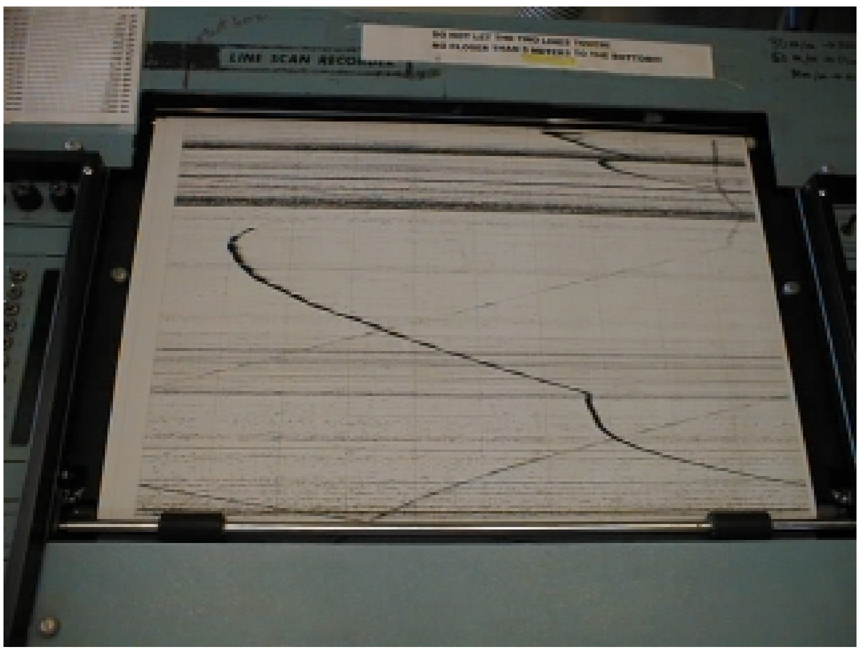


Figure 3.2. PDR monitor of pinger record from heat flow probe.

OC359-2 Heatflow Survey HFS1 18-19 July 2000

Site	Lat (N)		Long (W)		Depth m	Wire m	Pen	Time HP	Pullout
1	46	4.90	42	51.89	4606	4656	22:49	22:56	23:07
2	46	5.57	42	52.73	4595	4710	0:24	0:32	0:41
3	46	6.37	42	53.53	4569	4797	1:45	1:52	2:03
4	46	7.20	42	53.90	4566	4709	3:10	3:18	3:28
5	46	7.85	42	54.69	4560	4803	4:34	4:41	4:50
6	46	8.15	42	56.24	4544	4898	5:59		6:17
7	46	8.76	42	57.45	4520	4745	7:18	7:25	7:35
8	46	9.47	42	58.31	4495	4677	8:43	8:50	8:59
9	46	10.16	42	59.59	4455	4740	9:55	10:03	10:13
10	46	10.90	43	0.80	4448	4688	11:13		11:23
11	46	10.95	43	0.87	4448	4576	11:34	11:41	11:51
12	46	11.50	43	2.02	4420	4533	12:59	13:06	13:17

OC 359-2 Heat Flow Survey HFS2 5-6 August 2000

Site	Lat (N)		Long (W)		Depth m	Wire m	Pen	Time HP	Pullout
1	44	17.35	46	1.39	3937	3960	20:44		20:55
2	44	17.26	46	1.54	3937	3964	21:00		21:11
3	44	16.57	46	3.14	3955	3989	1:31	1:38	1:46
4	44	15.61	46	2.50	3951	4108	2:54	3:01	3:13
5	44	15.10	46	1.46	3948	4063	4:27	4:34	4:46
6	44	14.56	45	59.94	3942	4001	6:36	6:43	6:52
7	44	13.50	45	58.69	3946	3995	8:43	8:50	9:01
8	44	12.90	45	56.59	3941	4030	10:37	10:44	10:54
9	44	11.84	45	54.51	3945	4227	12:29	12:36	12:46
10	44	11.33	45	52.37	3952	4376	13:54	14:01	14:12
11	44	10.76	45	50.95	3967	4147	15:23	15:31/15:40	15:43
12	44	10.21	45	49.63	3983	4135	16:56	17:03	17:11

OC 359-2 Heat Flow Survey HFS3 **9 August 2000**

Site	Lat (N)		Long (W)		Depth m	Wire m	Pen	Time HP	Pullout
1	44	51.54	47	0.08	3648	3655	19:46	19:53	20:03
2	44	50.44	46	59.96	3647	3683	21:12	22:19	23:29
3	44	49.39	47	0.26	3655	3676	22:37		22:48
4	44	49.40	47	0.35	3655	3657	23:02	23:09	23:19
5	44	48.18	47	0.33	3665	3832	0:04		0:14
6	44	47.77	47	0.39	3666	3809	0:34	0:42	0:50
7	44	46.48	47	0.98	3682	3864	1:49	.	2:00
8	44	46.34	47	1.22	3687	3792	2:14	2:21	2:30