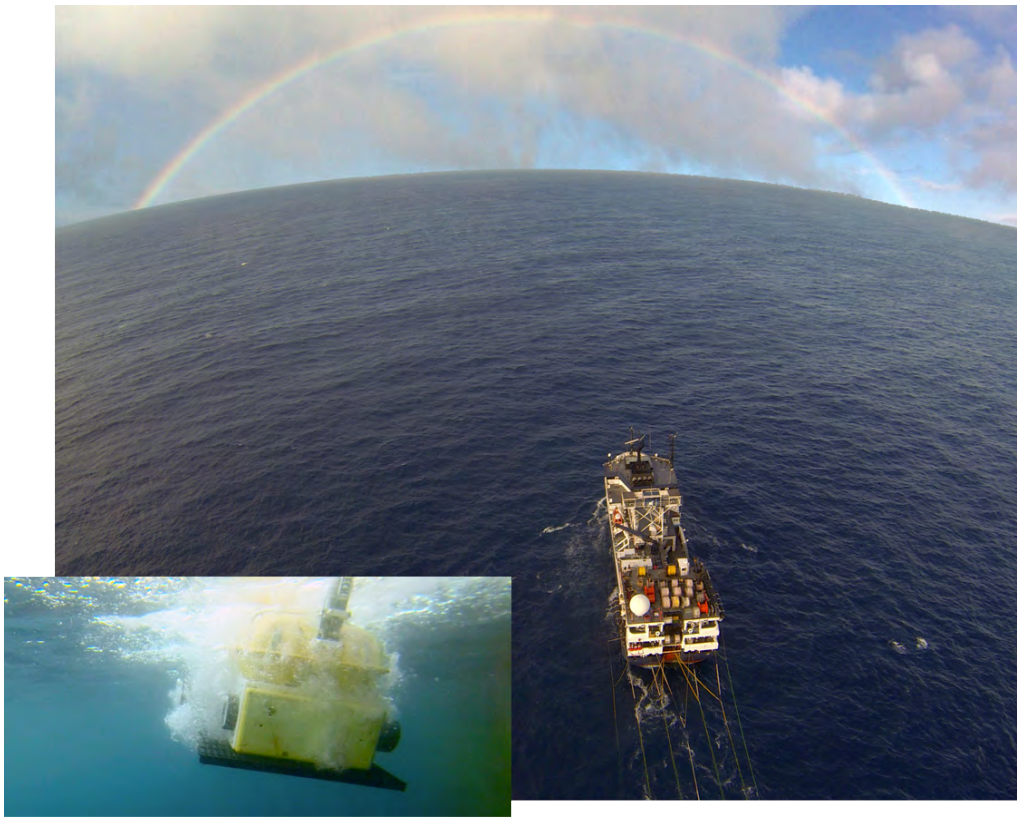
MARINER

SEISMIC INVESTIGATION OF THE RAINBOW HYDROTHERMAL FIELD AND ITS TECTONO/MAGMATIC SETTING, MID-ATLANTIC RIDGE 36° 14'N

Cruise Report
***R/V Marcus G. Langseth* MGL1305**
April 10 – May 19, 2013
St. Georges, Bermuda – Ponta Delgada, Azores



OBServing the Rainbow From the Langseth

Chief Scientist: J. Pablo Canales (*Woods Hole Oceanographic Institution*)

Co-chief Scientist: Robert Dunn (*University of Hawaii*)

Cover photos and design by Gregory Horning and J. Pablo Canales.

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APPENDICES

1. SCIENTIFIC MOTIVATION AND PROJECT OBJECTIVES

Hydrothermal systems extract approximately one third of the global Earth's yearly heat loss through mid-ocean ridges (MORs) and are a primary means of chemical exchange between the solid Earth and the oceans. Hydrothermal circulation occurs when seawater penetrating the lithosphere through fractures is heated through its contact with hot rock, undergoing chemical alteration. As it penetrates deeper, its temperature increases and the water becomes buoyant, rapidly rising back to the seafloor. Sections of MORs with greater magma supply, and hence greater heat flux, are thought to host a greater abundance of hydrothermal systems. This simple conceptual model provides a framework within which to understand hydrothermal heat generation and extraction, yet leaves open the question of the nature of heat sources and the physical mechanisms controlling hydrothermal fluid flow [e.g., *Wilcock and Delaney*, 1996].

Most of our understanding of hydrothermal systems along ridges results from studies of the materials output by this process [e.g., *Humphris et al.*, 1995; *Von Damm*, 1990]. In contrast, the deeper distributions of melt that may drive these systems and the general tectonic and thermal structure around them are inadequately known and have been studied in only a few locations, most of them along fast and intermediate spreading ridges like the East Pacific Rise and the Juan de Fuca Ridge. In these settings, hydrothermal systems are mainly located within the axial zone of a spreading segment, hosted in basaltic rock, and are primarily driven by heat extracted from crystallization of mid-crustal melt sills [e.g., *Canales et al.*, 2006; *Haymon et al.*, 1991; *Singh et al.*, 1998; *Van Ark et al.*, 2007]. In contrast, hydrothermal systems along slow spreading ridges like the Mid-Atlantic Ridge (MAR) show a great variety of venting styles and host-rock lithology, and are located in diverse tectonic settings like axial volcanic ridges, non-transform ridge discontinuities (NTDs), the foot of ridge valley walls, and off-axis inside corner highs [e.g., *German and Parson*, 1998; *German and Lin*, 2004]. Here the relative roles of magmatic heat input, tectonic heat advection, and faulting in controlling ridge thermal structure and hydrothermal circulation are still poorly understood [e.g., *Cannat et al.*, 2004].

The Rainbow hydrothermal field (RHF) is a major high-temperature hydrothermal system that is located within one such setting, a non-transform discontinuity of the MAR [*German et al.*, 1996] It is hosted in an ultramafic massif, venting methane-, hydrogen- and iron-rich fluids [e.g., *Holm and Charlou*, 2001] that support diverse macrofaunal and microbial communities [e.g. *Desbruyères et al.*, 2001; *O'Brien et al.*, 1998]. The tectonized setting of the NTD apparently lacks significant volcanic features, yet the RHF vents high-temperature fluids (up to 365 °C) at high flow rates [*German et al.*, 1996], which is difficult to explain without a magmatic heat source. This conundrum stands in the way of our ability to develop a model for the origin and functioning of the Rainbow vent field as well as inhibits development of more general models for the roles of magmatic heat input and tectonic faulting on controlling thermal structure and hydrothermal circulation, particularly for hydrothermal systems in regions dominated by ultramafic lithologies, which are common at slow and ultra-slow MORs [e.g., *Cannat et al.*, 1995; *Dick et al.*, 2003].

The fundamental question we aim to address in this NSF-funded project is: **What are the relationships between magmatism, faulting, substrate lithology, and hydrothermal circulation at the Rainbow hydrothermal field?**

By addressing this question and investigating the subsurface structure of this unique system, we will advance understanding of the relationships between magmatic processes, hydrothermal circulation, and the thermal and tectonic structure of a ridge discontinuity, which will be applicable to other regions. In

particular, understanding the mechanisms and processes that result in hydrothermal circulation at Rainbow will allow us to understand how high-temperature hydrothermal fluids can be generated in tectonized, ultramafic terrains (e.g., Logatchev and Ashazde fields in the MAR [*Bel'tenev et al.*, 2005; *Krasnov et al.*, 1996], and to make predictions about how common similar hydrothermal systems (i.e., hosted in ultramafic rocks, venting hydrogen, methane, and iron-rich high-temperature fluids) might be along other slow- and ultra-slow spreading ridges.

We will use geophysical observations to test a specific hypothesis against two alternates:

Hypothesis: *The heat driving hydrothermal circulation at Rainbow is provided by a magma body underlying the ultramafic rocks exposed on the massif, and steep normal faults crosscutting the massif provide permeability pathways for fluid circulation*. If this hypothesis is correct, then Rainbow may be experiencing a phase of enhanced melt supply from the mantle, therefore providing an excellent opportunity to investigate delivery and emplacement of melt beneath a NTD, where long-term magma supply should be very low [e.g., *Cannat et al.*, 1995; *Phipps Morgan and Forsyth*, 1988]. In addition, this hypothesis predicts that at least part of the Rainbow massif could be mafic in origin, despite indications suggesting is predominantly ultramafic [e.g., *Fouquet et al.*, 1997].

Alternate 1: *The heat driving hydrothermal circulation at Rainbow is extracted from the magmatic system(s) of the neighboring segment(s), and fluids are transported relatively large lateral distances on possibly low-angle fault(s).* An alternative to hypothesis 1 is that the NTD is currently magmatically starved, but fluids are taping magmatic heat from the neighboring segments [*German et al.*, 1996], possibly via low-angle faults that provide pathways for fluids to travel from the ends of the neighboring segments to the center of the NTD. Thus, this hypothesis does not require presence of a significant component of mafic lithologies beneath the massif, consistent with seafloor observations and exit fluid chemistry.

Alternate 2: *Detachment faulting controls hydrothermal circulation and uplift of the Rainbow massif*. There is increasing evidence that a variety of hydrothermal venting styles are intimately linked to detachment faulting and formation/evolution of oceanic core complexes [*McCaig et al.*, 2010]. It has been proposed that the RHF sits on the footwall of a detachment fault [*Gràcia et al.*, 2000], and some of the geological characteristics of the massif are consistent with this hypothesis [*Gaill et al.*, 2007; *Ildefonse et al.*, 2008]. In this scenario fluids could extract heat from the hot (and possibly partially molten) deep region of the mantle where a detachment fault roots, and/or from the exhuming footwall. If uplift of the massif is not the result of detachment faulting, then buoyant diapirism driven by serpentinization is a likely alternative [e.g., *Bonatti*, 1976], as substantial hydration of the mantle beneath the massif would be accompanied by volumetric expansion and reduced density.

To test these hypotheses we have conducted a geophysical survey of the Rainbow area (Fig. 1). The acquired data will allow us to carefully image the subsurface architecture (which is intimately linked to hydrothermal flow processes) around and beneath the RHF and map, in 3D, the seismicity associated with the vent field and the NTD. Our geophysical survey of the Rainbow area consists of:

(1) A large-scale 3D high-resolution active-source seismic tomography experiments using 46 ocean bottom seismometers (OBSs) and airgun sources. This dataset will be used for determining the 3D seismic velocity structure of the crust and upper mantle.

(2) A series of 2D multichannel seismic (MCS) reflection profiles using one 8-km-long hydrophone streamer and airgun sources. This dataset will be used for high-resolution 2D tomography of the

shallowmost lithosphere as well as for depth imaging of faults, melt bodies, and other major structural discontinuities.

(3) Deployment of a network of OBSs for long-term monitoring of the microseismicity of the Rainbow Massif and NTD. This dataset will be used for locating active faults and determine their 3D geometry, and for investigating hydrothermal processes along fluid flow paths.

(4) Multibeam bathymetry and backscatter echosounding. This dataset will provide the morphological context within which the other datasets can be interpreted.

(5) Potential fields (gravity and magnetics). These datasets will contribute towards improving our knowledge on variations in sub-surface density and magnetization (and therefore structure) of the study area, and age of the morphological features.

2. CRUISE PLAN AND SUMMARY OF ACCOMPLISHMENTS

The main components planed for Cruise MGL1305 consisted of (Figure 1):

(1) Deployment/recovery of 46 OBSs and airgun (36-element, 6,600 cu.in. RV *Langseth*'s array) shooting along profiles at 450 m shot interval for 3D active-source tomography.

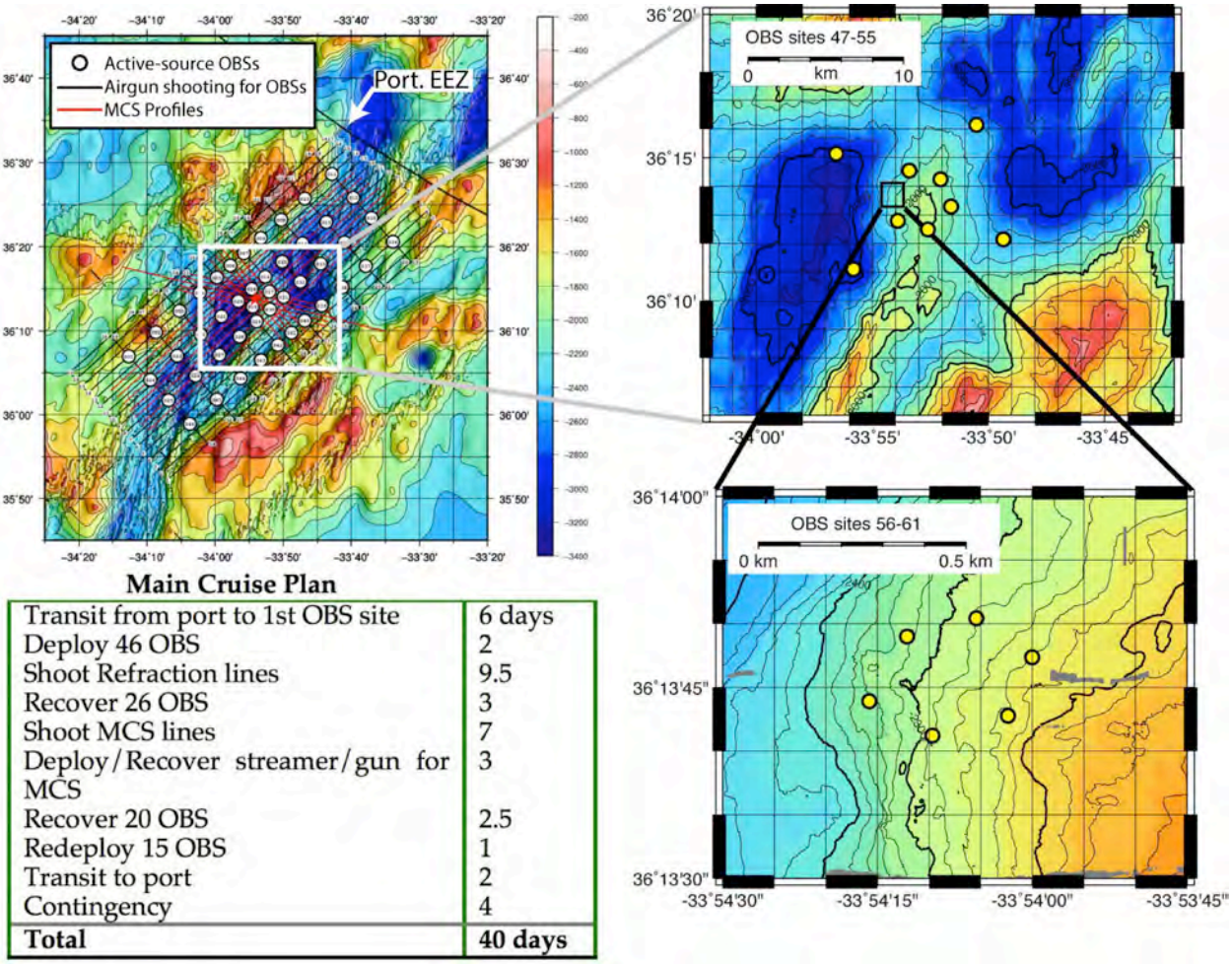
(2) Deployment of one of RV Langseth's hydrophone streamer (8-km-long, 636 active channels) and airgun (36-element, 6,600 cu.in. RV Langseth's array) shooting along profiles at 37.5 m shot interval for 2D MCS imaging.

(3) Deployment of 15 OBSs for long-term microseismicity monitoring. These instruments will be recovered during another cruise (to be determined) in 6-8 months.

For these operations we had budgeted 28 days of science ship time (not including transits to/from port) and 4 days of contingency time (Figure 1). We completed 100% of the planned operations within the allocated time (Table 1). Only ~3% of planned shots for OBS lines were dropped from the initial plan. Of the 46 planned OBS recoveries we successfully accomplished 45; only one OBS had to be abandoned due lack of response to acoustic commands. The contingency time was used by departure from port delayed due to ship's mechanical problems (see Cruise Narrative), being on stand-by due to inclement weather (Table 1), on equipment maintenance, and OBS recovery delays due to acoustic communication problems.

The 3D tomography experiment was designed for crustal and upper mantle seismic velocity imaging within a 30km x 80km area encompassing the Rainbow NTD and the northern and southern half of rift valley of the adjacent spreading segments to the SW and NE, respectively (Fig. 1). 46 OBS were deployed within this are at intervals of 4-7 km. The OBSs were provided by the Scripps group of the US Ocean Bottom Seismic Instrumentation Pool (OBSIP). OBSIP also provided personnel for their operations.

We planned 19 MCS 2D profiles. Seven of them were planned as ~80-km long and located within the central part of the tomography box 2 km apart from each other. Six other profiles spaced 1.0-1.5 km from each other were planed across the Rainbow massif along a direction perpendicular to the main trend of previously observed fissures cutting through the NE flank of the massif. The remaining 6 MCS profiles were also planed across the Rainbow massif, spaced 1 km from each other, but following a direction parallel to the current spreading direction. The main purpose of all these profiles was two-



Main Cruise Plan

Transit from port to 1st OBS site	6 days
Deploy 46 OBS	2
Shoot Refraction lines	9.5
Recover 26 OBS	3
Shoot MCS lines	7
Deploy/Recover streamer/gun for MCS	3
Recover 20 OBS	2.5
Redeploy 15 OBS	1
Transit to port	2
Contingency	4
Total	**40 days**

Figure 1: Proposed cruise plan. **Top-left**: Active-source OBS deployments, OBS lines, and MCS lines. **Right**: Passive OBS network for long-term monitoring.

fold: to use sub-seafloor refraction for high-resolution tomography of the upper (<2 km) lithosphere to map lateral variations in major lithological units; and to image lithospheric features such as faults and magma bodies.

Gravity data were recorded continuously during the duration of the cruise. Sub-bottom profiler and multibeam bathymetry/backscatter data were recorded nearly continuously when in international waters; the echosounders were only stopped during OBS operations to avoid interferences with the acoustic transponders. Magnetic data were recorded along most of the seismic lines (both OBS and MCS). Expendable bathythermograph (XBT) vertical profiles were conducted regularly. A few grams of deep-sea sediments were recovered from some of the OBS stations as additional samples that will supplement GEOTRACES studies of chemical fluxes in the study area.

In summary, Cruise MGL1305 accomplished the following:

- Deployment of 61 OBSs.
- Recovery of 45 OBSs.
- ~1,700 km of shooting along 26 OBS lines (3823 shots, at 450 m spacing).

- ~1300 km of shooting along 21 MCS lines (~35,000 Shots, at 37.5 m spacing).
- Acquisition of multibeam bathymetry and backscatter data with full coverage within a 30km x 80km area, plus ~2,500 km of transit from Bermuda to the study area.
- ~3,600 km of magnetic data.
- 35 XBT vertical profiles.

Table 1. Timeline of science operations.

Date	Operation	Duration (days:hours)
April 11-16	Departure from St. Georges, Bermuda. Transit. Tests of acoustic releases.	5d:19h 0d:08h
April 17-18	Deployment of 46 OBS.	1d:07h
April 19-23	Airgun deployment. Shooting OBS lines.	0d:06h 4d:16h
April 24-26	Operations interrupted due to weather. Airgun recovery.	3d:06h 0d:03h
April 27-May 1	Airgun deployment. Shooting OBS lines. Airgun recovery.	0d:02h 4d:08h 0d:01h
May 2-3	Recovery of 26 OBSs. Deployment of 7 long-term OBSs.	1d:16h 0d:03h
May 4-12	Streamer deployment. Airgun deployment. Shooting MCS lines.	0d:10h 0d:02h 7d:13h
May 13-14	Airgun recovery. Streamer recovery. Recovery of 20 OBS.	0d:01h 0d:04h 1d:08h
May 15	Deployment of 8 long-term OBSs and acoustic surveys.	0d:21h
May 16-19	Multibeam bathymetry survey Transit to Ponta Delgada	1d:21h

3. CRUISE NARRATIVE

All times in this section are local ship time, which changed through the transit. In Bermuda local time is 3 hours behind UTC. Rainbow Area local time is 1 hour behind UTC. In Ponta Delgada local time is the same as UTC time. JD=Julian Day. A calendar day table is available in Appendix 2.

JD 098 Monday April 08, 2013 – All members of the science party arrived to St. Georges, Bermuda, during this day. Local time is 3 hours behind UTC.

JD 099 Tuesday April 09, 2013 – Science party moved into the ship. We found out that Sci. Officer Robert Steinhaus had a medical emergency and will not be sailing with us. Dave Martinson will be replacing him. The compressors needed cooling pipes replaced. The parts had arrived and were ready to be installed. We were made aware of two problems that delayed our departure originally planned for the next day. First, a crewmember had a medical emergency and needed to be replaced. Second, the

starboard rudder was having problems. Divers were inspecting it and the situation would be assed later in the day.

JD 100 Wednesday April 10, 2013 – The departure was postponed for the next day (April 11th) because the rudder was missing a piece that needed to be made and installed. Science party attended a safety briefing. Co-chief Sci. Canales and Dunn met with Protected Species Observers (PSOs) S. Milne and M. Piercy, Chief Sci. Officer and Captain to go over the IHA with a conference call with Meagan Cummings at LDEO OMO.

JD 101 Thursday April 11, 2013 – Departure planned for 1900. The rudder piece was installed in the afternoon, and the engine tests were successful. Underway, leaving St. Georges' pier at 18:58. This was a delay of 1.5 days.

JD 102 Friday April 12, 2013 – Canales requested to LDEO OMO that we were granted permission to transit at ~11-12 knots instead of the standard 10 kt to recover some of the lost time due to the ship's mechanical problems. Permission granted. Science watches started at 2000.

JD 103 Saturday April 13, 2013 – At 0919 we started the tests of the OBS acoustic releases. The releases were put into a rosette and lowered to a depth of ~3000 m using the CTD winch. Two sets of tests were conducted and finished by 1630. There were two units that did not work: one flooded, the other did not work for unknown reasons at the time since it worked well on deck. The OBSIP techs had one spare unit to replace the flooded one.

JD 104 Sunday April 14, 2013 – Transiting. Clocks advanced 1 hour. Local time is 2 hours behind UTC.

JD 105 Monday April 15, 2013 – At 16:25 we conducted another rosette test with the problematic acoustic unit. It did not work. However, upon recovery and inspection on board, Ernie Aaron realized that the package was transmitting in a different frequency than what they were expecting. They changed this and the unit was ready for use.

JD 106 Tuesday April 16, 2013 – Transiting.

JD 107 Wednesday April 17, 2013 – Clocks advanced 1 hour. Local time is 1 hour behind UTC. OBS deployments started at 1600. Eleven OBSs deployed: Sites# 01-11.

JD 108 Thursday April 18, 2013 – Thirty-five OBSs deployed: Sites# 12-46. Finished with OBS deployments at 2230. It was too late for shooting, so we planned to deploy airguns before sunrise. We conducted a short bathymetry mapping survey over the east flank of the S. AMAR segment.

JD 109 Friday April 19, 2013 – Airgun array deployment started at 0330, and was completed at 0920. First good shot fired at 1000. We had trouble deploying the magnetometer and had to find a new way to keep it from getting too close to the guns. At 1530 the magnetometer was deployed and acquiring data. Shooting of OBS Line 01 completed.

JD 110 Saturday April 20, 2013 – OBS Lines 02, 03 completed.

JD 111 Sunday April 21, 2013 – OBS Lines 04, 05 completed.

JD 112 Monday April 22, 2013 – OBS Lines 06, 07, 08 completed. Weather had been ok so far, but predictions were looking bad. In ~48 hours we were expecting very large swells (10 m significant swell

height) so we would need to recover the gear and move away to calmer seas. We were monitoring weather forecasts from the US navy (www.fnmoc.navy.mil) and NOAA (www.opc.ncep.noaa.gov).

JD 113 Tuesday April 23, 2013 – OBS Lines 09, 10 completed.

JD 114 Wednesday April 24, 2013 – OBS Lines 11 completed by 0230. The Captain gave order to stop science operations to move away from impending storm. All guns recovered by 0500 and we started transiting heading 070N at 9 kt.

JD 115 Thursday April 25, 2013 – We were ~250 km NE from the study area, waiting for the storm to pass. We still had 4.5 days of shooting to be done for the OBSs. On the way back to Rainbow site at 1830.

JD 116 Friday April 26, 2013 – Arrived to the site at 0600 but winds were still too strong for any science work. We stayed around in the area waiting for the weather to improve.

JD 117 Saturday April 27, 2013 – Start airgun deployment at 0700 and completed by 0830. We started shooting OBS Line 12 at 11:30. This means we had used 3days+8hours of the total of 4 days of contingency time we had budgeted for this cruise. OBS Line 12 completed.

JD 118 Sunday April 28, 2013 – OBS Lines 13, 14 completed.

JD 119 Monday April 29, 2013 – OBS Lines 15, 16, 17 completed.

JD 120 Tuesday April 30, 2013 – OBS Lines 19, 21, 23, 25, and 29 completed. Since we had consumed most of our contingency time, we decided to drop OBS Lines 27 and 31 out of concerns of not having enough time if we run into problems during the OBS recoveries.

JD 121 Wednesday May 01, 2013 – OBS Lines 33, 35, 37, and 39 completed. Airgun recovery started at 1900 and finished at 2000. Start of OBS recovery operations. OBS 01 recovered.

JD 122 Thursday May 02, 2013 – Fifteen OBSs recovered: Sites# 02-12, 35-38.

JD 123 Friday May 03, 2013 – Nine OBSs recovered: Sites# 39, 41-46, 25, and 24. We were not able to recover OBS 40. We spent 2.5 hours on site but the instrument did not respond to any acoustic command. We sent several release commands and waited for it to surface, but no success. We abandoned the site at 0300. The recovery of OBS 42 was also problematic. At 05:26, while being retrieved, we noticed that the battery cap was missing. The lithium battery had flooded and reacted. It was not reacting at the time of recovery, so it was considered safe to bring it onboard. Immediately, the battery and data logger packages were thrown overboard for safety. No data returned by this instrument. This means that out of the 15 OBSs with Li batteries that we are planning to use for the passive deployment, we were down to 13. The OBSIP techs came up with the idea of reconfiguring some of the 2-component instruments with Li batteries from the existing instruments to make up for the loss of two instruments. The idea was that, since each Li battery is composed of 4 packs, they could use 6 of the 4-pack batteries to build 2 extra batteries with only 3 packs, so we would end up with 8 instruments having 3-pack Li batteries. The downside is that their recording and clock life would be shortened, and this was an important risk if the recovery cruise doesn't happen early enough. Canales called co-PI Rob Sohn in the morning and talked to him about this, and ask him to enquire at NSF about the plans for scheduling a recovery cruise. OBSIP were crunching numbers to have a good estimate of the battery life if we were

to go ahead with this reconfiguration. We would wait to hear from Sohn next week before making a decision.

After recoveries were finished we deployed 7 OBSs (4-pack Li batteries) for the passive deployment. That way we started to get things done without leaving them for the last thing of the cruise. Deployments started at 1642. We deployed OBS Sites# 55, 54, 53, 50, 49, 48, and 57.

Start of MCS operations. Streamer deployment started at 2128.

JD 124 Saturday May 04, 2013 – Streamer deployment was nearly completed by 0730. We notice what it looked like 60 Hz noise in many of the channels. This noise went away if we turned off the tail buoy positioning. So it appears that it was noise from the TB power package; we decided not to use the TB GPS. Dave Martinson said he could reconstruct streamer shape just from the compasses, although it takes more processing. Airgun deployment started at 0900, finished at 1030. Start of shooting MCS Line 101. MCS Line 101 completed.

JD 125 Sunday May 05, 2013 – MCS Lines 102, 103 completed.

JD 126 Monday May 06, 2013 – MCS Lines 104, 105 completed.

JD 127 Tuesday May 07, 2013 – MCS Lines 106, 107 completed. Rob Sohn replied that he's got confirmation from NSF (D. Blackman) that the recovery cruise is scheduled for ~January 5-15, 2014, on a British ship. Jeff Babcock sent his best estimates for power consumption and these are the numbers:

Data recording capacity:
200 sps * 4 byte/samp * 86400 s/day * 4 channels * 1.015 (header overhead) = 200*4*86400*4*1.015 = ~0.28 Gb/day
If we derate for binary vs. decimal terminology, a 64 Gb data card may actually only hold 1000/1024*64 = 62.5 Gb of "actual" data.

62.5 Gb / 0.28 = ~223 days of recording @ 200 sps

Power estimates:
@200sps we use 653mW (92mA @ 7.1V)
@100sps we use 596mW (84mA @ 7.1V)
@50sps we use 568mW (80mA @ 7.1V)

Add ~ 30mW (4mA @ 7.1V) to power the hydrophone.

(6 strings/pack) * 30 AH/string = 180AH
180AH/.096A = 1875H = ~78 days per 12DD-cell pack
-or-
~234 days w/ 3 packs @ 200 sps
~312 days w/ 4 packs @ 200 sps

The instruments have been running since April 17, 2013. Therefore, for a recovery date of January 15, 2014, their deployment length would be 273 days. This is 51 days less than the 324 days () estimated for the clock battery for the 3-pack Li instruments. We send these numbers to Sohn and asked him to make a decision: do we reconfigure the OBSs, or not?

JD 128 Wednesday May 08, 2013 – MCS Lines 108, 109, 110 completed. Rob Sohn confirmed that he is comfortable with the numbers above and gave us the OK for reconfiguring the OBSs.

JD 129 Thursday May 09, 2013 – MCS Lines 111, 112, 112T, 113 completed.

JD 130 Friday May 10, 2013 – MCS Lines 114, 115, 116 completed.

JD 131 Saturday May 11, 2013 – MCS Lines 117, 118, 119, 119T, 119T2 completed.

JD 132 Sunday May 12, 2013 – MCS Lines 122, 123, 123T, 115R, 110R, and 113R completed. End of MCS shooting.

JD 133 Monday May 13, 2013 – Airgun recovery started at midnight and lasted about 1.5 hours. Streamer recovery started at 01:30 and was finished by 05:40. It took just over 4 hours to recover 8 km of streamer! Nine OBSs recovered: Sites# 30-34, 13-16.

JD 134 Tuesday May 14, 2013 – Eleven OBSs recovered: Sites# 17-23, 26-29. Deployment of passive network of OBSs: OBS Site# 47 and 51 deployed. We conducted acoustic surveys at these two sites.

JD 135 Wednesday May 15, 2013 – Deployment of passive network of OBSs: OBS Site# 51, 58-61, and 56 deployed. We conducted acoustic surveys at all of these sites. We returned to OBS Site# 40 and tried again recovery of this instrument. No success. We deployed magie and started a bathymetry/mag/grav survey around the perimeter of our study area to expand coverage and fill in gaps.

JD 136 Thursday May 16, 2013 – Continued with bathymetry survey.

JD 137 Friday May 17, 2013 – Bathymetry survey finished at 15:53. End of data collection for cruise MGL1305. On the way to Ponta Delgada.

JD 138 Saturday May 18, 2013 – Transiting to Ponta Delgada. Clocks advanced 1 hour. Local time is same as UTC.

JD 139 Sunday May 19, 2013 – Arrived to Ponta Delgada at 08:00.

4. PRELIMINARY CRUISE ASSESSMENT

4.1 OBS Operations

4.1.1. Deployments

On route to a drop site, OBS instruments are built in the wet lab on a portable frame. Both OBSIP and science party members are involved. The data logger and acoustics are checked and all serial numbers of components are written onto an OBSIP check sheet. It takes ~30 minutes to build and check each instrument. About 5-10 minutes out, the OBS is wheeled out to the deck and tag lines and a winch cable are attached. Tag lines are attached to the release mechanism, not the OBS. Deck personnel required: A single winch/A-frame operator; two OBSIP personnel; two science party members. Science party members tend the tag lines and one OBSIP person holds the release rope and directs operations. At about 50 m from the drop location, the bridge gives a 50-m warning via radio and glides to a stop.

When the 50-m call is received, the OBS is lifted by the winch and sent out over the side by the A-frame; the instrument is lowered into the water and immediately released. Afterwards all lines are recoiled and stored, the winch is secured. The portable OBS frame is moved back into wet lab. Before departure, an anchor is set on the portable frame for the next deployment and a release system is attached. The OBS lab gives the OK to the bridge for departure to the next drop location. Deployment maps and tables are in Appendix 5.

4.1.2. Recoveries

The bridge usually gives 15 min, 1 mile, 500 m, 200 m, and 50 m notice via radio. At about 1 mile or less the pingers from the echosounders are secured at the console in the main lab; within the dry lab, enable commands are sent by the OBSIP group to the instrument until it responds. Once a response is recorded, a burn command is sent. The OBS responds if it accepts the command. If so, OBSIP gives a radio alert that they will wait 15 min to see if the instrument has released. Rise time is 40 m/min for a typical SIO SP instrument and 80 m/min for the over-sized converted L-22 instruments. Once they confirm that the OBS is rising, the OBSIP personnel give another radio announcement. Once the OBS surfaces, the bridge picks up a radio beacon from the OBS (often before visual contact) and moves along an azimuth to that beacon. Once visual contact is established, the boat moves alongside the OBS. The deck calls out, via radio, the OBS distance fore and athwart the A-frame. The OBS is snagged by a tag line ahead of the A-frame. A radio confirmation of the tag is broadcast. The OBS is pulled tight against the ship and a winch line is attached. The OBS is raised up the side of the ship and lowered onto the portable frame. Additional tag lines are not used. A radio confirmation of the OBS onboard is broadcast by the deck. The data logger is removed and the OBS is washed and disassembled. The OBS is moved to the wet lab for complete take down.

4.1.3. Onboard Data Processing

Raw data is written from the memory card(s) to a local drive and converted to `miniseed` format. Using a shot log, the data are cut into `segy` records, one per station/channel. The shot log was obtained from the Chief Sci. Officer and verified for accurate numbering and navigation. Bad navigation points were re-navigated. Some bad positions were hand-interpolated into position. Some shot-number errors were also fixed.

4.1.4. Data Quality

Data quality was established visually via examination of the `segy` records. OBS04 slammed into the side of the ship during deployment, the data cables became disconnected and it recorded no data. Noise levels are generally much higher on the L-28/L-22 sensors than on the hydrophone sensor. “Typical” 6.5 Hz noise is observed on most geophone channels. A qualitative summary of the data quality of each instrument and channel is included in Appendix 5.

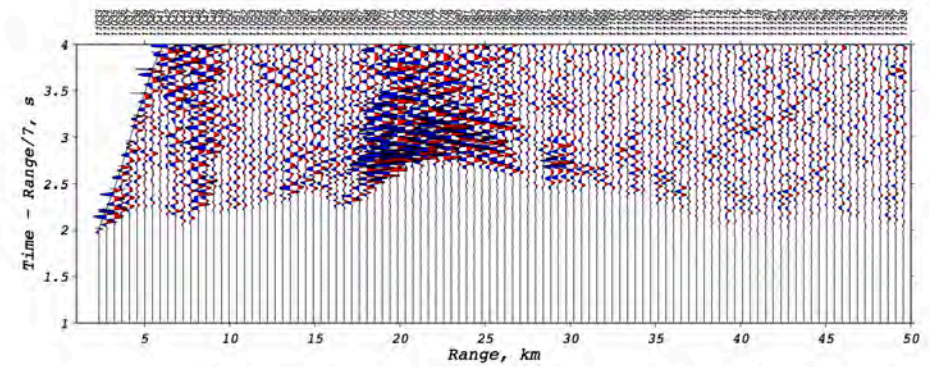
4.1.5. Preliminary Observations

Examples of some record sections are shown in Figure 2.

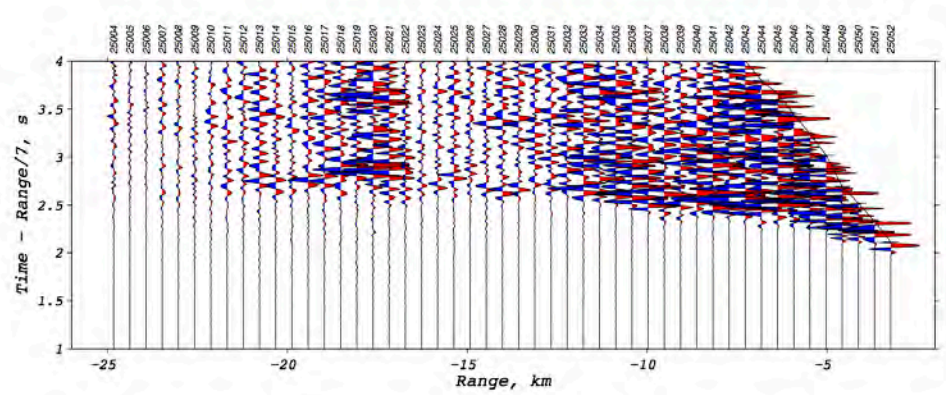
4.1.6. Acoustic Surveys

Ten of the 15 OBSs deployed for long-term passive component were acoustically surveyed for relocation. These instruments are OBS Sites 47, 51, 52, 55, 56, 57, 58, 59, 60, and 61. The remaining passive OBSs (Sites 48, 49, 50, 53, and 54) where deployed before shooting the MCS profiles and

therefore have recorded airgun shots with nearly complete azimuthal coverage. These OBSs can be relocated using the airgun recordings.



OBS01 Hydrophone channel. Axis-parallel seismic line.



OBS01 Hydrophone channel. Axis-perpendicular seismic line.

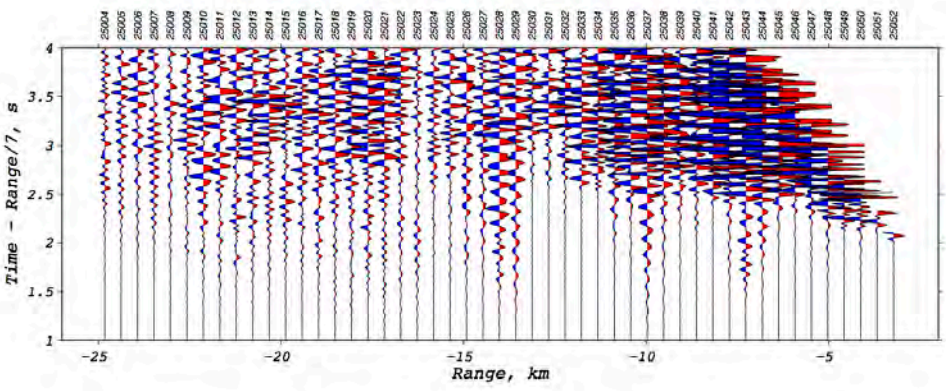


Figure 2. OBS01 L288 vertical channel. Axis perpendicular seismic line.

The procedure was as follows: the instrument was enabled when the ship was at a distance of ~3 km. At that point, the ship started to circle around the instrument with a radius of ~1/2 the water depth at a speed of ~6 knots. If communications with the instrument were not good, the radius of the circle and the

speed of the ship were reduced. Acoustic interrogation was done as the ship circled until 360 degrees were completed. The acoustic pings were then processed by the SIO engineers, who produced a final file for each site named OBS*_Corrected.txt. Appendix 6 contains a table for the relocated positions as well as a map of the deployed instruments for the passive component.

4.2. MCS Operations

4.2.1. Streamer Deployment/Recovery

For MCS acquisition during this cruise we used a hydrophone streamer with an 8-km-long active section composed of 636 channels. The streamer was put together by deploying 2 km of cable from the Langseth's streamer #1, and then joining them into the 6 km of streamer #3. Streamer deployment took 10 hours as birds and compasses were put at regular intervals and tested in the lab. Recovery of the streamer was much faster than anticipated and probably was the fastest recovery of an 8-km cable done to date on the Langseth. It took just over 4 hours.

Tailbuoy was deployed, but its GPS was not used. The reason for this was that there seemed to be a power leakage from the TB power supply into the streamer data channels, which introduced significant noise in the channels. Thus, reconstruction of the streamer shape was done using only the compasses' information.

4.2.2. Onboard Data Processing

Onboard MCS data processing consisted of: (1) using *sioseis* software, create a brute stack and f-k (water velocity) time-migrated image of each line for QC and preliminary assessment of crustal features; (2) reading the SEG-D raw files into database of Paradigm's software *Echos*, merge it with the P190 navigation files, and save as external `.dsk` files for post-cruise processing. Processing was done in the ship's Linux server *proc1*. Detailed description of these procedures and parameters used are in Appendix 10.

4.2.3. Data Quality

MCS data quality is excellent. By towing the streamer and the airgun array at a nominal depth of 12 m we obtained a source that is rich in low frequencies, at the expense of less richness in higher frequencies (Figure 3). This optimizes deep imaging at crustal and upper mantle depths, the target depths of our study. The far-field source signature for this configuration, as modeled by Helene Carton at LDEO using the software *Nucleus*, is shown in Figure 4.

Of the 636 channels only a few had bad signal. Figure 5 shows on example of a good-quality channel, while Figure 6 shows the 6 channels from Line 117 that were deemed of bad quality. Not all same channels had the same quality for all lines. For example, channel 119 had bad data at Line 117 (near the end of the experiment), but it had good data early in the experiment, indicating a degrading of data quality as the cruise progressed. In any case, the low number of bad channels observed was considered acceptable for the purposes of this experiment.

4.2.4. Preliminary Observations

The brute stack and time-migrated sections show a variety of reflectors whose nature will be investigated in post-cruise analysis, but they range from possible magma sills, to Moho, to large crustal faults. Figure 7 shows two examples of the MCS lines. All the onboard-processed migrated sections are included in Appendix 11.

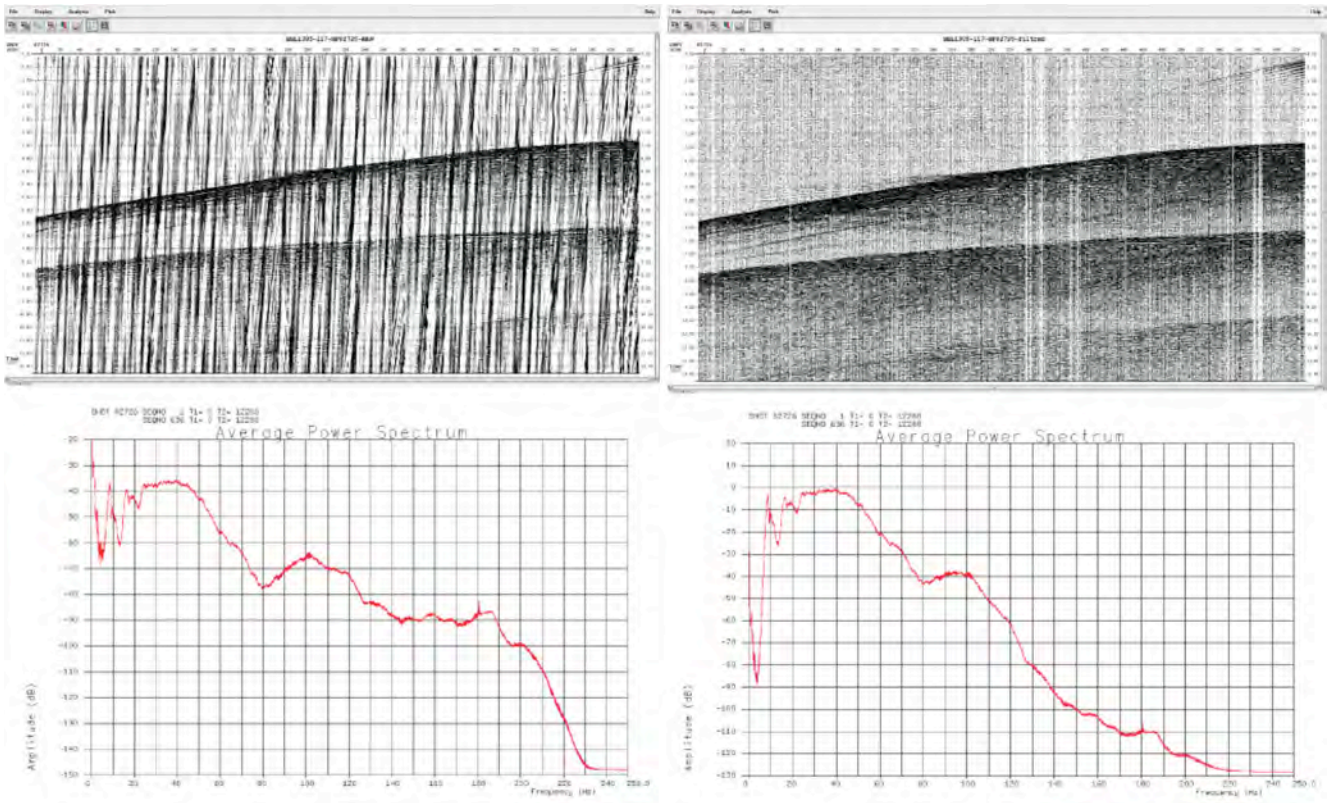


Figure 3. Examples of one shot gather (left raw; right band-pass filtered 8-90 Hz 36 db/oct) and their corresponding power spectra.

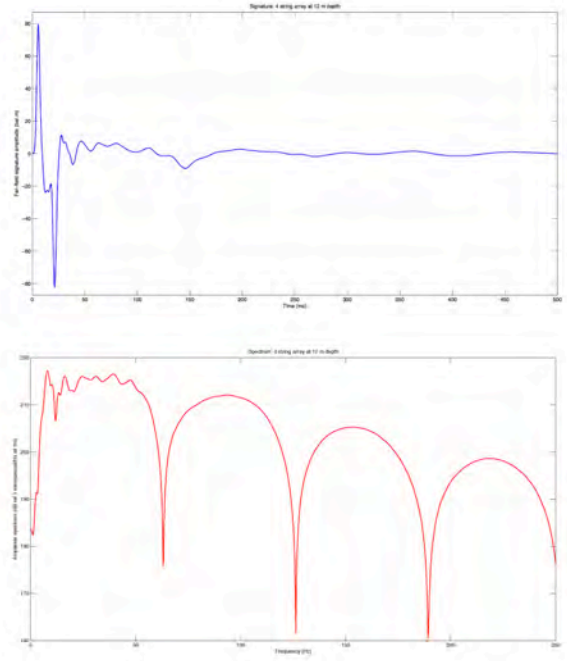


Figure 4. Modeled far-field source signature for a 4-string airgun array at 12 m depth. Figures courtesy of H. Carton, LDEO.

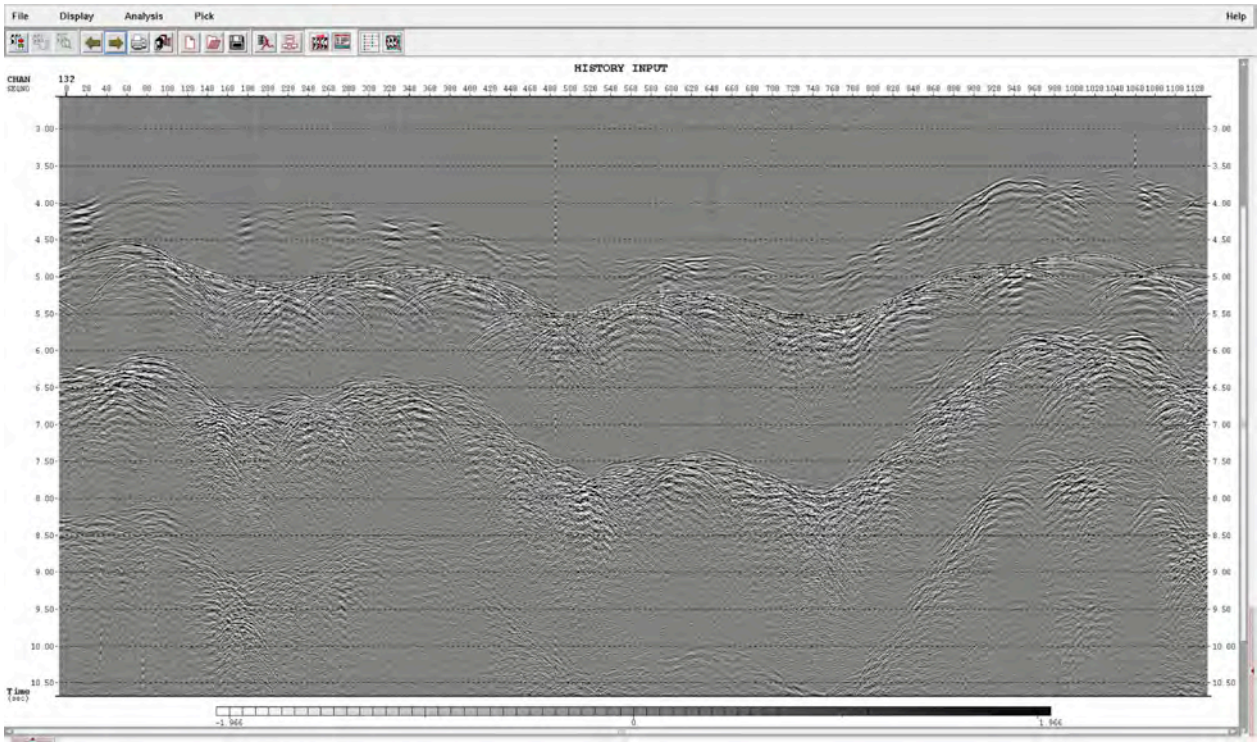


Figure 5. Example of a good channel (Line 117).

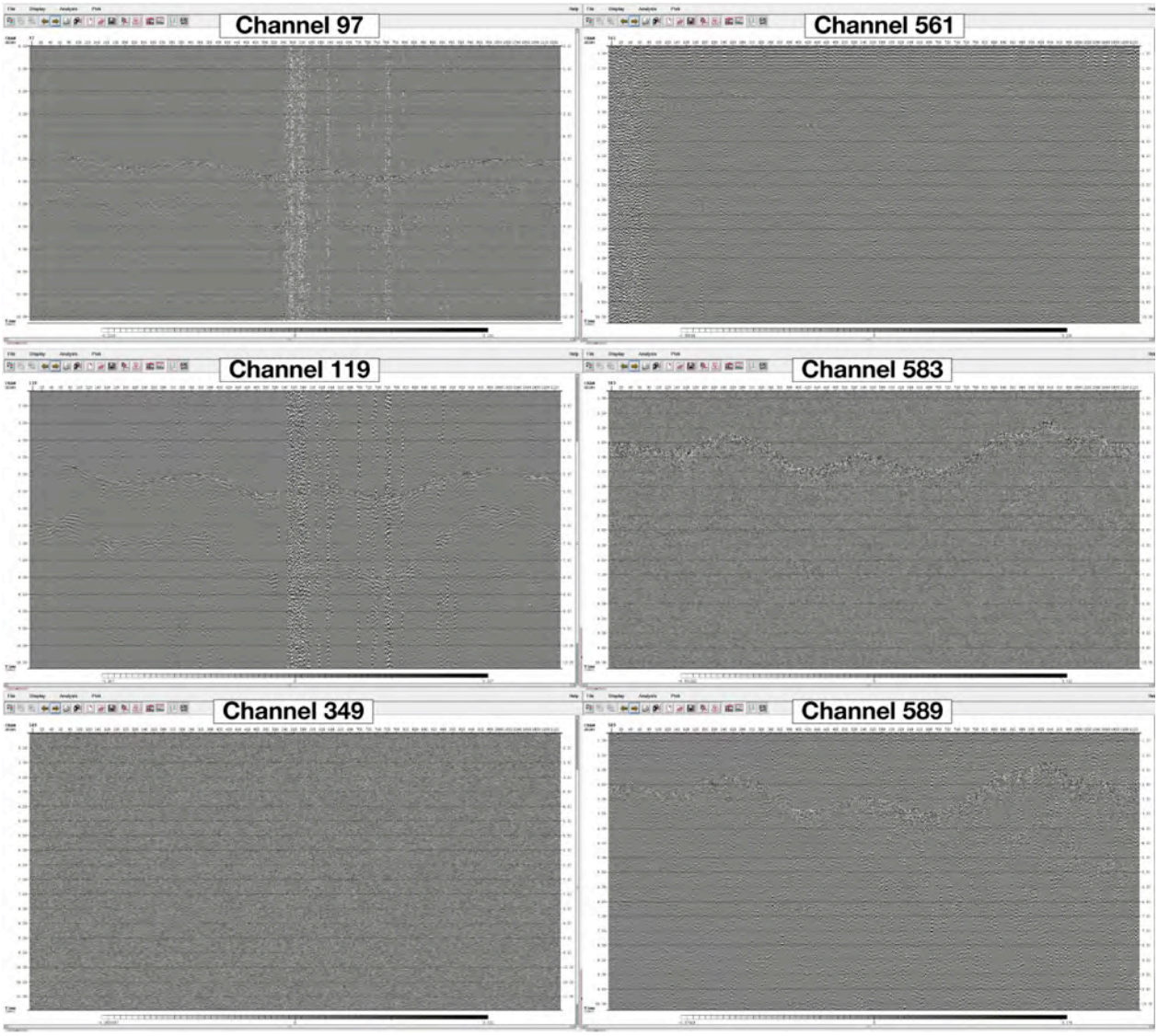


Figure 6. Bad channels for Line 117.

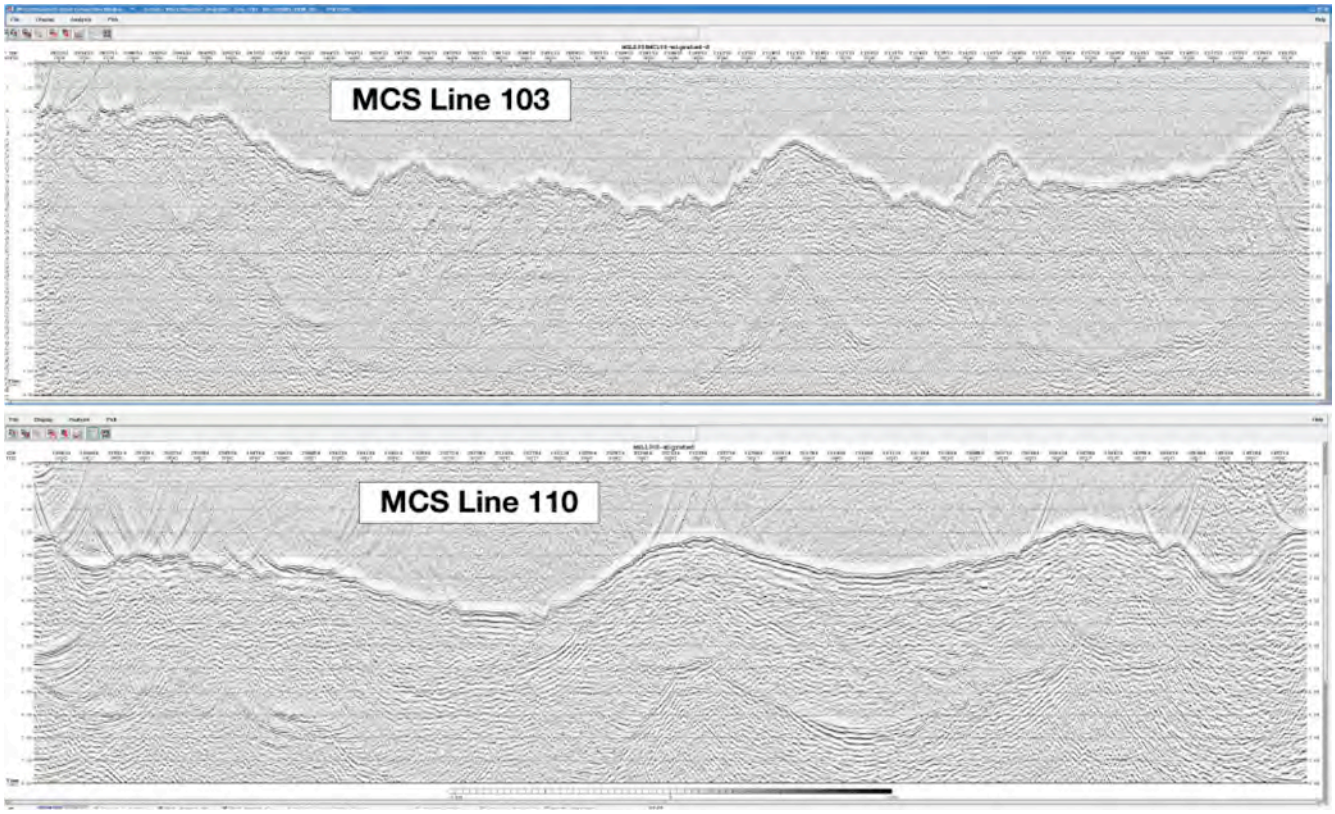


Figure 7. Examples of f-k time-migrated brute stacks. Amplitudes are scaled with an AGC window of 500 ms. Sections have been band-pass filtered 5-20 Hz 48 db.oct.

4.3. EM-122 Multibeam Echosounder

4.3.1. Acquisition

The multibeam system on board R/V M.G. Langseth is a hull mounted 1°x1° Kongsberg EM-122 multibeam system with 432 beams athwartship per ping, transmitting at a frequency of 12.0 kHz with maximum angular coverage of 150°. For this cruise the system was run with an angular swath width of 124˚ to 130˚ in an equal area mode, where the beamformer projects beams of varying angle across the swath to create equal size sonar footprints on the seafloor, resulting in a footprint of roughly 20 m in 2500m of water. The resulting swath width is between 2,5 and 3.5 times the water depth, corresponding to 1000-12,000 m in our survey area.

The ping rate was 13 s and most survey lines were collected at 4.5 knots for an inter-ping distance of roughly 30 m, while a fewer number were collected at speeds up to 8 knots. The system had been fully calibrated 8 months prior to this survey and patch tests found no obvious problems with the sound-speed profiles or artifacts due to roll bias or other such effects.

Beam angles: initially +-65 degrees, then reduced to +-62 degrees since the outer beams were always noisy and had to be discarded with the previous configuration

SVP profile: from World Ocean Atlas database

SV at Transduce: from sensor or from SVP profile in bad weather. Air bubbles cause incorrect readings at the sensor

Acquisition parameters:

- Auto angular coverage mode: the most limiting between max beam angle and max swath width criteria is used to determine swath width
- High-density equidistant beam spacing: increased number of soundings by directing some of the beams closer to the center of the survey and performing several soundings per beam on the edge of the swath
- Dynamic dual swath: two swaths are transmitted in succession, increasing coverage of the seafloor

Acquisition software: Kongsberg Seafloor Information System

4.3.2. Bathymetry Data Processing

The acquisition system output data in .all format separated into 30 min files. Using the `copy.sh` script (Appendix 12) these data were copied to a work directory using the *MB-system* utility `mbkongsbergpreprocess` which converts the format to mb59:

```
mbkongsbergpreprocess –I<file>.all –F58 –O<file>_raw.mb59 –S1/12 –S2/12 –S3/18
```

The use of `mbkongsbergpreprocess` is recommended instead of `mbcopy` for third-generation Kongsberg multibeam sonar data. It interpolates the asynchronous navigation and attitude data and correctly embeds them into the headers. This program also creates four ancillary files containing the full asynchronous attitude, sonar depth, and heading data and the synchronous attitude data. The `copy` sh script also resets the backscatter recalculation flag using `mbset` and performs preliminary data cleaning with `mbedit` using general conservative parameters:

```
mbset –I<file>_raw.mb59 =PSSRECALCMODE:1
mbclean –Idatalist.mb-1 –F-1 –M1 –C86/2 –D0.01/0.20 –S55/3/2 –G0.80/1.20
```

The volume of data collected was too large in relation to the number of processors available to fully ping edit the dataset during the cruise. Instead different parts of the dataset were prioritized for cleaning, to ensure maximum coverage and leaving redundant repeats unprocessed. Most regions of the survey area were surveyed 3-4 times and the central region over 20 times since the swath width was much larger than the line spacing of the seismic survey.

The clean data comprise some section of the transit, which were used as training dataset, the first OBS deployment, the long SW-NE OBS shooting lines (2 km spacing), the short SW-NE OBS shooting lines and various sections of the MCS shooting phase, selected to provide coverage in areas not previously sampled or to improve sampling in regions of particular interest or affected by poor data because of averse weather conditions.

The data were manually cleaned to remove artifacts and noisy sections and then output as xyz with `mblist`. The point cloud was then gridded using a combination of the *GMT* commands `blockmedian`, `surface`, `grdsample` and `grdmask` to create a 0.0002x0.0002 degrees grid (approximately 20 m spacing). Daily grids were generated for raw and cleaned data as well as a combined grid of all cleaned data. An extract of the processing script (`gridMGL1305.sh`, Appendix 12) is provided below:

```
mbprocess –Idatalist.mb-1 –F-1
mblist –Idatalist.mb-1 –F-1 –R-34:30/-33:15/35:40/36:50 –S4 –D2 –A > MGL1305.xyz
blockmedian MGL1305.xyz –I0.0002 –R-34:30/-33:15/35:40/36:50 –V –bi3 –bo3 >> median.txt
surface median.xyz –R-34:30/-33:15/35:40/36:50 –I6201+/5801+ -T0.5 –Gtemp.grd –bi3
grdsample temp.grd –R-34:25/-33:20/35:45/36:45 –I0.0002 –Gsurf.grd
```

```
grdmask median.xyz –R-34:25/-33:20/35:45/36:45 –I0.0002 –S0.080k –Gmask.grd –NnaN/1/1 –bi3
grdmath surf.grd mask.grd MUL = MGL1305.grd
```

The data quality was very variable, ranging from very good to noisy over the duration of the cruise depending on the sea state, on whether the Knudsen sub-bottom profiler was on and shooting was ongoing, but even in the worst conditions (35 knots wind, 4 m swell) the data were satisfactory after careful editing (Figure 8).

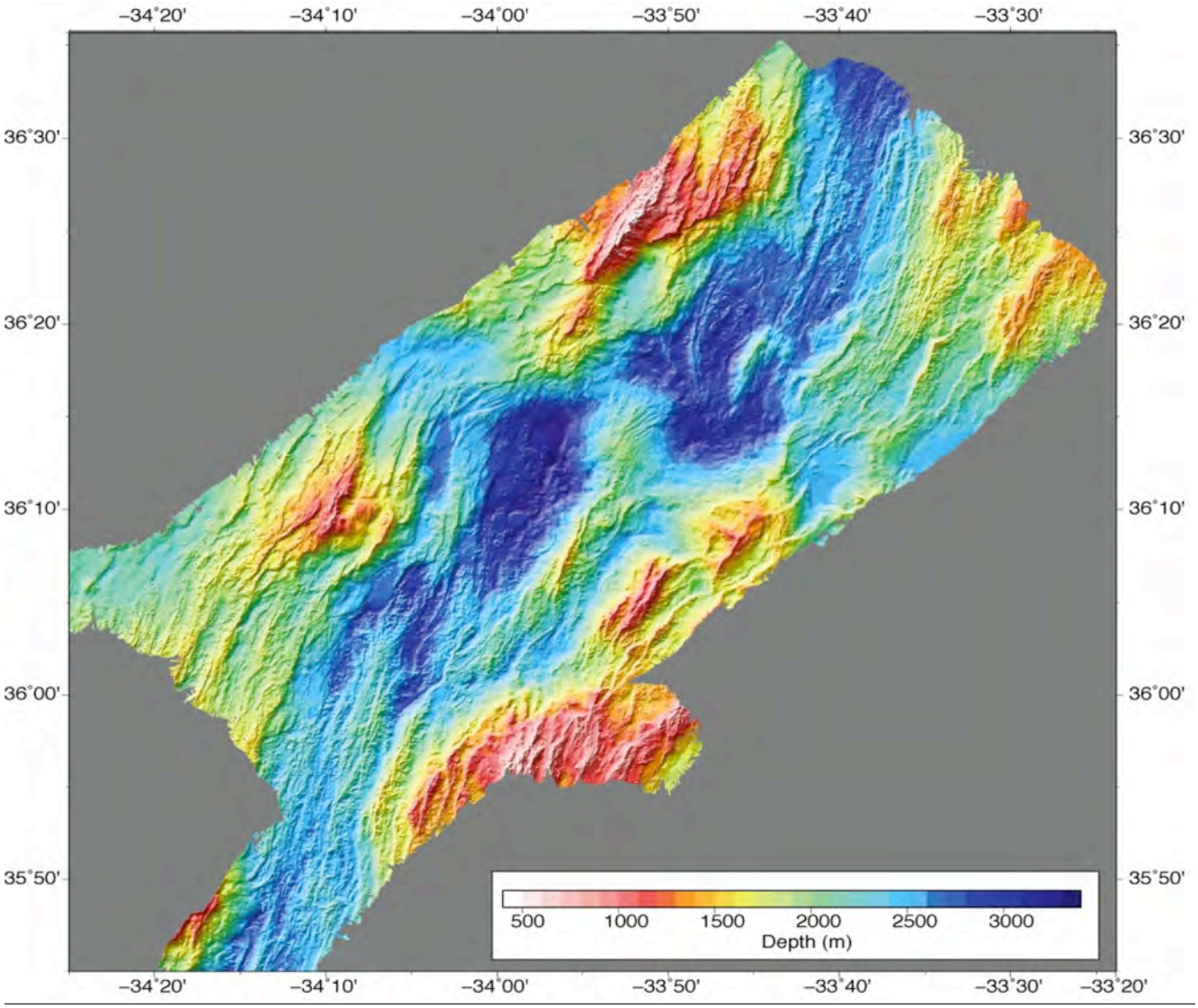


Figure 8. Multibeam bathymetry map from Cruise MGL1305.

The clean grid was further combined with data from previous cruises including a number of publicly available datasets and a compilation of swath data from IFREMER and with satellite derived bathymetry. A list of the cruise names, dates, vessel and acquisition system is provided in Table 2.

Table 2. Available Multibeam Bathymetry Data in the Survey Area

Cruise ID	Start date	End date	Vessel	System	Institution
KN145L19	1996-06-27	1996-08-07	R/V Knorr	SeaBeam 2100	WHOI

FLORES	1997-07-07	1997-09-08	L'Atalante	EM12D	IFREMER
AT3L3	1997-07-05	1997-07-25	R/V Atlantis	SeaBeam 2100	WHOI
KN161L04	2000-02-23	2000-03-19	R/V Knorr	SeaBeam 2100	WHOI
KNOX18RR	2008-07-09	2008-08-13	R/V R. Revelle	EM120	SIO
KN207L02	2012-05-06	2012-06-11	R/V Knorr	SeaBeam 3112	WHOI

4.3.3. Backscatter Data Processing

Apart from data pre-processing performed by the EM122 system, processing included merging data and navigation and hand filtering the data to remove bad returns. In the latter case `mbedit` was used. In the former case `mbkongsberreprocess` was used (see `mbsystem` man page). Processing scripts are included in the Appendix 13. Figure 9 show a backscatter intensity map of the study area.

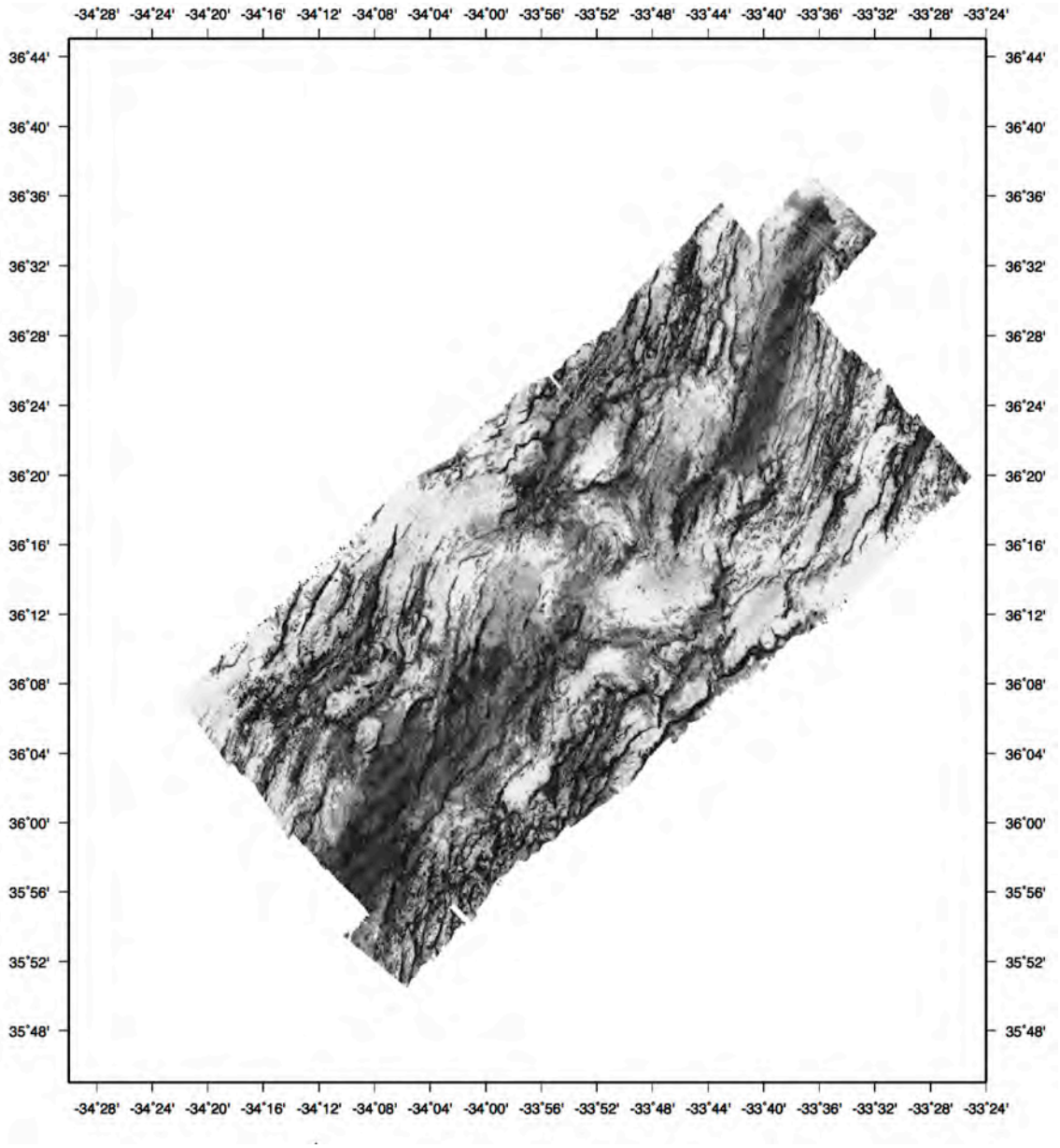


Figure 9. Multibeam backscatter intensity map from Cruise MGL1305.

4.4. Gravity

The R/V *Marcus G. Langseth* is equipped with a Bell Aerospace BGM-3 marine gravimeter installed in the main lab at approximately mid-ship. The BGM-3 gravimeter consists of a force-balance vertical accelerometer mounted on a gyro-stabilized free rotating platform and an associated data logger. The sensor employed is axis-symmetric and does not require cross-coupling error correction. During the cruise the raw data was stored in real time as a two-column ascii file containing time and raw counts in mV from the accelerometer force-balance circuit.

The gravity data was processed with *matlab* (Appendix 14). After reading the data into *matlab* they were converted from counts of the instrument into mGal. In doing so a conversion factor *cf*=5.0962178 was used (Appendix 14). Then the DC and Eötvos corrections were made and the Free-Air anomaly was calculated:

$$FAA = g_{raw} + DC - g_0 + E \qquad (1)$$

where g_{raw} is the measured gravity on board, DC the value for the DC-shift, g_0 the calculated gravity and E the Eötvos correction.

DC-shift

The DC-shift was calculated as:

$$DC = G_S - G_{raw}(t_T) \qquad (2)$$

where $G_{raw}(t_T)$ is the raw gravity data (in mGal) measured with the instrument on board at the time when the MISTIE was measured (at 14:00 on April 9th $\rightarrow$ $t_T = 50400s$ on Julian Day 99).

G_S was calculated as:

$$G_S = G_T - MISTIE + \Delta z \cdot A \qquad (3)$$

where G_T=979808.43 mGal is the gravity at the harbor in St. Georges, Bermuda, measured in September 1978. Δz=2.51 m is the difference in altitude between the measurements for the MISTIE and the instrument on board (altitude of measurements at harbor: 0.2m, altitude of instrument on board: −2.31 m). A=0.3086 is the factor for the free air reduction (P. Dehlinger, *Marine Gravity*, Elsevier Scientific Publish Company, 1978).

To get the MISTIE the difference between the gravity at the tie point and at the pier side in Bermuda was necessary. To minimize the error of the shift of the instrument, three measurements were made at the pier side, three at the tie point, and again three at the pier side, all of them made with the ship's *LaCoste&Romberg* portable gravimeter (see Table 3):

$$MISTIE = LR_{tie} - LR_{Pier} \qquad (4)$$

where LR_{tie} is the mean of the three measurements at the tie point. The mean of the measured values at the pier before and after the measurement at the tie point each have been calculated. These two values then have been interpolated at the time when the tie point measurement where taken.

Table 3. Measurements for the MISTIE. Each values is given in counts of the instrument				
	Measurement 1	Measurement 2	Measurement 3	Mean

LR_{Pier} 1	3406.07	3405.85	3406.08	3406.00
LR_{tie}	3405.94	3405.99	3406.19	3406.04
LR_{Pier} 2	3405.85	3405.98	3406.05	3405.96

Eötvos Correction

The Eötvos correction was calculated as:

$$E = 7.5038 \cdot speed \cdot \sin(course) \cdot \cos(latitude) + 0.004154 \cdot speed \qquad (5)$$

The *speed* (knots), *course* (degrees clockwise from N) and *latitude* (degrees) values were taken from CNAV-350 navigations files. Anomalous peaks in the speed data were filtered with a *matlab* median-filter of order 41.

Free-Air Anomaly

The Free-Air anomaly was calculated using Equation (1). To obtain g_0, the international geomagnetic reference field was used:

$$g_0 = 978032.68 \frac{1 + 0.00193185138639 \cdot \sin^2(latitude)}{\sqrt{1 - 0.00669437999013 \cdot \sin^2(latitude)}} \qquad (6)$$

The *latitude* values (degrees) were taken from CNAV-350 navigations files. A free-air anomaly map is shown in Figure 10.

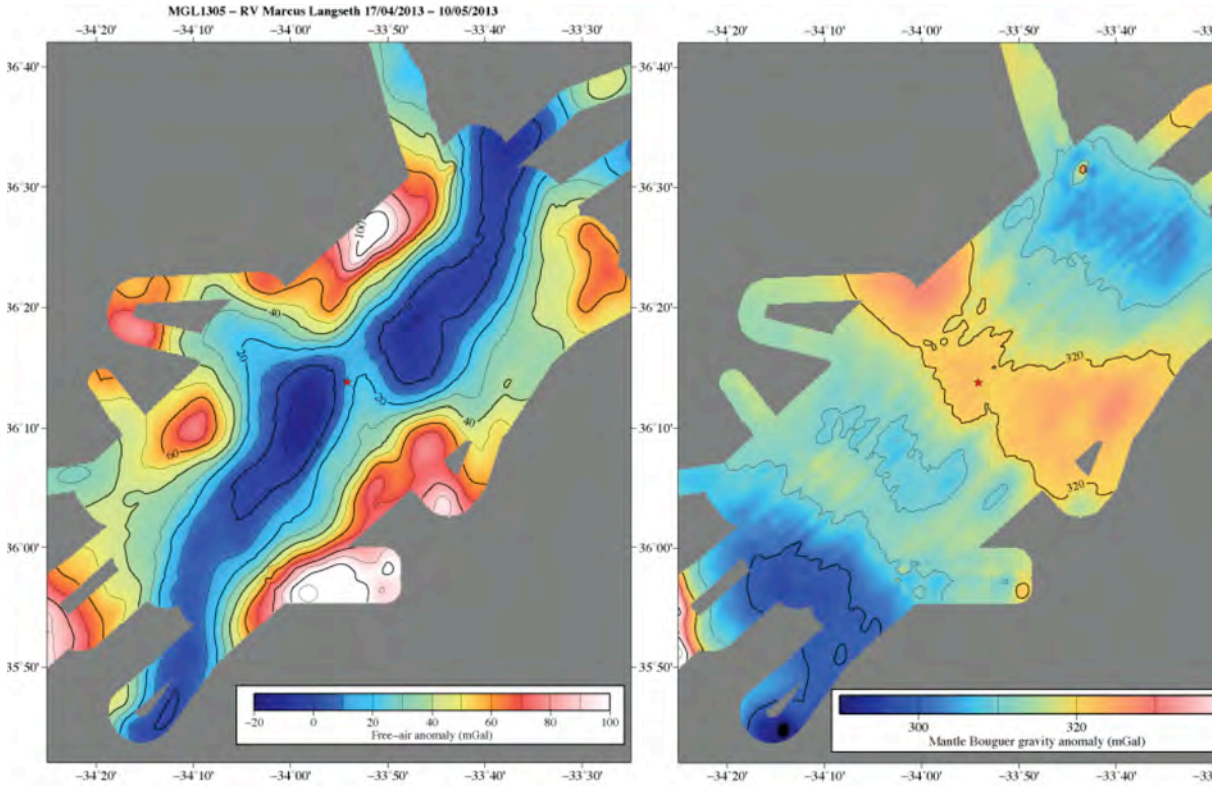


Figure 10. Free-air (left) and mantle Bouguer (right) gravity anomaly maps.

Daily plots

For QC, each day a plot was made, displaying the gravity data (Appendix 14). The free-air anomaly was plotted once unfiltered and filtered by a Gaussian filter with the length of 900 s. Also the speed, the heading, the position and the bathymetry were displayed.

Mantle Bouguer anomaly

The multibeam bathymetry was merged with multibeam data from previous cruises in the survey area and satellite derived bathymetry and used to calculate a Bouguer correction using a *matlab* implementation of the spectral method of Parker [1973], see script `ggrid.m` in the directory `/Gravity/Bouguer`. We used a water density of 1030 kg/m^3 and a crustal density of 2700 kg/m^3. The same script was used to calculate the mantle Bouguer correction, using a 6.0 km constant thickness crust and densities of 2900 kg/m^3 3300 kg/m^3 for the crust and upper mantle respectively. The Bouguer correction and mantle Bouguer correction were subtracted from the free-air gravity anomaly to obtain the mantle Bouguer anomaly (Figure 10).

4.5. Magnetics

4.5.1. Background

The Earth's magnetic field undergoes changes in polarity with an average frequency of about once every million years. When rocks from the seafloor cool down below the Curie temperature of their magnetic minerals, these minerals acquire a natural remanent magnetization which is parallel to the magnetic field's direction at that time. Another magnetization, called induced magnetization, is generated by the ambient field and is proportional and parallel to it.

The remanent magnetization of volcanic rocks such as example extrusive basalts from the oceanic crust, is usually strong and dominates the induced magnetization. Consequently, the oceanic crust is characterized by a succession of normal (i.e. same orientation as today's Earth magnetic field) and reverse polarities (i.e. opposite direction), generating symmetrical magnetic anomalies that are observed on both sides of mid-ocean ridges. These anomalies played a key role in the understanding of plate tectonics [e.g., *Vine and Matthews*, 1963].

As a result of alteration, the titanomagnetite of basalts slowly turns into titanomaghemite, which has a weaker magnetization, and finally into non-magnetic minerals [e.g., *Tivey and Johnson*, 2002; *Tivey et al.*, 1993]. Therefore, circulation of fluids in extrusive basalts reduces their average magnetization and the intensity of associated magnetic anomalies. Consequently, anomalies associated to young volcanic structures (ridge axis, active volcanoes, etc.) are comparatively stronger than those from the surroundings.

4.5.2. Surface Magnetometer

The surface magnetometer used during Langseth cruise MGL1305 is a Geometrics 882 magnetometer with a precision of 0.1 nT. This magnetometer was towed at the end of a 140 m long cable. This length is required to avoid magnetic perturbations from the ship and make the hypothesis that measurements are only influenced by the structures of the seafloor. The total offset between the sensor and the GPS antenna onboard was 170 m. Data were collected with a frequency of 10 samples per second and merged with navigation files.

4.5.3. Data Processing

The surface magnetic data were acquired along parallel profiles following the global orientation of the ridge axis, as well as along crossing lines coincident with seismic profiles. Processing onboard did not use data from these lines crossing lines because of inconsistency at the crossing points; this will need further post-cruise processing. The studied area has a 100-km-by-60-km rectangular shape with a NE-SW orientation and is therefore wider than the axial normal-polarity anomaly.

The data processing consists of two steps. The first step is removing the International Geomagnetic Reference Field (IGRF) from the data to get anomalies with a close-to-zero mean. The study area was sub-divided in 5-km-by-5km subareas, and the average IGRF value within each subarea was removed form the observed data. The resulting magnetic anomaly were along the survey lines and interpolated to get an homogeneous map (Figure 11). Because of the inclination and declination of the magnetization vector, the anomalies are not focused on the sources.

The second step consists in reducing these anomalies to the pole. Reduction to the pole is a mathematical transformation performed in the spectral domain that corrects the observed anomalies to the hypothetical situation in which inclination and declination of the magnetization vector would be 90° and 0° respectively (equivalent to what happens at the magnetic poles). This transformation is stable, unless if the latitude is comprised between -10° and 10°, and gives monopolar, instead of dipolar, anomalies centered on the sources (Figure 11).

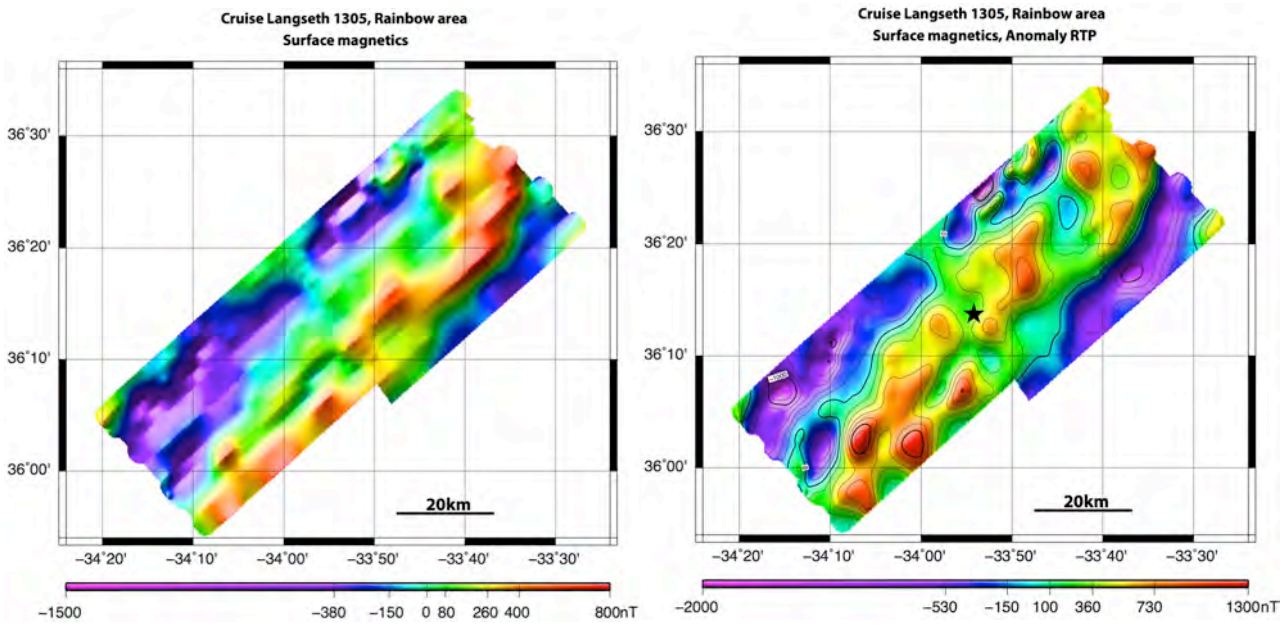


Figure 11. Left: Magnetic anomalies after removal of the local IGRF. **Right**: Magnetic anomalies after reduction to the pole. The hydrothermal site is symbolized by a Black star indicates location of the Rainbow hydrothermal site, which sits within an area of weaker magnetic anomaly. Two areas with a reverse polarity clearly appear on both sides of the map.

4.5.4. Preliminary Interpretations

On a first order, the magnetic anomaly map shows two parallel areas with a strongly negative anomaly encompassing a positive anomaly following the central valley of the ridge (Figure 12). The negative anomaly corresponds to seafloor older than the Bruhnes-Matuyama inversion (780,000 years). It has therefore been created at a time of reverse polarity of the Earth's magnetic field and a strong magnetization results in a negative magnetic anomaly.

On the opposite, younger seafloor (i.e. closer to the ridge axis) is characterized by a positive anomaly than can also be linked to a high magnetization because of its normal polarity. The magnetic anomaly map consequently allows to make an estimation of the age of the oceanic crust in the study area: it is 780,000 years where polarity changes, younger in areas closer to the axis and older elsewhere.

Shorter wavelength anomalies also appear in the normal polarity area. The Rainbow hydrothermal site is localized in the center of a lower magnetic anomaly. Because the magnetic measurements are performed far from the sources (on average 2600m), the structures we see are relatively deep. The weaker magnetic anomaly could be linked to a local decrease of the depth of the Curie isotherm of titanomagnetite (around 200°C), which would be consistent with the heat flux resulting in hydrothermal activity. Other positive anomalies may correspond to young structures with highly magnetized basalt.

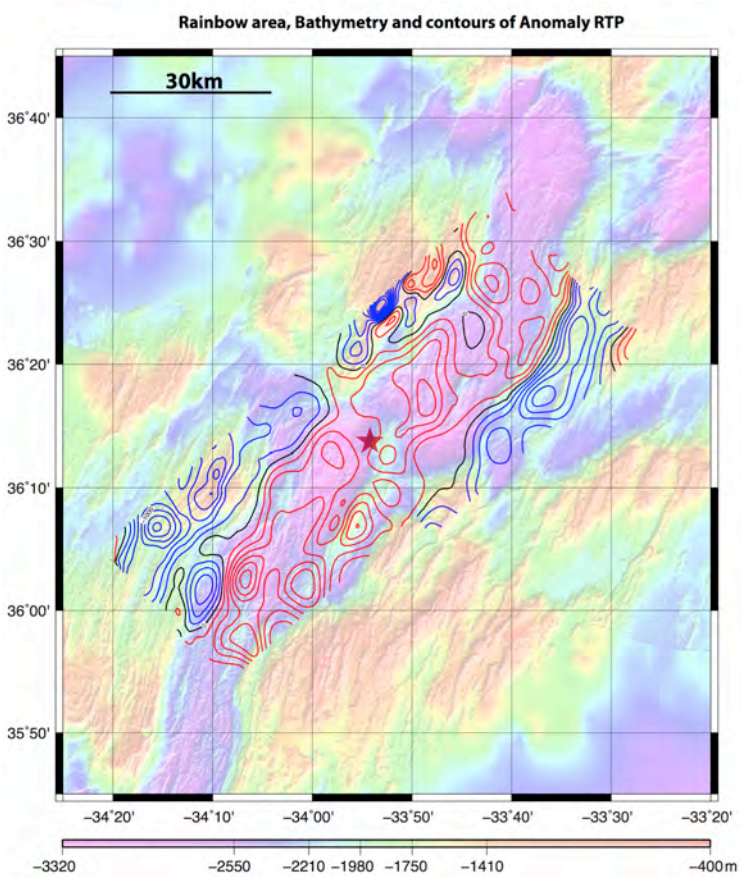


Figure 12. Contour lines of the anomaly reduced to the pole superimposed on a bathymetry map. The red isocontours correspond to a positive anomaly, the blue to a negative one and the black line is the 0 nT isocontour. The inversion of polarity globally follows the bathymetry and to a first order represents an isochron.

4.6. Protected Species Observations and Procedures

An Incidental Harassment Authorization (IHA) was issued just before the cruise (Appendix 17). Protected Species Observers (PSOs) were on watch 24/7 conducting visual (only during daytime) and acoustic monitoring using a Passive Acoustic Monitor (PAM). As specified in the IHA, different procedures had to be followed whenever marine mammals or other protected species were observed. Figure 13 shows a flow chart of the different situations that were anticipated to occur. Shooting during night was permitted as long as at least one gun was operating during daylight. In addition, a 30-minute period of clear observations was required before starting gun operations. Power down: reduction of the source volume to a single mitigation 40-cu-in gun. Shut down: immediate shut down off all guns, including mitigation gun. Rum-up: this procedure involves shooting every 17 s and increasing the source volume by turning on one gun at a time. It usually takes about 30 minutes to complete.

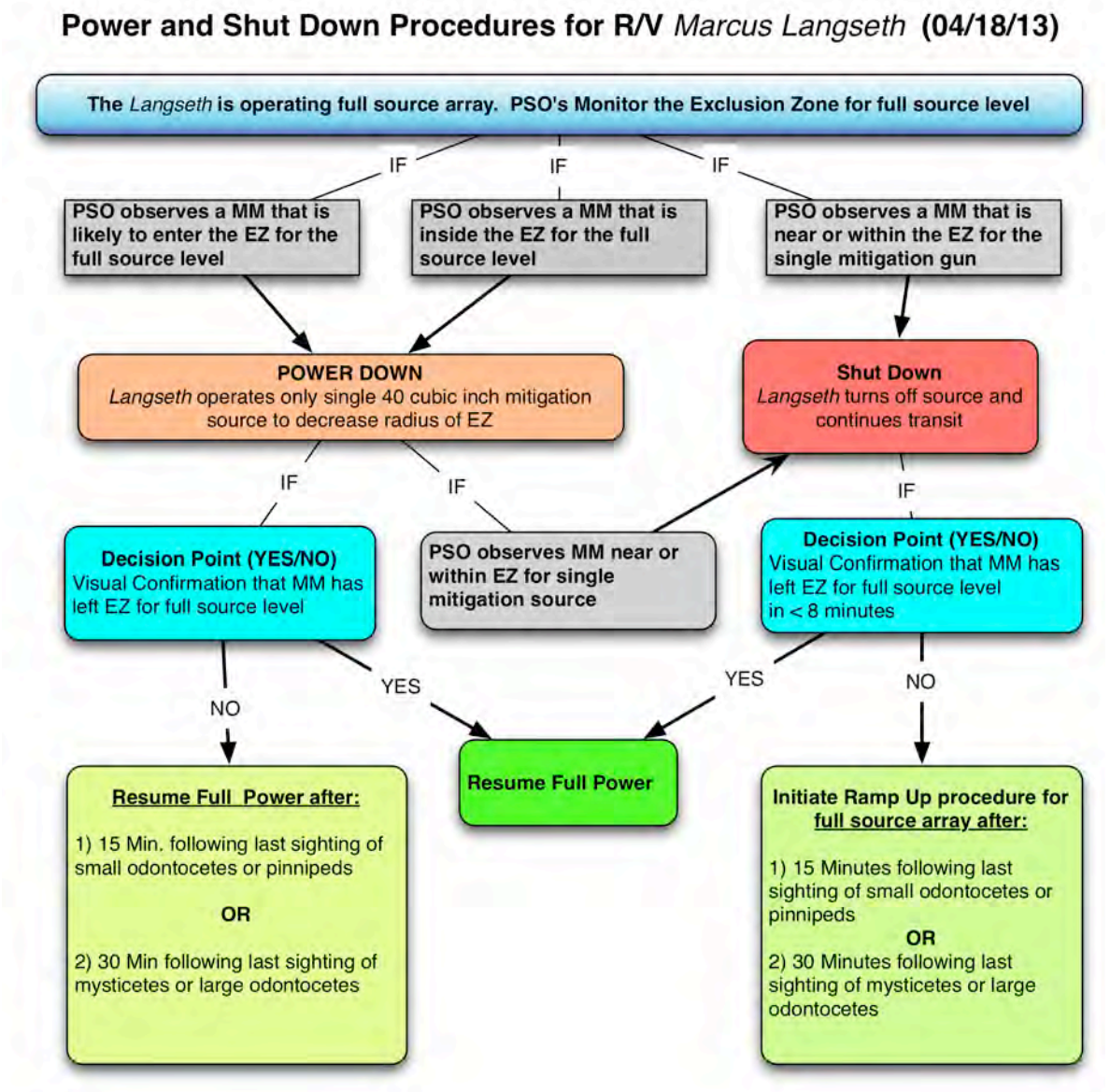


Figure 13. Power and shut down procedures.

Impact of mitigation procedures on data acquisition was small. Power downs and shut downs were mainly cause by turtles, and occasionally by dolphins and whales, but they typically lasted for a few minutes (Appendix 9). Where impact on data acquisition was found to be significant, we conducted reshoot of some portion of the MCS lines to fill-in for data gaps.

4.7. Other Science Activities

4.7.1. Sediment Sampling

During the first phase of OBS recoveries we noticed that a few instruments came back with quite a few of sediments trapped with their frames. Therefore during the second phase of OBS recoveries we made an effort to collect sediment samples form the instruments when enough material was preserved in the frames. Drs. Susan Humphris and Chris German form WHOI both expressed interest in these samples, as they can be used to study the dispersal of metallic elements from the hydrothermal plume, and will be of interest for the international GEOTRACES Program studying global ocean chemical cycles.

As this activity was not anticipated. We did not have onboard the proper equipment for sample collection. We proceeded to collect the material in coffee filters. Half of the wet material was immediately transferred to plastic zip-lock bags and stored refrigerated at 4°C. The other half was let to air-dry, and once dried it was transferred to plastic zip-lock bags and stored refrigerated at 4°C.

4.7.2. Sun Photometer Measurements

A handheld sun photometer (Microtops II) device was used during the cruise to take spectral measurements of direct solar radiation. Microtops II measurements provide information for calculating the columnar aerosol optical depth (AOD), water vapor and Angstrom parameter. These calculations will be used by NASA's AERONET: Maritime Aerosol Network (MAN) in order to establish validation points for satellite and aerosol transport models.

MGL1305 sun photometer measurements were taken intermittently during the cruise (starting on April 10th - May 19th) depending on daily weather conditions. Measurements were taken approximately at noon on days of relatively clear-sky conditions. In order to record sun photometer data, GPS is plugged into the Microtops II device to lock the position, date, and time of measurement. The lid of the Microtops II is then aimed toward the sun and is scanned sequentially 6-10 times within a two minute time period. Recordings are then stored in the device to later be processed and used by NASA to calculate atmospheric properties.

5. ACKNOWLEDGEMENTS AND RECOMMENDATIONS

We want to express our gratitude to NSF managers for supporting this project, and to personnel from the LDEO Office of Marine Operations for their assistance in preparing for this cruise. We thank the OBSIP managers and engineers, who made extraordinary efforts on pre-cruise instrument scheduling and preparation to ensure that all of our scientific needs were met. OBSIP personnel Ernie Aaron, Mark Gibaud, and Phil Thai did an excellent job on running the OBS operations, and showed great resourcefulness when addressing the technical challenges that arose during this experiment. We also want to thank the InterRidge program (www.interridge.org) for funding the cruise bursaries for participants Michele Paulatto, Maja Fabeta, and Omar Benazzouz, and the MATE Program (www.marinetech.org) for supporting the participation of Chris McHugh.

And last but no least, this project could not have been conducted without the skillfulness of RV *Langseth*'s crew and technical personnel. Their expertise and hard work maintain the *Langseth* facility in excellent shape, and have made it a state-of-the-art mobile laboratory for cutting-edge science. The airgun arrays worked flawlessly with only minor glitches that were efficiently solved; we did not suffer any significant loss of data due to gun or compressors' problems. The streamer was deployed and recovered in the most efficient manner we've seen in any other cruises, and only a small percentage of streamer channels recorded degraded signal. These all speak to the professionalism of Science officer Dave Martinson, Tech. Bern McKiernan, navigator Mike Martello, and gunners Tom Spoto, Carlos Gutierrez, and Robbie Gunn. Thank you all for a smooth and successful cruise.

Recommendations:

Computing Resources. There are currently two *linux* servers available to the science party: *proc1* and *proc2*. *proc2* was exclusively used for ping editing and processing the multibeam bathymetry data. While the multibeam system EM122 is a fabulous system, the sheer amount of data generated requires 24/7 dedication to data editing and QC using one of the two servers. *proc1* was mainly used to run seismic processing software such as *sioseis* and the Paradigm packages such as *Echos*. We find that having only one server available for seismic data QC and processing is not nearly enough. Brute stacks had to be made on the go as lines were finished; then the data had to be merged with navigation, and finally some preliminary processing and QC was done. We were able to accomplish all of these without creating a backlog, but performing these high-priority tasks prevented some of the students to engage in other specific data processing routines and to explore the dataset. Having two additional terminals for more in-depth MCS data processing should be a high priority for the future, particularly for 3D MCS cruises or collecting larger datasets than ours. The main lab, including the small room at the back, is large enough so a redistribution of space with more benches for computer monitors could be done.

Networking. During our cruise we used the HighSeasNet service to connect to the internet. We find the performance of this service less then satisfactory. There are many reasons for the low transmission speed and numerous drops of connectivity, including having a full ship with people using more than one personal computer and smart phone/tablets. While the use of bandwidth for personal use was reasonably restricted to some level, the reality is that reliable internet access for science and personal matters is a necessity of modern life. NSF and ship's operator should look into available options for improving and upgrading the current service.

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APPENDICES

A.1. Science/Technical/Ship's Crew and Watch Schedule

MGL1305 Ship's Officers and Crew

Name	Position		Name	Position
Mark Landow	Master		Albert Karlyn	Chief Engr.
David Wolford	Chief Mate		Matthew Tucke	1st Engr.
Lee Dortzbach	2nd Mate		Michael Romero	2nd Engr.
West Wilson	3rd Mate		Apolinario Scalacal	3rd Engr.
Jason Woronowicz	Bosun		Cheryl Gutkowski	Oiler
George Cereno	AB		Guillermo Uribe	Oiler
Peter Piscitello	AB		Jack Billings	Oiler
Inocencio Rimando	AB		Michael McCoy	Steward
Jeromiel Webster	OS		Ricardo Rios	Cook
Joselyn White	OS			

MGL1305 Shipboard Technical Staff

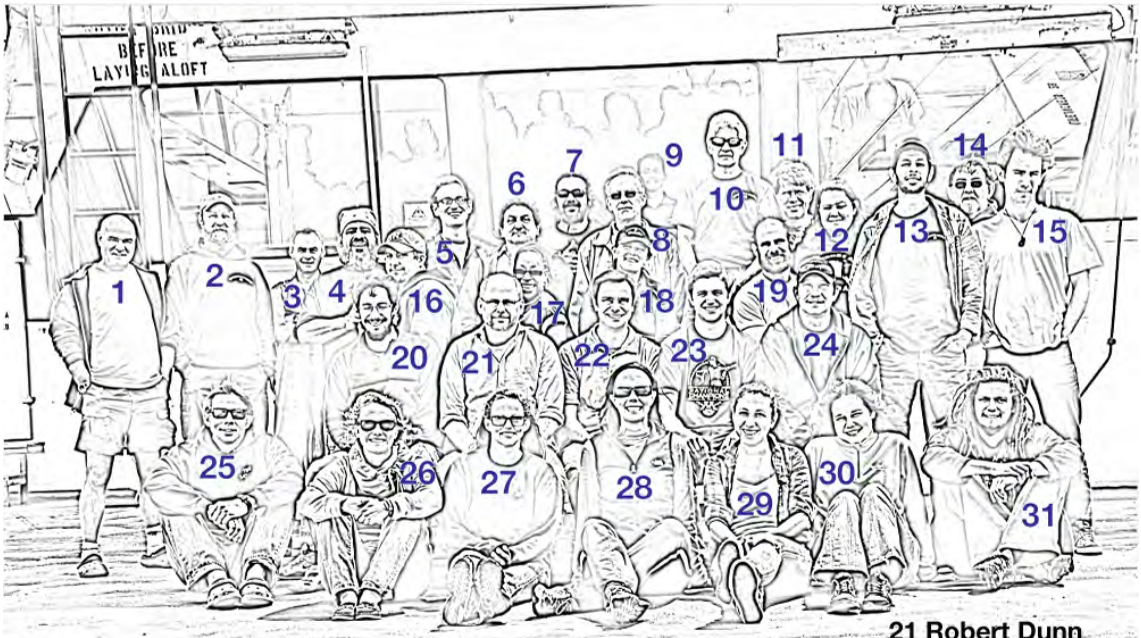
Name	Position		Name	Position
David Martinson	Chief Science Officer		Joshua Kasinger	Gunner
Bernard McKiernan	Science Tech		John Schwartz	Gunner
Michael Martello	Acquisition/Navigation		Stephanie Milne	Chief PSO
Nigel Crane	Acquisition/Navigation		Dara Cameron	PSO
Klayton Curtis	Acquisition/Navigation		Meghan Piercy	PSO
Thomas Spoto	Chief gunner		Leslie Curran	PSO
Carlos Gutierrez	Gunner		Katelyn Morrell	PSO
Robert Gunn	Gunner			

MGL1305 Science Party

Name	Position	Institution	E-mail
J. Pablo Canales	Co-chief scientist	Woods Hole Oceanographic Institution	jpcanales@whoi.edu
Robert Dunn	Co-chief scientist	University of Hawaii	dunnr@hawaii.edu
Steve Swift	Scientist	Woods Hole Oceanographic Institution	sswift@whoi.edu
Ernie Aaron	OBSIP Senior Development Engr.	Scripps Institution of Oceanography	eaaron@ucsd.edu
Mark Gibaud	OBSIP Senior Development Engr.	Scripps Institution of Oceanography	mgibaud@ucsd.edu
Phil Thai	OBSIP Jr. Development Engr.	Scripps Institution of Oceanography	pthai@ucsd.edu
Ryuta Arai	Postdoctoral Researcher	University of Hawaii	ryuta7@hawaii.edu
Michele Paulatto	Postdoctoral Researcher	University of Oxford, UK	michelep@earth.ox.ac.uk
Greg Horning	Graduate Student	Woods Hole Oceanographic Institution	horning@mit.edu
Florent Szitkar	Graduate Student	Institut de Physique du Globe de Paris, France	szitkar@ipgp.fr
Maja Fabeta	Graduate Student	National University of Ireland, Galway	M.FABETA1@nuigalway.ie
Omar Benazzouz	Graduate Student	University of Aveiro, Portugal	gibnem@gmail.com
Eva Kakone	Undergraduate Student	University of Hawaii	ekakone@hawaii.edu
Hannes Griesche	Undergraduate Student	University of Münster, Germany	h.griesche@gmail.com
Chris McHugh	MATE Intern	Coastal Carolina University	crmchugh@g.coastal.edu

MGL1305 Science Party Watches

	00-02	02-04	04-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24
Canales												
Dunn												
Swift												
Aaron												
Gibaud												
Thai												
Arai												
Horning												
Fabeta												
Szitkar												
McHugh												
Benazzouz												
Kakone												
Griesche												
Paulatto												



1 Nigel Crane
2 Klayton Curtis
3 Robert Gunn
4 Ricardo Rios
5 West Wilson
6 Tom Spoto
7 Bernard McKiernan
8 David Martinson
9 Lee Dortzbach
10 Carlos Gutierrez
11 Steve Swift
12 Leslie Curran
13 Omar Benazzouz
14 Michael Martello
15 Florent Szitkar
16 Mark Gibaud
17 Joselyn White
18 Meghan Piercy
19 Chris McHugh
20 Michele Paulatto
21 Robert Dunn
22 J. Pablo Canales
23 Greg Horning
24 George Cereno
25 Ernie Aaron
26 Katelyn Morrell
27 Dara Cameron
28 Stephanie Milne
29 Eva Kakone
30 Maja Fabeta
31 Hannes Griesche

A.2. MGL1305 Cruise Calendar Table

Day of cruise	Day of year	Date	Day of cruise	Day of year	Date
1	100	2013-04-10	21	120	2013-04-30
2	101	2013-04-11	22	121	2013-05-01
3	102	2013-04-12	23	122	2013-05-02
4	103	2013-04-13	24	123	2013-05-03
5	104	2013-04-14	25	124	2013-05-04
6	105	2013-04-15	26	125	2013-05-05
7	106	2013-04-16	27	126	2013-05-06
8	107	2013-04-17	28	127	2013-05-07
9	108	2013-04-18	29	128	2013-05-08
10	109	2013-04-19	30	129	2013-05-09
11	110	2013-04-20	31	130	2013-05-10
12	111	2013-04-21	32	131	2013-05-11
13	112	2013-04-22	33	132	2013-05-12
14	113	2013-04-23	34	133	2013-05-13
15	114	2013-04-24	35	134	2013-05-14
16	115	2013-04-25	36	135	2013-05-15
17	116	2013-04-26	37	136	2013-05-16
18	117	2013-04-27	38	137	2013-05-17
19	118	2013-04-28	39	138	2013-05-18
20	119	2013-04-29	40	139	2013-05-19

A.3. MGL1305 Cruise File and Tracks

The gravity, magnetic and center beam depth data were filtered and sampled at 10s intervals and merged into a single cruise-file in .gmt format (gmt = gravity/magnetic/topography). The .gmt format is a 6-column binary format with a short header, containing time, longitude, latitude, free-air gravity anomaly, magnetic anomaly, and depth for the entire cruise.

The GMT package contains a number of routines designed to easily extract and plot information from the .gmt file as well as finding cross-over points and calculating cross-over errors. These are found in some of the supplemental packages MGG, X2SYS and X_SYSTEM.

```
#               $Id: gmt.def 9545 2011-07-27 19:31:54Z pwessel $
#
# Define file for X2SYS processing of GMT/MGG files
#
# This file applies to the GMT MGG file format.
# This format was developed by P. Wessel and
# Walter H.F. Smith at Lamont in the late 1980ies
# Utilities to deal with these files are supplied
# in the GMT supplemental package mgg
#
#-------------------------------------------------------------------------
#BINARY         # The input file is binary
#SKIP 18        # The number of header bytes to skip
#-------------------------------------------------------------------------
#name    intype  NaN-proxy?      NaN-proxy       scale   offset  oformat
time     i       N               0               1       0       %10.0f
lat      i       N               0               1.0e-6  0       %9.5f
lon      i       N               0               1.0e-6  0       %10.5f
faa      h       Y               -32000          0.1     0       %6.1f
mag      h       Y               -32000          1       32000   %6.0f
top      h       Y               -32000          1       0       %6.0f
#-------------------------------------------------------------------------
```

Resampling and filtering of the geophysical data time series was accomplished using a combination of Unix and GMT routines in a bash script (gravfilterplot.sh, extract attached below). The free-air gravity anomaly time series was first filtered with a 200 s Gaussian filter, then some sections containing spikes, arising from errors in the speed record introducing errors in the Eötvos correction, were cut out. Then the time series was filtered again with a 300 s Gaussian filter before being resampled at 10s. Finally a noisy section corresponding to OBS recoveries was cut out before a final 600 s Gaussian filter was applied.

```
#! /bin/bash
# gravfilterplot.sh - Read and filter gravity data
##

infilt=raw_new
in=Grav_data_${infilt}
file=MGL1305_grav_${infilt}.dat

## Reformat grav file to make it smaller
awk '{printf "%4d %03d %02d %02d %6.3f %15.0f\n", $1,$2,$3,$4,$5,$6}' \
$in > $file

awk '{printf "%15.2f %15.2f\n", $5+$4*60+$3*3600+($2-101)*86400,$6}' $file \
| sort -g -u | filter1d -Fg200 -N2/0 -D1 -L5 > t0

# Remove spikes (add more sections to delete more spikes)
r1=`echo "134.2" | awk '{print $1*3600}'`
```

```
r2=`echo "134.75" | awk '{print $1*3600}'`
awk -v r1=$r1 -v r2=$r2 '{if ($1 < r1 || $1 > r2) print $1,$2}' t0 > t1
r1=`echo "331.2" | awk '{print $1*3600}'`
r2=`echo "331.6" | awk '{print $1*3600}'`
awk -v r1=$r1 -v r2=$r2 '{if ($1 < r1 || $1 > r2) print $1,$2}' t1 > t2

filter1d t2 -Fg300 -N2/0 -E -D1 -L5 -bo2 \
| sample1d -Fl -I10 -T0 -bi2 -bo2 > MGL1305_grav.tg
tg=MGL1305_grav.tg

# Output timeseries for desired filter
filt=600
r1=`echo "803" | awk '{print $1*3600}'`
r2=`echo "836" | awk '{print $1*3600}'`

filter1d $tg -Fg$filt -N2/0 -E -bi2 -bo2 | filter1d $tg -Fg$filt -N2/0 -E -bi2 \
| awk -v r1=$r1 -v r2=$r2 '{if ($1 < r1 || $1 > r2) print $1,$2}' \
> Grav_data_$filt.dat
```

The processed free-air gravity anomaly from gravfilterplot.sh was merged with the navigation, magnetic and center beam depth data using the script cruisefile.sh (attached below), which also resamples the navigation to 10 s and performs some preprocessing of the magnetic and depth data.

The navigation data is read from the MGL-cnav3050.yYYYYdJJJ files in the /raw/serial/ folder. The script extracts the lines containing the flag $GPGGA, then calculates the total time in seconds from the beginning of the experiment (Julian day 101/00:00) and then resamples the timeseries to 10 s.

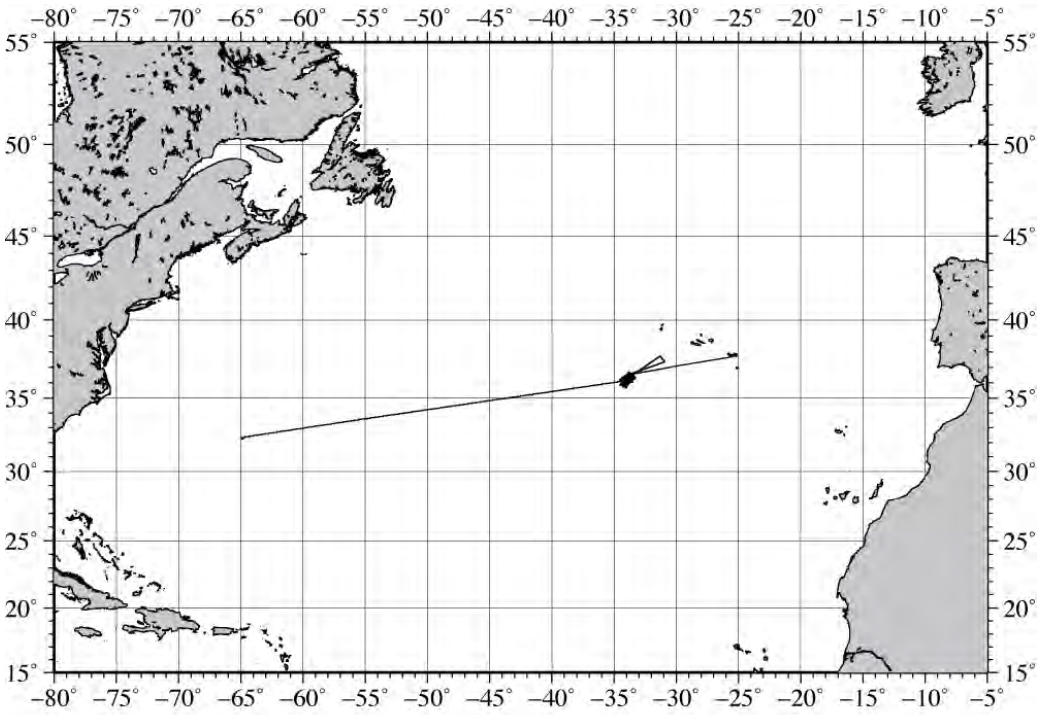
The script then reads the center beam depth data from the MGL-bath02.yYYYYdJJJ files in the /raw/serial/ directory. These are resampled to 10 s using a combination of nearneighbour and grdtrack, to avoid filling in sections with no data. It's not an elegant solution but it works and is portable to any platform with GMT.

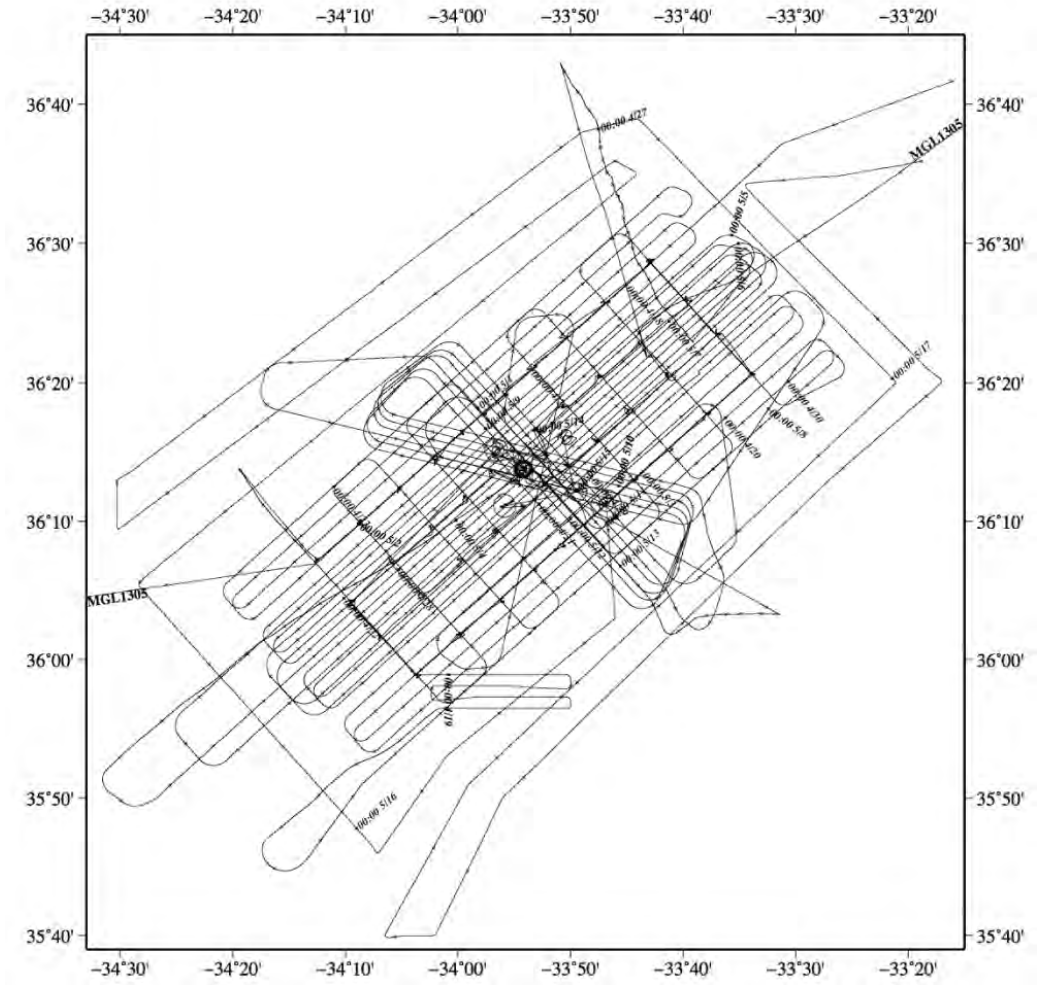
The magnetics data are read from the directory /public/Magnetics/Trimmed_Data/. These have been pre-processed by eliminating any noisy sections from periods at the beginning or end of recordings when the magnetometer was being deployed or recovered. The reference magnetic field calculated with the IGRF Fortran routines is then subtracted before running a despike 21 s median filter and resampling to 10 s.

Finally the free-air gravity anomaly, magnetic anomaly and centerbeam depth are merged into a single ascii file MGL1305_in.dat which is then converted to .gmt format using dat2gmt.

```
#! /bin/bash
# cruisefile.sh
# Script to merge navigation with center beam depth from multibeam
# bathymetry, gravity and magnetic data and create gmt cruise file
# used on RV Langseth during cruise MGL1305 - 11/04 - 19/05 2013
# Michele Paulatto - University of Oxford
# It's not fast, it's not elegant, but it works (mostly)
##
gmtset INPUT_CLOCK_FORMAT hh:mm:ss.xxx
gmtset INPUT_DATE_FORMAT yyyy/jjj
gmtset TIME_UNIT c
# Define function to do floating point math
######################################################################
# Default scale used by float functions.
float_scale=2
######################################################################
# Evaluate a floating point number expression.
function float_eval()
{
    local stat=0
    local result=0.0
    if [[ $# -gt 0 ]]; then
        result=$(echo "scale=$float_scale; $*" | bc -q 2>/dev/null)
        stat=$?
        if [[ $stat -eq 0  &&  -z "$result" ]]; then stat=1; fi
    fi
    echo $result
    return $stat
}
rm MGL1305_nav.tmp
touch MGL1305_nav.tmp
dstart=$1
dend=$2
for jday in $(seq $dstart $dend)
do
# Calculate calendar day and month (only valid for April/May)
if [[ ${jday} -lt 121 ]]; then
  month=04
  day=$(float_eval "$jday-90")
elif [[ ${jday}  -ge 121 ]]; then
  month=05
  day=$(float_eval "$jday-120")
fi
echo "############################################"
echo "Generating cruise file for" $day $month - $jday
navfile=../../raw/serial/MGL-cnav3050.y2013d${jday}
rm TMP/nav_fill
# Read navigation reformat and resample every 10s
grep -h '$GPGGA' $navfile \
| awk -v day=$day -v mon=$month '{gsub(","," "); \
hrd=$4/10000; hr=int(hrd); \
mnd=($4-hr*10000)/100; mn=int(mnd); \
scd=$4-hr*10000-mn*100; sc=int(scd); \
res=sc%10; \
lond=int($7/100); minlo=($7-lond*100)/60; lon=-lond-minlo; \
latd=int($5/100); minla=($5-latd*100)/60; lat=latd+minla; \
totsc=sc+mn*60+hr*3600 ; \
if ( res == 0 ) printf "%8i%11.6f%12.6f\n", totsc,lat,lon}' | sort -g -u > TMP/nav
#| awk '!a[$1] {b[++i]=$1} {a[$1]=$0} END {for (i in b) print a[b[i]]}' > TMP/nav
# Use sample1d to fill in any gaps in navigation
sample1d TMP/nav -Fl -I10 -V > TMP/nav_fill
# Generate centerbeam from -bath02 files
rm TMP/centerbeam_10s
cbfile=../../raw/serial/MGL-bath02.y2013d${jday}
# Use gmt nearneighbor and gmttrack to resample the bathymetry every 10s
awk -v day=$day -v mon=$month '{gsub(","," "); gsub(":"," "); \
sec=$6; min=$5; hh=$4; \
totalsec=sec+min*60+hh*3600; \
printf "%15.3f 0 %10.2f\n", totalsec,$8}' $cbfile > TMP/centerbeam_seconds
awk -v day=$day -v mon=$month '{gsub(","," "); gsub(":"," "); \
sec=$6; min=$5; hh=$4; \
totalsec=sec+min*60+hh*3600; \
printf "%15.3f 10 %10.2f\n", totalsec,$8}' $cbfile >> TMP/centerbeam_seconds
nearneighbor TMP/centerbeam_seconds -I10/10 -S60 -N2/1 -R0/86400/0/10 -V -
```

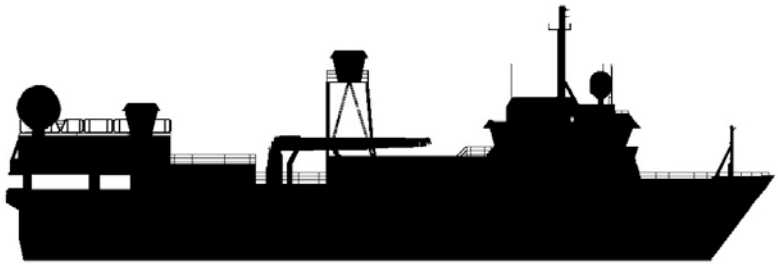
```
GTMP/centerbeam_seconds.grd
project -C0/5 -E8.70/5 -G0.001 -L0/8.6390 | awk '{print $3*10000,"2.5"}' > TMP/timeseries_10s.txt
grdtrack TMP/timeseries_10s.txt -GTMP/centerbeam_seconds.grd -Q \
| awk '{printf "%8i %8.2f\n",$1,$3}' > TMP/centerbeam_10s
# Reformat Magnetic data
magfile=../Magnetics/Trimmed_Data/magNavd${jday}.txt
if [ -f $magfile ]; then
tail -n +2 $magfile | awk '{ gsub(":"," "); \
totalsec=$5+$4*60+$3*3600; \
printf "%10.6f %10.6f %8i %12.3f\n", $7,$6,totalsec,$8}' > TMP/mag0
# Remove reference field
grdtrack TMP/mag0 -G../Magnetics/rainbow_mf.grd | awk '{print $3,$4-$5}' > TMP/mag1
# Despike
filter1d TMP/mag1 -Fm21 -N2/0 > TMP/mag_filt
# Resample at 10 s
awk '{ res=$1%10; if ( res == 0 ) \
printf "%8i 0 %12.3f\n", $1,$2}' TMP/mag_filt > TMP/mag
awk '{ res=$1%10; if ( res == 0 ) \
printf "%8i 10 %12.3f\n", $1,$2}' TMP/mag_filt >> TMP/mag
nearneighbor TMP/mag -I10/10 -S60 -N2/1 -R0/86400/0/10 -V -GTMP/mag_array.grd
grdtrack TMP/timeseries_10s.txt -GTMP/mag_array.grd -Q \
| awk '{printf "%8i %8.0f\n",$1,$3}' > TMP/mag_10s
rm TMP/mag0 TMP/mag1 TMP/mag_filt TMP/mag TMP/mag_array.grd
# Merge magnetics and resampled bathymetry
join -1 1 -2 1 TMP/nav_fill TMP/mag_10s > TMP/tmp
join -1 1 -2 1 TMP/tmp TMP/centerbeam_10s \
| awk -v jday=$jday -v day=$day -v mon=$month \
'{ tottime=$1+(jday-101)*86400; year=2013; \
hr=int($1/3600);mn=int(($1-hr*3600)/60);sc=int($1-hr*3600-mn*60); \
printf "%10.0f %4d/%02d/%02d/%02d:%02d:%02d%10.5f%10.5f%9s%7s%7.0f\n", \
tottime,"2013",mon,day,hr,mn,sc,$2,$3,"NaN",$4,-$5}' \
> Dayfiles/MGL1305_${jday}_nav.dat
else
# Merge resampled bathymetry only
join -1 1 -2 1 TMP/nav_fill TMP/centerbeam_10s \
| awk -v jday=$jday -v day=$day -v mon=$month \
'{ tottime=$1+(jday-101)*86400; year=2013; \
hr=int($1/3600);mn=int(($1-hr*3600)/60);sc=int($1-hr*3600-mn*60); \
printf "%10.0f %4d/%02d/%02d/%02d:%02d:%02d%10.5f%10.5f%9s%7s%7.0f\n", \
tottime,"2013",mon,day,hr,mn,sc,$2,$3,"NaN","NaN",-$4}' \
> Dayfiles/MGL1305_${jday}_nav.dat
fi
# Concatenate all days into single file
#mv MGL1305_nav.dat temp
cat Dayfiles/MGL1305_${jday}_nav.dat >> MGL1305_nav.tmp
done
# Merge gravity
filt=600
gravfile=../Gravity/Grav_data_${filt}.dat
join -1 1 -2 1 -a 1 -e NaN MGL1305_nav.tmp $gravfile \
| awk '{ if ( NF == 8 ) printf "%19s%10.5f%10.5f%9.1f%7s%7.0f\n", $2,$3,$4,$8,$6,$7 ;\
else printf "%19s%10.5f%10.5f%9s%7s%7.0f\n", $2,$3,$4,"NaN",$6,$7}' \
> MGL1305_in.dat
# Convert dat file to gmt cruise file
dat2gmt MGL1305_in.dat MGL1305.gmt
```


−80° −75° −70° −65° −60° −55° −50° −45° −40° −35° −30° −25° −20° −15° −10° −5°
55° 50° 45° 40° 35° 30° 25° 20° 15°


−34°30' −34°20' −34°10' −34°00' −33°50' −33°40' −33°30' −33°20'
36°40' 36°30' 36°20' 36°10' 36°00' 35°50' 35°40'
MGL1305
MGL1305

A.4. OBSIP SIO Senior Engineer Report

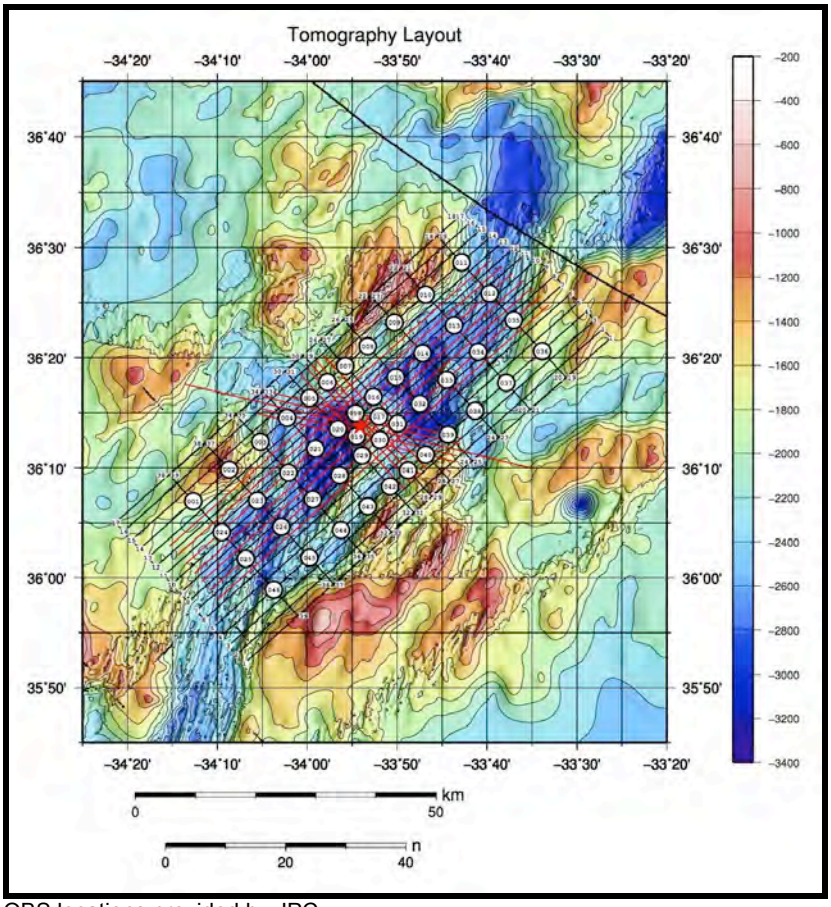
Cruise: RAINBOW (MGL1305)
IRIS Network Code: X3
SIO Purpose: Deploy 46 OBS, Recover 46 OBS, Deploy 15 OBS
Vessel: M/V Marcus G Langseth
Ports: St George's, Bermuda – Ponta DelGada, Portugal
Master/Captain: Mark Landow
Chief Scientists: JPC, Rob Dunn
SIO Personnel (OBSIP): Mark Gibaud, Ernest Aaron, Phil Thai
WHOI Personnel: Steve Swift
Marine Technician: Bern McIntyre, Tom Spoto
Cruise Dates: 04/11/13 – 05/21/13



M/V Marcus G Langseth

I. Summary of SIO OBS Activities

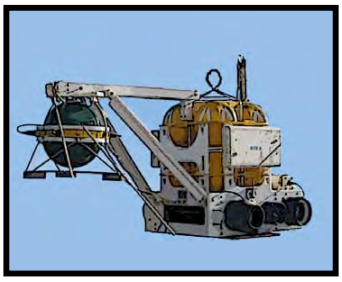
We will be performing a total of 61 OBS deployments, utilizing 46 Scripps OBS (36- L28/Hyd SP's & 10- L22/Hyd modified LP's). We will recover all 46 OBS in two recovery phases, and then redeploy 15 of the L28/Hyd SP's for a longer-term portion of the experiment- to be recovered in approximately 6-months.



OBS locations provided by JPC

II. Instrumentation
SIO LC4X4, LPOBS

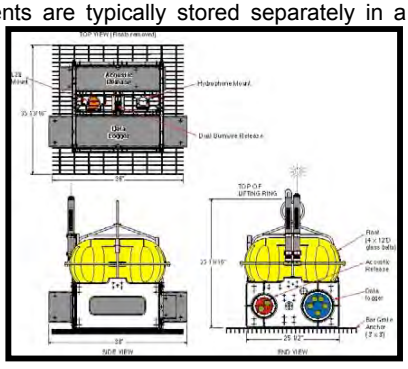
Scripps provided 10 modified long period LC4X4s for this experiment. The sensors associated with these instruments are L22 single channel geophone and a hydrophone. Each instrument consists of a 160# anchor and an eight glass-ball McLane float assembly. The polyethylene frame holds the acoustic release transponder the data logger, the battery bottle, and a dual mechanical release system.



After the anchor is released for recovery, this instrument will ascend at more than 50 m/min. To increase visibility once at the surface, an orange flag on a 48" fiberglass staff is attached to the lift bale. Also, a Novatech low-pressure activated strobe-beacon and radio are mounted near the base of the flag on the lift bale. The radio operates at 160.725 MHz.

The acoustic release transponder developed in conjunction with ORE/EdgeTech is interrogated at 11kHz and responds at 13kHz. Alkaline batteries provide 18 volts power for the burn, 12 volts power for the transponder, and 9 volts power for the circuit board logic. The release mechanism includes two double wire burn elements. When fresh, two battery strings are combined to provide the 18 volts to burn one of two release wires in an average of 7-minutes for water depths encountered during this experiment.

The SP-OBS float and frame components are typically stored separately in a custom rack system, and are assembled and tested prior to deployment. The complete instrument weighs approximately 400 pounds in air. This is inclusive of the 100-pound iron anchor grate held to the base of the poly frame, by a single 2" oval quick-link. When the anchor is released for recovery, the four 12" glass spherical floats, as well as the syntactic foam blocks provide sufficient buoyancy to lift the instrument at about 42 m/min to the sea surface.



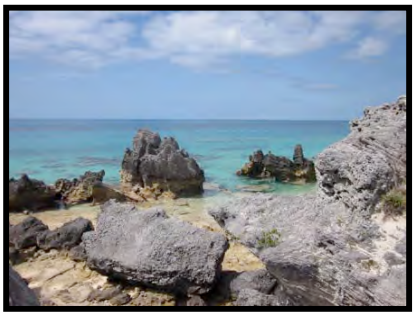
III. Areas of Concern
At the end of the experiment we will be deploying 15 SP's to remain for ~6 months time. It would be best if we used the Langseth to relocate/survey these OBS before we leave the area because the ship slated for the recovery will most likely be a "vessel of opportunity", which means it will be a local fishing vessel. This "vessel of opportunity" will not have a hull mounted 12kHz transducer and will not be an ideal platform to use for the relocation process.

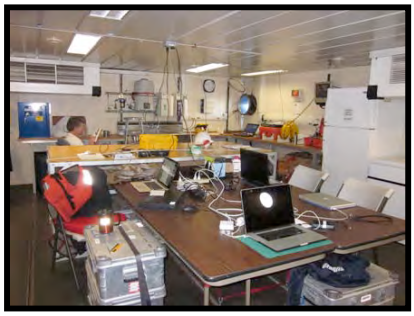
IV. Ships Equipment and Condition
Excellent. There have been many improvements made to the Langseth, which is a reflection of the lessons learned over the years. A few of these enhancements are:
-Replacement of the plastic deck plugs with stainless plugs.
-CTD winch functionality and preparedness.
-Hull transducer cabling upgrade to incorporate a grounded shield.
-Convenient clean power receptacles in the dry lab overhead.
-Willingness to provide use of the entire wet lab space for our instruments.

V. Journal of Events in Chronological Order
All times and dates in this report are UTC/GMT unless otherwise noted as local.

1. Loading & Setup
03/28/13 Galveston, TX
Martin and I arrived at Pier 37 at 08:00 to meet the Langseth and wait for the truck to show with our gear. After some gate access issues, we were able to get the truck through security and to the Pier. Everything was loaded, and secured for the transit to Bermuda by days end.

04/07/13 St. Georges, Bermuda
We arrived in Bermuda on the afternoon of the 7th and the Langseth arrived the morning of the 8th. We spent the day reorganizing our gear, setting up the lab and testing the new logger electronics and ships transducer connection.

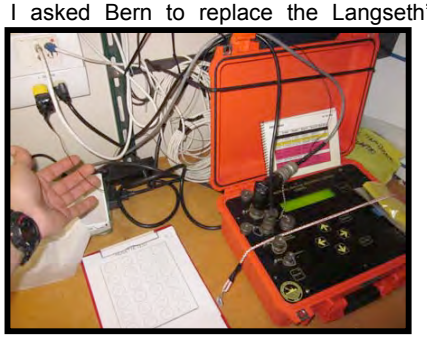




2. Transit
04/11/13 19:00 Local Bermuda
We just pulled away from the dock and expect a 4-5 day transit to the first deployment station. Our departure was delayed a little over one day in Bermuda due to a bushing issue on the starboard rudder.

3. Acoustic Rosette Tests
Test #1- 2013:103:12:22:00
Saber deck box #2
Bottom depth = 5050M
All stop at 500M to enable one acoustic
Test depth = 3000M
Winch payout speed = 50 M/min

I asked Bern to replace the Langseth's transducer cable with 2-conductor, shielded cable so that the entire length would be shielded, which was not the case previously. I also soldered a wire to the shield and attached it to the ground pin of a standard receptacle plug so that we could plug it into the ships ground (clean power).



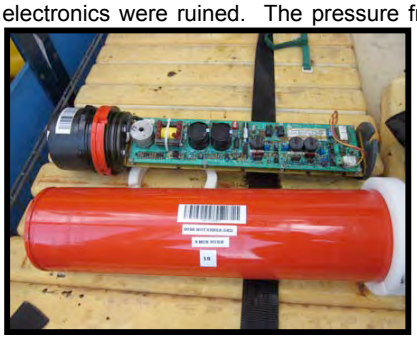
So far the acoustic communications are very clear. We had a little trouble with the first acoustic unit at 100M depth, but at 500M all was fine.

Test #2- 2013:103:16:15:00
Saber deck box #1 and 8011-M
Bottom depth = 5050M
All stop at 500M to enable one acoustic
Test depth = 3000M
Winch payout speed = 50 M/min

We have two acoustic units that will not talk to us (15 & 88). We had the rosette retrieved to 2000M and no still luck; we then came up to 1000M and no luck. All other acoustics are talking loud and clear.

We asked for the rosette to be brought to the surface, so that we can inspect the two faulty acoustic units.

After inspection in the lab we found that acoustic #15 had flooded at the ducer face seal where there is one o-ring sealing it to the mounting plate. All of the electronics were ruined. The pressure from the alkaline/seawater reaction was great enough to blow the head off as I separated the poly split-ring spacer. It shot halfway out of the tube and puked black acrid water on the floor. Luckily no one was in the path of the splash. The battery pack was hot, so it was jettisoned.



Acoustic #88 looked fine. All o-rings looked good, batteries looked fine and it passed all bench testing you'd expect from a good unit. It just wouldn't communicate with us in the water. Our best guess is that there is an issue with the ITC ducer head. We have a spare, so we swapped it out, replaced the ducer face o-ring and retested it. We told the PI's that we'd be willing to use it if we did one rosette test with it at 1000M to ensure that it was talking under pressure.

04/15/13 14:30 Local
We attempted a 1000-meter rosette deployment for the retesting of acoustic #88. It passed all tests in the lab and was confirmed enabled on the deck in the vertical orientation of the 24-rosette package. Upon submersion in saltwater the acoustic failed to respond to commands from the hull transducer. We were able to communicate with neighboring acoustics, but not #88. After recovery of the rosette we inspected the unit again and there was no flooding, or anything apparently wrong.

And then I decided to look at the dip-switch settings on the board of acoustic #88. They are supposed to be open-open-closed-open (1234), but were set to open-open-closed-closed, which changed the frequency that the acoustic uses for response chirps. This is why we could hear it fine on deck, but the acoustic boxes would ignore its reply pings in the water because they were not at 13kHz. After all of this, we have decided to use this acoustic unit for this experiment at the last station.

4. OBS Deployments (Phase I- 46 OBS)

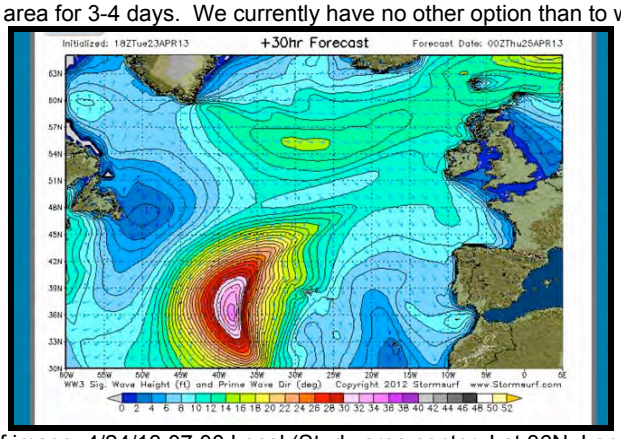
Station	Comp	S/N	AC	LAT	LON	Depth
OBS1	3	13005	30	36.11773	-34.21014	1503
OBS2	3	13007	106	36.163727	-34.144841	1536
OBS3	3	13008	20	36.204097	-34.089568	1689
OBS4	2	LP119	100	36.242114	-34.037506	2506
OBS5	2	LP126	77	36.272362	-33.995543	2339
OBS6	3	13004	149	36.296373	-33.962775	1895
OBS7	3	13003	89	36.318517	-33.929898	1612
OBS8	3	13001	49	36.350436	-33.888317	2117
OBS9	3	13015	57	36.386497	-33.838458	1823
OBS10	3	13014	122	36.428546	-33.778848	1693
OBS11	3	13002	55	36.477182	-33.715898	1908
OBS12	2	LP115	50	36.430331	-33.662221	2534
OBS13	3	13021	104	36.381596	-33.727922	2751
OBS14	3	13023	75	36.340366	-33.786088	2865
OBS15	3	13024	80	36.30397	-33.835859	2871
OBS16	3	13022	139	36.273674	-33.877482	2475
OBS17	3	13020	65	36.24475	-33.867589	2141
OBS18	3	13026	99	36.249569	-33.9103	2721
OBS19	3	13025	43	36.214657	-33.909331	2452
OBS20	3	13034	129	36.225317	-33.943089	3219
OBS21	3	13035	7	36.195199	-33.984742	3035
OBS22	3	13030	94	36.159697	-34.034753	2231
OBS23	3	13019	124	36.117154	-34.092858	2506
OBS24	2	LP117	119	36.069147	-34.158895	2321
OBS25	2	LP113	110	36.028607	-34.11482	2268
OBS26	3	13018	137	36.077292	-34.048671	2620
OBS27	3	13031	135	36.119315	-33.990522	2801
OBS28	3	13027	123	36.155411	-33.940563	2693
OBS29	3	13029	1	36.18579	-33.899467	2219
OBS30	3	13017	131	36.209443	-33.866079	2071
OBS31	3	13028	127	36.233733	-33.832303	2736
OBS32	3	13016	101	36.263659	-33.79085	2836
OBS33	3	13036	113	36.299903	-33.74165	2547
OBS34	3	13032	136	36.341979	-33.6837	2786
OBS35	2	LP124	115	36.390592	-33.617659	2212
OBS36	3	13013	47	36.343535	-33.565265	1918
OBS37	3	13012	107	36.295553	-33.631209	1966
OBS38	2	LP129	112	36.253315	-33.689169	2277
OBS39	2	LP130	41	36.217308	-33.738661	2435
OBS40	3	13006	140	36.187138	-33.780248	2087
OBS41	3	13010	117	36.163057	-33.813307	1878
OBS42	3	13009	142	36.139041	-33.846388	2266
OBS43	2	LP125	111	36.108927	-33.887727	2147
OBS44	3	13011	130	36.072544	-33.937177	2315
OBS45	2	LP121	118	36.030141	-33.997854	2234
OBS46	3	13033	88	35.982284	-34.061708	2422

We started deploying the OBS at 16:00 on 04/17/13, local time. We deployed the last instrument (OBS46) at 23:00 on 04/18/13, local time.

This operation went very well and we were seeing transit times of 20-30 minutes between stations, which was about how long it was taking us to fully prepare an OBS. It helped that we had decided to checkout all of the new electronics loggers beforehand. The downside to this was the additional labor of moving the loggers back and forth between labs. We then had to pull the loggers and place them in a cradle before moving the frames for buildup, and then back into the frames. This was not a task for the weak, or uncoordinated.

The new SP launch/recovery table has been working great although it can slide a little on the pallet-jack forks in rough seas, so I'll need to add some antiskid below the lower rack, or to the surface of our pallet jacks.

2013:114:20:00:00 (4/24/13 19:00, Local time)
We are currently sitting at Lat 37N, Lon 30W because of a very big storm that moved over our study area. The StormSurf models predict that it will linger over our study area for 3-4 days. We currently have no other option than to wait it out.



StormSurf image, 4/24/13 07:00 Local (Study area center: Lat 36N, Lon 34W)

5. OBS Recoveries (Phase I- 26 OBS)

Station	S/N	AC	Depth	LAT	LON	Type	Comment	CH0-X	CH1-Y	CH2-Z	CH3-HYD
OBS1	13005	30	1503	36.11781	-34.21040	3-comp lithium		Y	Y	Y	Y
OBS2	13007	106	1536	36.16386	-34.14491	3-comp lithium		N	Y	Y	Noisy
OBS3	13008	20	1689	36.20420	-34.08961	3-comp lithium		Y	Y	Y	Y
OBS4	LP119	100	2506	36.24222	-34.03740	2-comp	Run-plug short - no data	NA	NA	N	N
OBS5	LP126	77	2339	36.27255	-33.99559	2-comp		NA	NA	Y	Y
OBS6	13004	149	1895	36.29640	-33.96266	3-comp lithium		Y	Y	Y	Y
OBS7	13003	89	1612	36.31870	-33.92976	3-comp lithium		Y	Y	Y	Y
OBS8	13001	49	2117	36.35060	-33.88821	3-comp lithium		Y	Y	Y	Y
OBS9	13015	57	1823	36.38668	-33.83832	3-comp lithium		Y	Y	Y	Y
OBS10	13014	122	1693	36.42862	-33.77868	3-comp lithium		Y	Y	Y	Y
OBS11	13002	55	1908	36.47736	-33.71575	3-comp lithium		Y	Y	OFFSET	Y
OBS12	LP115	50	2534	36.43038	-33.66202	2-comp		NA	NA	Y	Y
OBS13	13021	104	2751	36.38074	-33.72792	3-comp alkaline					
OBS14	13023	75	2865	36.34018	-33.78602	3-comp alkaline					
OBS15	13024	80	2871	36.30381	-33.83574	3-comp alkaline					
OBS16	13022	139	2475	36.27352	-33.87733	3-comp alkaline					
OBS17	13020	65	2141	36.24466	-33.86739	3-comp alkaline					
OBS18	13026	99	2721	36.24974	-33.91034	3-comp alkaline					
OBS19	13025	43	2452	36.21456	-33.90916	3-comp alkaline					
OBS20	13034	129	3219	36.22547	-33.94320	3-comp alkaline					
OBS21	13035	7	3035	36.19504	-33.98465	3-comp alkaline					
OBS22	13030	94	2231	36.15954	-34.03473	3-comp alkaline					
OBS23	13019	124	2506	36.11701	-34.09273	3-comp alkaline					
OBS24	LP117	119	2321	36.06898	-34.15878	2-comp		NA	NA	Y	Y
OBS25	LP113	110	2268	36.02665	-34.11458	2-comp		NA	NA	Y	Y
OBS26	13018	137	2620	36.07739	-34.04847	3-comp alkaline					
OBS27	13031	135	2801	36.11940	-33.99030	3-comp alkaline					
OBS28	13027	123	2693	36.15550	-33.94035	3-comp alkaline					
OBS29	13029	1	2219	36.18582	-33.89922	3-comp alkaline					
OBS30	13017	131	2071	36.20956	-33.86589	3-comp alkaline					
OBS31	13028	127	2736	36.23379	-33.83210	3-comp alkaline					
OBS32	13016	101	2836	36.26394	-33.79074	3-comp alkaline					
OBS33	13036	113	2547	36.30010	-33.74169	3-comp alkaline					
OBS34	13032	136	2786	36.34203	-33.68356	3-comp alkaline					
OBS35	LP124	115	2212	36.39039	-33.61755	2-comp		NA	NA	Y	Y
OBS36	13013	47	1918	36.34358	-33.56527	3-comp lithium		Y	Y	OFFSET	N
OBS37	13012	107	1966	36.29551	-33.63141	3-comp lithium		Y	Y	Y	Y
OBS38	LP129	112	2277	36.25339	-33.68889	2-comp		NA	NA	Y	Y
OBS39	LP130	41	2435	36.21707	-33.73883	2-comp		NA	NA	Y	Y
OBS40	13006	140	2087	36.18699	-33.78007	3-comp lithium	No response - lost OBS	N	N	N	N
OBS41	13010	117	1878	36.16287	-33.81322	3-comp lithium		Y	Y	Y	Y
OBS42	13009	142	2266	36.13886	-33.84628	3-comp lithium	Logger flooded - no data	N	N	N	N
OBS43	LP125	111	2147	36.10881	-33.88760	2-comp		NA	NA	Y	Y
OBS44	13011	130	2315	36.07237	-33.93733	3-comp lithium		Y	N	Y	Y
OBS45	LP121	118	2234	36.03031	-33.99781	2-comp		NA	NA	Y	Y
OBS46	13033	88	2422	35.98215	-34.06173	3-comp alkaline		Y	Y	Y	Y

- Phase I Recoveries
- Phase II Recoveries
- Phase II A Deployments
- Phase II B Deployments

05/01/13 21:00, Local
Site OBS01 recovery went very smooth. The acoustic wouldn't respond to us until we were almost directly over the OBS. The new logger recorded a full set of data and all four channels look good.

05/02/13 14:30:00, Local
Site OBS04 recovery went as anticipated. The instrument ascended at a rate near 75 meters/min because of all of the additional flotation, being a converted LP unit. The unfortunate discovery identified upon securing the OBS on deck was that the run-plug had been knocked askew during the deployment operation. This allowed seawater to enter the 3-pin HPD and short out the batteries. Fortunately

the logger did not flood. The instrument recorded for ~15 hours before the batteries died.

05/03/13 01:50, Local
Site OBS40, AC# 140 is not responding. We have passed over the drop coordinates, circumnavigated the OBS at a 1km radius, and are now sitting on station over the OBS. We will stay on station for 1-hour (estimated rise time from last release command) and then send disable and move on. We should be able to return to this station at least one more time before the end of this cruise and then again during the recoveries of the lithium OBS in six months time.

02:45, Local
We have sent disable commands and will abandon this station for now. We did not receive a single indication of acoustic life for this site.

05/03/13 05:30, Local
Site OBS42 has a flooded logger, which was identified at recovery. The lithium

reaction was finished as far as I could tell, so we were able to recover the instrument, unbolt the retaining rings and then jettison the logger (13009) overboard. There was nothing in the logger worth salvaging and opening it was too dangerous to consider. The black mess flushing out of the logger was acrid and irritating to the skin, so we got the mess cleaned up as quickly and safely as possible. The logger appeared to have reacted from the back end cap, which Phil noted had no seal screws, so it must have leaked from the rear bore seals. Aside from the logger and data loss, all other components of this OBS were saved.

05/04/13
Because of the instrumentation losses from those OBS designated for the long-term deployments and containing lithium batteries, we have been exploring a few ideas on how we might be able to redistribute some of the remaining lithium battery packs and convert two alkaline powered OBS to lithium, which would get us back to 15-OBS for the final deployment schme.

Email correspondence:
On May 8, 2013, at 12:18 AM, Aaron, Ernest wrote:

Rob and Pablo,
Phil and I have revisited the power numbers for the proposed 3-lithium pack powered loggers and based on your recovery dates find that it will be close, but doable if you are willing to accept the risk of ship schedule change, which is not uncommon.

The numbers:
3 lithium packs will run for ~234 days Alkaline clock backup packs (modified 4-packs) will run for ~90 days

Total days without safety factor = 324

These instruments have been running since their setup date of 4/5/13

If we recover on 1/5/14 that will be 275 days of runtime, recovery on 1/15/14 will be 290 days of runtime

324-290 = 34 days of clock backup buffer

Please let us know how you would like to proceed as soon as possible so that we can begin preparation of these loggers (13-obs, or 15-obs). We have a good bit of prep work to do with the instruments, those that are currently onboard, regardless of the battery configurations, but we are waiting until we know which way we are going before getting started so that we don't have to make additional changes later.

———

Phase II A Deployments, Lithium powered station locations:

Station	Latitude	Longitude
OBS 55	36.252463	-33.942908
OBS 54	36.242191	-33.889423
OBS 53	36.237229	-33.867382
OBS 50	36.221843	-33.860324
OBS 49	36.208282	-33.876709
OBS 48	36.213327	-33.898227
OBS 57	36.230077	-33.903190

———

6. OBS Deployments (Phase II A- 07 OBS)

Station	S/N	AC	Depth	LAT	LON	Type	Comment	CH0-X	CH1-Y	CH2-Z	CH3-HYD
OBS47	13023	75	3153	36.18469	-33.93060	3-comp lithium	Surveyed				
OBS48	13014	122	2227	36.21333	-33.89823	3-comp lithium	Shot to (MCS)				
OBS49	13003	89	2021	36.20828	-33.87671	3-comp lithium	Shot to (MCS)				
OBS50	13004	149	2169	36.22184	-33.86032	3-comp lithium	Shot to (MCS)				
OBS51	13036	113	2550	36.20261	-33.82282	3-comp lithium	Surveyed				
OBS52	13021	104	2588	36.26930	-33.84217	3-comp lithium	Surveyed				
OBS53	13001	49	2120	36.23723	-33.86738	3-comp lithium	Shot to (MCS)				
OBS54	13005	30	2282	36.24219	-33.88942	3-comp lithium	Shot to (MCS)				
OBS55	13008	20	3016	36.25246	-33.94291	3-comp lithium	Surveyed				
OBS56	13012	107	2345	36.22865	-33.90509	3-comp lithium	Surveyed				
OBS57	13015	57	2377	36.23008	-33.90319	3-comp lithium	Surveyed				
OBS58	13033	88	2296	36.23039	-33.90227	3-comp lithium	Surveyed				
OBS59	13002	65	2248	36.22939	-33.90087	3-comp lithium	Surveyed				
OBS60	13010	117	2237	36.22809	-33.90138	3-comp lithium	Surveyed				
OBS61	13011	142	2294	36.22762	-33.90347	3-comp lithium	Surveyed				

- Phase I Recoveries
- Phase II Recoveries
- Phase II A Deployments
- Phase II B Deployments

2013:123:16:30:00
Upon the completion of the Phase I recoveries we immediately deployed seven, of the fifteen, lithium powered SP OBS, to remain out here until January of 2014. The remaining 6-lithium powered OBS were held aboard until a decision is made as to using one lithium power pack from each of the six and creating two additional lithium powered OBS for the long-term deployment scheme, or not.

———

Response email from Rob Sohn:

Sent: Wednesday, May 08, 2013 6:20 AM
To: Juan Pablo Canales [jpcanales@whoi.edu]
Cc: Stephen Swift; Babcock, Jeffrey; Gibaud, Mark; Thai, Philip; Aaron, Ernest

Pablo et al.,
Word from NSF is that the recovery leg aboard a British vessel for Jan 2014 is firm. We all know that 'firm' is no guarantee in this business, but based on that input I'm comfortable making the decision to reconfigure some of the OBSs to allow for deployment of the full complement of 15 passive instruments. In terms of the remaining deployments, I guess the best thing would be to put as many of the reconfigured (i.e., smaller battery pack) instruments in the center of the network as possible. So load up the vent field network with the reconfigured instruments, and then put a few more in the middle ring, if necessary.

Thanks to the SIO OBS group for their willingness to go the extra mile for our experiment.

Cheers, Rob

———

We anticipate starting Phase II recoveries on Monday, May 13 before noon. This will give us approximately 1.25 days of contingency (based on my calculations) after all work is complete and all goes well. We can then revisit site OBS40 and attempt to get it to talk to us.

Calculations for remaining OBS work:
Recover 20 SP OBS @ 2-hours per station and 30-minutes transit time between sites. **~50 hours**

Deploy and survey 8 SP OBS @ 1.5-hours per station and 30-minutes transit time between sites. **~16 hours**

66-hours = 2.75 days
If we start at 12:00 on May 13th we'll have 4-days
Contingency = 1.25 days

7. OBS Recoveries (Phase II- 20 OBS)

Station	S/N	AC	Depth	LAT	LON	Type	Comment	CH0-X	CH1-Y	CH2-Z	CH3-HYD
OBS1	13005	30	1503	36.11781	-34.21040	3-comp lithium		Y	Y	Y	Y
OBS2	13007	106	1536	36.16386	-34.14491	3-comp lithium		N	Y	Y	Noisy
OBS3	13008	20	1689	36.20420	-34.08961	3-comp lithium		Y	Y	Y	Y
OBS4	LP119	100	2506	36.24222	-34.03740	2-comp	Run-plug short - no data	NA	NA	N	N
OBS5	LP126	77	2339	36.27255	-33.99559	2-comp		NA	NA	Y	Y
OBS6	13004	149	1895	36.29640	-33.96266	3-comp lithium		Y	Y	Y	Y
OBS7	13003	89	1612	36.31870	-33.92976	3-comp lithium		Y	Y	Y	Y
OBS8	13001	49	2117	36.35060	-33.88821	3-comp lithium		Y	Y	Y	Y
OBS9	13015	57	1823	36.38668	-33.83832	3-comp lithium		Y	Y	Y	Y
OBS10	13014	122	1693	36.42862	-33.77868	3-comp lithium		Y	Y	Y	Y
OBS11	13002	55	1908	36.47736	-33.71575	3-comp lithium		Y	Y	OFFSET	Y
OBS12	LP115	50	2534	36.43038	-33.66202	2-comp		NA	NA	Y	Y
OBS13	13021	104	2751	36.38074	-33.72792	3-comp alkaline		Y	Y	Y	Y
OBS14	13023	75	2865	36.34018	-33.78602	3-comp alkaline		Y	Y	Y	Y
OBS15	13024	80	2871	36.30381	-33.83574	3-comp alkaline		Y	Y	Weak	Y
OBS16	13022	139	2475	36.27352	-33.87733	3-comp alkaline		Y	Y	Weak	Y
OBS17	13020	65	2141	36.24466	-33.86739	3-comp alkaline		Y	Y	Weak	N
OBS18	13026	99	2721	36.24974	-33.91034	3-comp alkaline		Y	Y	Y	Y
OBS19	13025	43	2452	36.21456	-33.90916	3-comp alkaline		Y	Y	Weak	Y
OBS20	13034	129	3219	36.22547	-33.94320	3-comp alkaline		Y	Y	Y	Y
OBS21	13035	7	3035	36.19504	-33.98465	3-comp alkaline		Y	Y	Y	Y
OBS22	13030	94	2231	36.15954	-34.03473	3-comp alkaline		Y	Y	Y	N
OBS23	13019	124	2506	36.11701	-34.09273	3-comp alkaline		Y	Y	Y	Y
OBS24	LP117	119	2321	36.06898	-34.15878	2-comp		NA	NA	Y	Y
OBS25	LP113	110	2268	36.02665	-34.11458	2-comp		NA	NA	Y	Y
OBS26	13018	137	2620	36.07739	-34.04847	3-comp alkaline		Y	Y	Y	Y
OBS27	13031	135	2801	36.11940	-33.99030	3-comp alkaline		Y	Y	Y	Y
OBS28	13027	123	2693	36.15550	-33.94035	3-comp alkaline		Y	Y	Y	Y
OBS29	13029	1	2219	36.18582	-33.89922	3-comp alkaline		Y	Y	Y	Y
OBS30	13017	131	2071	36.20956	-33.86589	3-comp alkaline		N	Y	Y	Y
OBS31	13028	127	2736	36.23379	-33.83210	3-comp alkaline		Y	Y	Weak	Y
OBS32	13016	101	2836	36.26394	-33.79074	3-comp alkaline		Y	Weak	Weak	Y
OBS33	13036	113	2547	36.30010	-33.74169	3-comp alkaline		Y	Y	Y	Y
OBS34	13032	136	2786	36.34203	-33.68356	3-comp alkaline		Y	Y	Weak	Y
OBS35	LP124	115	2212	36.39039	-33.61755	2-comp		NA	NA	Y	Y
OBS36	13013	47	1918	36.34358	-33.56527	3-comp lithium		Y	Y	OFFSET	N
OBS37	13012	107	1966	36.29551	-33.63141	3-comp lithium		Y	Y	Y	Y
OBS38	LP129	112	2277	36.25339	-33.68889	2-comp		NA	NA	Y	Y
OBS39	LP130	41	2435	36.21707	-33.73883	2-comp		NA	NA	Y	Y
OBS40	13006	140	2087	36.18699	-33.78007	3-comp lithium	No response - lost OBS	N	N	N	N
OBS41	13010	117	1878	36.16287	-33.81322	3-comp lithium		Y	Y	Y	Y
OBS42	13009	142	2266	36.13886	-33.84628	3-comp lithium	Logger flooded - no data	N	N	N	N
OBS43	LP125	111	2147	36.10881	-33.88760	2-comp		NA	NA	Y	Y
OBS44	13011	130	2315	36.07237	-33.93733	3-comp lithium		Y	N	Y	Y
OBS45	LP121	118	2234	36.03031	-33.99781	2-comp		NA	NA	Y	Y
OBS46	13033	88	2422	35.98215	-34.06173	3-comp alkaline		Y	Y	Y	Y

- Phase I Recoveries
- Phase II Recoveries
- Phase II A Deployments
- Phase II B Deployments

2013:133:07:00:00
The air guns and the six kilometers of streamers have been recovered. We expect to be at site OBS30 in about two hours to begin recoveries.

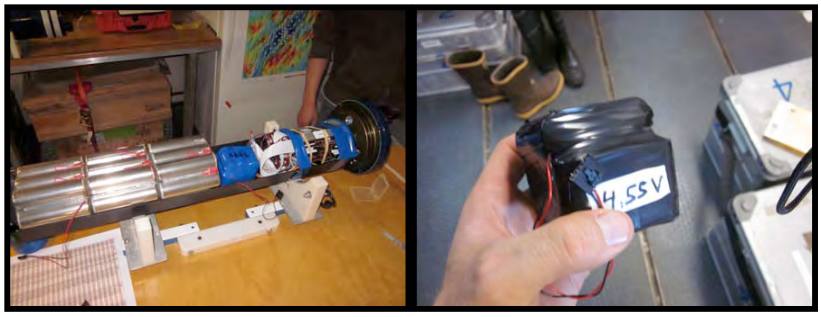
We are on station at site OBS30 @ 07:30 local time, which according to my earlier calculations, will give us 22.5 hours of contingency time if all goes well.

Site OBS16 we recovered a small white'ish crayfish looking crustacean that likely lives on, or near a black smoker (hydrothermal vent). This means that we were pretty damn close to a vent and are lucky we didn't suffer any damage.

Site OBS19 had a leaked alkaline cell in the NovaTech radio, which killed it. There was no water intrusion. On a different site when one of the NoveTechs were being installed it must have hung up on the polly mounting bracket and the installer must have twisted it (rotated) to get it to slide all the way down. The problem was that it was rotated counterclockwise and the switch-base was unscrewed a half turn from the body and it caused the unit to leak. If it had been twisted clockwise it would have been fine.

The instrument at site OBS22 had acoustic #94 inside, which is a 5-minute burn cycle unit. The OBS released from its anchor within the 5-minute burn window. Inspection of the mechanical release after recovery revealed that the burn wire was the single thread type, which are the newer ones we have recently switched to in hopes of shortening the release times from the anchor, or in the case of a faltering battery pack, a shorter amount of time spent coaxing it off the bottom.

2013:134:09:00:00
The eight lithium powered loggers, which are to be deployed after we finish the



alkaline SP recoveries, are setup and ready to go. We made two clock battery backup packs by soldering four of the 3-C cell alkaline packs together, in parallel. This should be enough amp hours to support the clocks for more than three months.

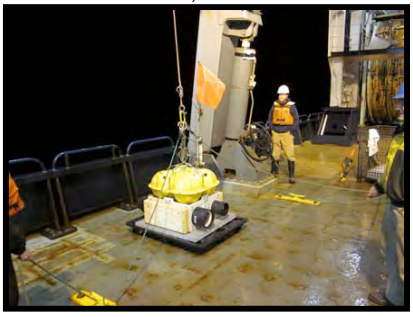
8. OBS Deployments (Phase II B- 08 OBS)

Station	S/N	AC	Depth	LAT	LON	Type	Comment	CH0-X	CH1-Y	CH2-Z	CH3-HYD
OBS47	13023	75	3153	36.18469	-33.93060	3-comp lithium	Surveyed				
OBS48	13014	122	2227	36.21333	-33.89823	3-comp lithium	Shot to (MCS)				
OBS49	13003	89	2021	36.20828	-33.87671	3-comp lithium	Shot to (MCS)				
OBS50	13004	149	2169	36.22184	-33.86032	3-comp lithium	Shot to (MCS)				
OBS51	13036	113	2550	36.20261	-33.82282	3-comp lithium	Surveyed				
OBS52	13021	104	2588	36.26930	-33.84217	3-comp lithium	Surveyed				
OBS53	13001	49	2120	36.23723	-33.88738	3-comp lithium	Shot to (MCS)				
OBS54	13005	30	2282	36.24219	-33.88942	3-comp lithium	Shot to (MCS)				
OBS55	13008	20	3016	36.25246	-33.94291	3-comp lithium	Surveyed				
OBS56	13012	107	2345	36.22865	-33.90509	3-comp lithium	Surveyed				
OBS57	13015	57	2377	36.23008	-33.90319	3-comp lithium	Surveyed				
OBS58	13033	88	2296	36.23039	-33.90227	3-comp lithium	Surveyed				
OBS59	13002	65	2248	36.22939	-33.90087	3-comp lithium	Surveyed				
OBS60	13010	117	2237	36.22809	-33.90138	3-comp lithium	Surveyed				
OBS61	13011	142	2294	36.22762	-33.90347	3-comp lithium	Surveyed				

- Phase I Recoveries
- Phase II Recoveries
- Phase II A Deployments
- Phase II B Deployments

For the first three of these deployments we will wait for the OBS to touchdown on the seafloor, and then we will begin the relocation survey. For the last five of these deployments we will deploy them disabled and in rapid sequence because they are relatively close to one another. Once these five OBS are deployed we will enable the first (OBS58), determine that it is stable, and then begin the relocation survey- repeating this for the remaining four sites.

2013:134:19:10:00 Site OBS47, 3175 meters
It took about 70-minutes for the OBS to hit the sea floor, which is about a 45 m/min sink rate.



The instrument prepped for site OBS59 originally had acoustic #55, which was replaced with acoustic #65 because acoustic #55 displayed an erratic, broken sound from the ITC 3013 transducer head- possibly an issue with the ceramic.

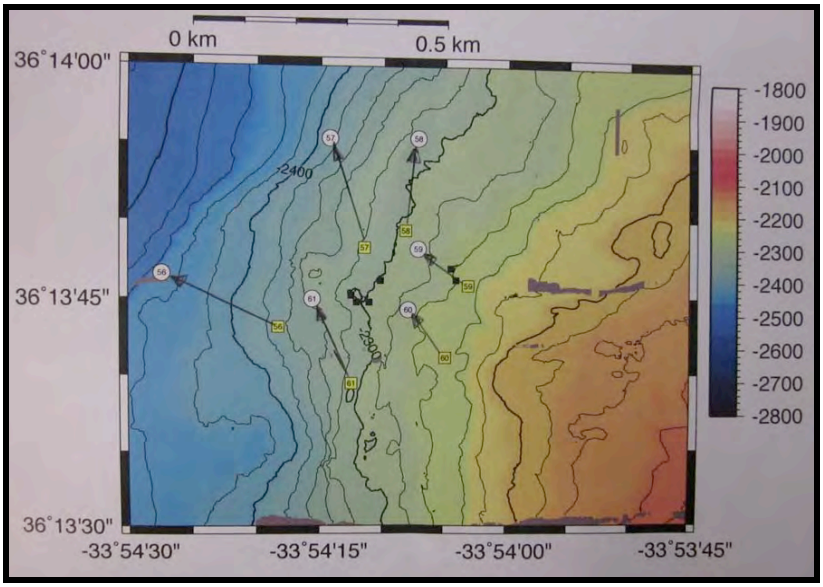
Phil has fixed the script for the Saber acoustic box so we are now able to perform our relocation surveys with it instead of the 8011-M. The saber seems to be working fine.

For a few of our sites we are seeing a shadowing effect, like a dead acoustic side of the survey pattern. It could be topography, OBS orientation, distance from the drop location, or any combination of the three.

2013:135:07:00:00
We have finished with the Phase II B deployments, which consisted of the remaining eight lithium powered SP OBS. The final five instruments were deployed around a series of hydrothermal vents in a fairly tight pattern; therefore they were deployed in rapid succession and with acoustics disabled.

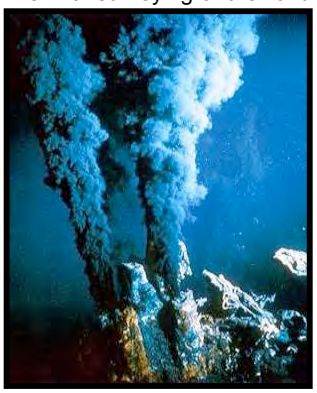
Instruments that required survey relocation:

Station	Corrected Positions
OBS 47	**Lat: 36 11.1316 (36.1855), Lon: -33 55.9637 (-33.9327), depth: 3153**
OBS 51	**Lat: 36 12.2122 (36.2035), Lon: -33 49.5618 (-33.8260), depth: 2550**
OBS 52	**Lat: 36 16.2169 (36.2703), Lon: -33 50.5704 (-33.8428), depth: 2597**
OBS 55	**Lat: 36 15.1597 (36.2527), Lon: -33 56.6773 (-33.9446), depth: 3016**
OBS 56	**Lat: 36 13.7761 (36.2296), Lon: -33 54.4569 (-33.9076), depth: 2345**
OBS 57	**Lat: 36 13.9226 (36.2320), Lon: -33 54.2377 (-33.9040), depth: 2377**
OBS 58	**Lat: 36 13.9230 (36.2321), Lon: -33 54.1200 (-33.9020), depth: 2296**
OBS 59	**Lat: 36 13.8034 (36.2301), Lon: -33 54.1194 (-33.9020), depth: 2248**
OBS 60	**Lat: 36 13.7375 (36.2290), Lon: -33 54.1323 (-33.9022), depth: 2237**
OBS 61	**Lat: 36 13.7488 (36.2291), Lon: -33 54.2604 (-33.9043), depth: 2294**



Yellow Square = Release Coordinates (sea surface)
White Circle = Surveyed Location (actual seafloor location)
Black Square = Known Hydrothermal Vents

2013:135:13:15:00
The final surveying of the lithium powered SP's is complete. We surveyed 10 of 15 sites. OBS55 and OBS57, which were deployed before the streamer work, were also surveyed because their seafloor positions are needed fairly immediately. Some of these OBS are deployed very near known hydrothermal vents so their positions need to be shared with any other deep-sea science cruises operating in this area, which may be collecting physical samples, images and video from these sites. It would be really cool if we received images of our OBS near one of these vents.



Example of a Mid-Atlantic Ridge hydrothermal vent

9. Data Processing & Instrument assessment
By Phil Thai

Of the 46 instruments that were deployed 43 returned capable of having data extracted. Of these 43 instruments 37 came back with data on all 4 channels. On three instruments the hydrophones failed (OBS36, OBS22, OBS17)

10. Cruise Summary
This was a successful cruise as we were able to deploy, and then recover 45 of our 46 OBS. For the final 15 OBS deployments we adapted to the loss of two of our lithium powered loggers by altering the battery configurations of six loggers. This allowed us to provide the 15 lithium powered OBS for the longer-term deployment portion of this experiment. These 15 OBS are to remain in operation until January 2014.

The deck operations went very well. We have had ample experience with OBS operations on this ship allowing for a routine work environment.

The majority of the logger electronics (36 of 46) were assembled and tested just before the shipping deadline for this cruise, so in many ways this cruise was a test of our latest version of the new logger system, GUI setup interface, and processing software.

The acoustic operations were much improved as a result of having a grounded shield associated with the 12kHz hull-mounted transducer cable. There was absolutely no background noise, or static reflections that have plagued us in the past. The acoustic returns were not 100%, but the elimination of the background

noise greatly simplified our ability to discern direct returns from bounces, as well as defining specific shadow zones, which were unique to each OBS station.

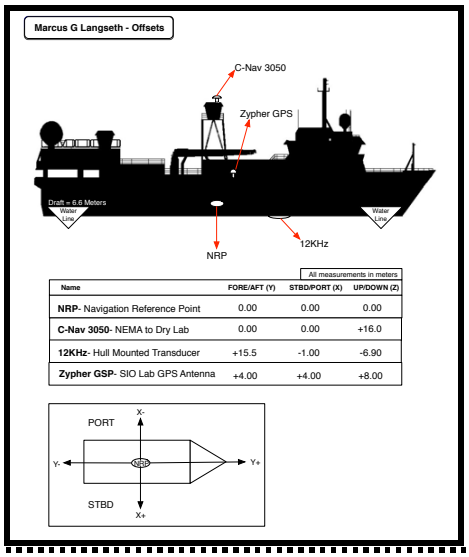
11. Room for improvement

As requested many times in the past, it would be very helpful if there were a repeated display of the ships GUI navigation, for our viewing in the dry lab. We do have a monitor displaying the ship's heading, position coordinates, speed (SOG), etc., but having an active display of the ship and its vector in relation to the drop, or recovery site locations is invaluable. It would eliminate more than half of the lab to bridge communications required to help us (in the dry lab) understand our distance and bearing from station with respect to the evolving science objectives.

12. Other Documentation

Instrument attrition:

- SP lost, Site OBS40
- SP logger flooded, Site OBS42
- Acoustic unit flooded at face seal, AC#15
- Two NovaTech radios flooded
- Two NovaTech radios with battery leaks
- Run-plug damaged during deployment, LP-119
- Recovery tag pole bent
- Acoustic release cable leaked and corroded 4-pin connectors, AC#47
- Acoustic transducer head sounds damaged, AC#55

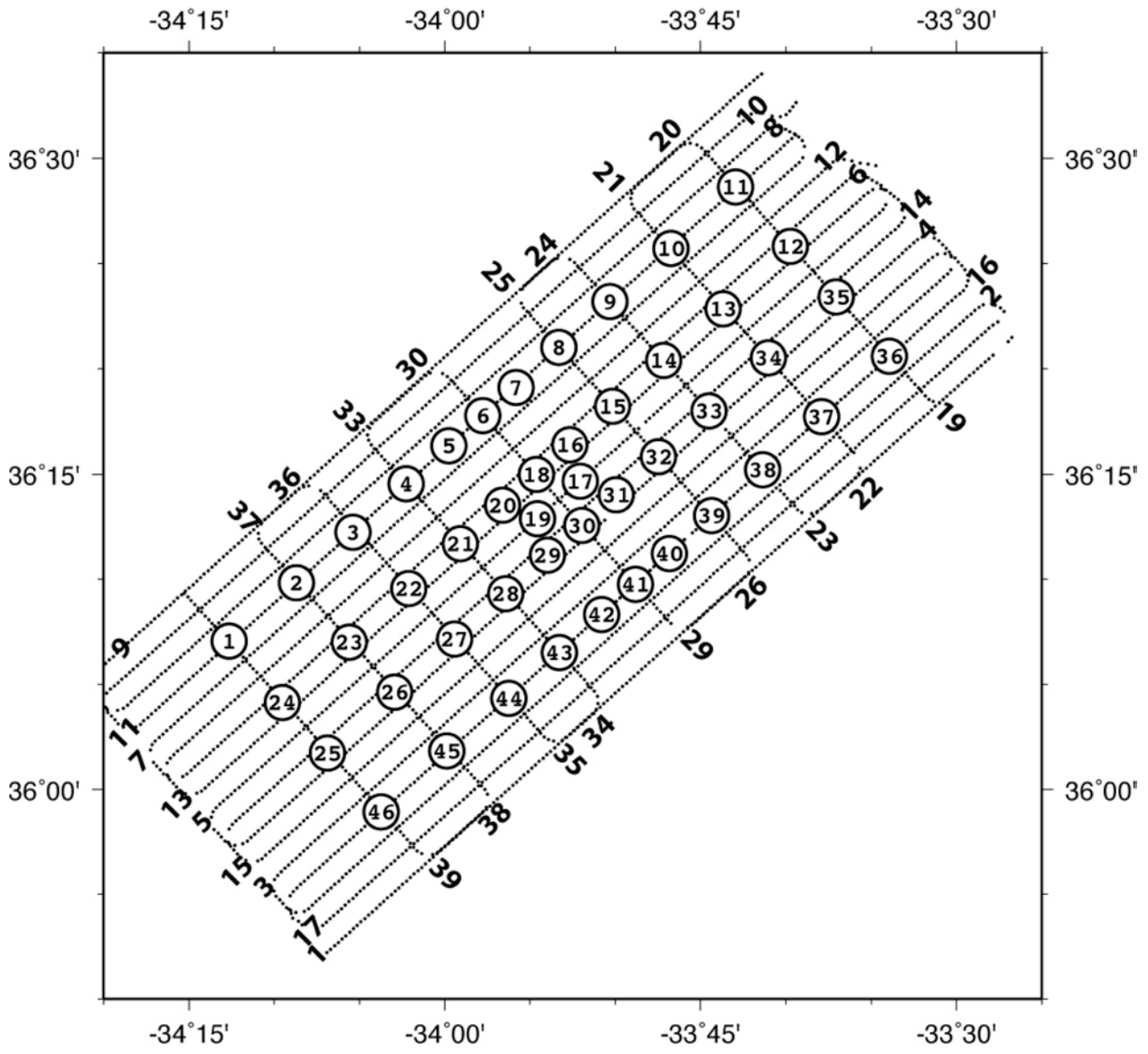


All measurements in meters

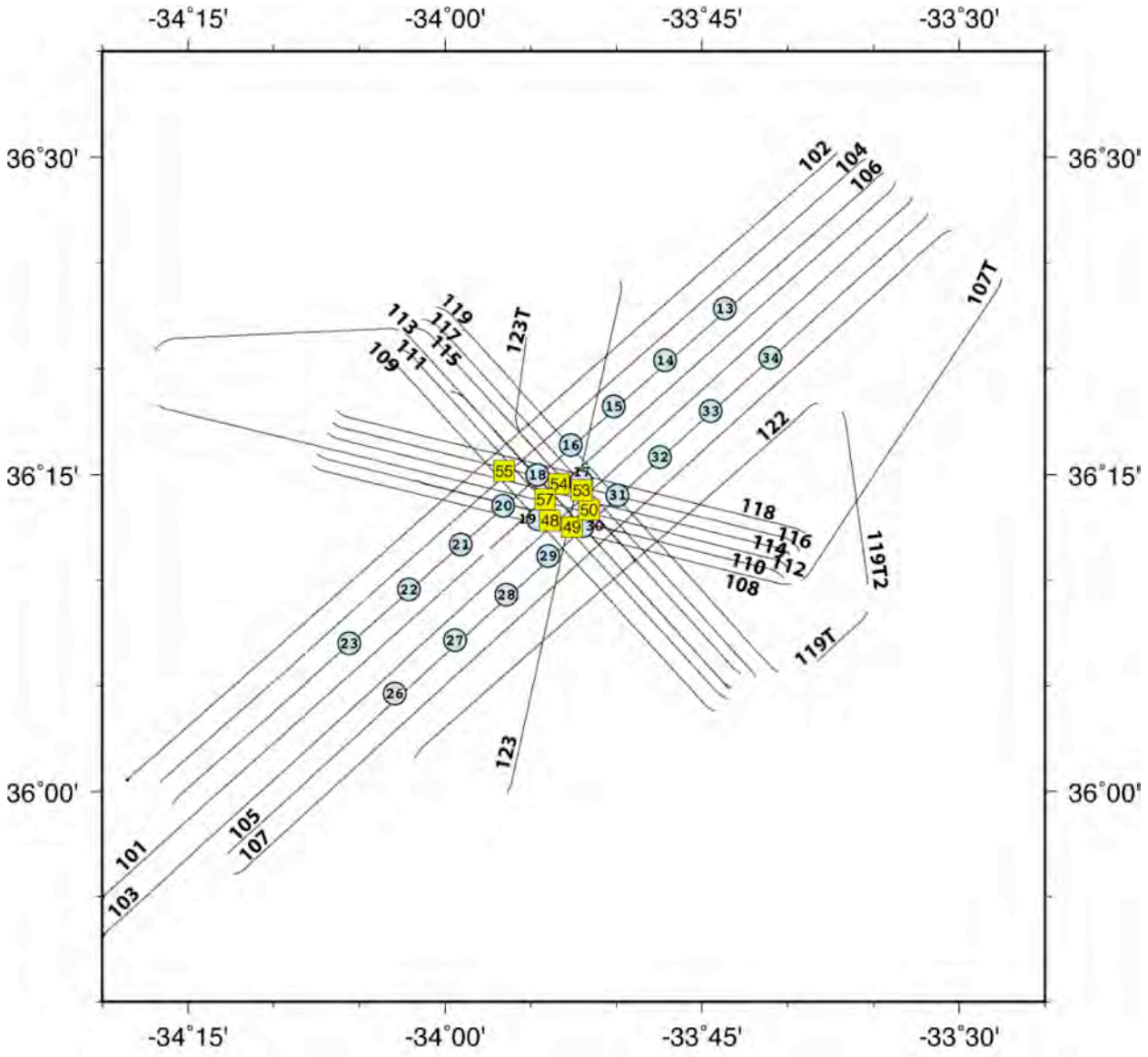
Name	FORE/AFT (Y)	STBD/PORT (X)	UP/DOWN (Z)
NRP- Navigation Reference Point	0.00	0.00	0.00
C-Nav 3050- NEMA to Dry Lab	0.00	0.00	+16.0
12KHz- Hull Mounted Transducer	+15.5	-1.00	-6.90
Zypher GSP- SIO Lab GPS Antenna	+4.00	+4.00	+8.00

A.5 Active-Source OBSs: Deployment/Recovery Table, Maps, and Data Quality Table

Station (+ drop order)	Drop Date	Drop Time UTC	Drop Depth (m)	Drop Lat. (deg)	Drop Lat. (min)	Drop Long. (deg)	Drop Long. (min)	Drop Latitude (dec. deg.)	Drop Longitude (dec. deg.)	Phase1 Recovery Order	Phase2 Recovery Order	Recover Lat. (deg)	Recover Lat. (min)	Recover Long. (deg)	Recover Long. (min)	Recover Latitude (dec. deg.)	Recover Longitude (dec. deg.)	Recover Date	Recover Time	First Shot Recorded	Last Shot Recdorded
OBS1	17-Apr-13	17:04:49	1503	36	07.0688	-34	12.6241	36.11781	-34.21040	1		36	7.1373	-34	12.6484	36.118955	-34.210807	1-May-13	23:10:18	1001	25072
OBS2	17-Apr-13	17:41:38	1536	36	09.8316	-34	08.6947	36.16386	-34.14491	2		36	9.8317	-34	8.6807	36.163862	-34.144679	2-May-13	1:03:09	1001	25072
OBS3	17-Apr-13	18:17:10	1689	36	12.2521	-34	05.3766	36.20420	-34.08961	3		36	12.1637	-34	5.3248	36.202728	-34.088747	2-May-13	2:33:48	1001	25072
OBS4	17-Apr-13	19:01:09	2506	36	14.5329	-34	02.2439	36.24222	-34.03740	4		36	14.4576	-34	2.0268	36.240960	-34.03378	2-May-13	4:22:11		
OBS5	17-Apr-13	19:36:18	2339	36	16.3530	-33	59.7355	36.27255	-33.99559	5		36	16.3100	-33	59.7378	36.271834	-33.99563	2-May-13	5:51:06	1001	25072
OBS6	17-Apr-13	20:05:03	1895	36	17.7841	-33	57.7595	36.29640	-33.96266	6		36	17.6808	-33	57.8305	36.294680	-33.963841	2-May-13	7:15:00	1001	25072
OBS7	17-Apr-13	20:40:55	1612	36	19.1217	-33	55.7855	36.31870	-33.92976	7		36	19.0977	-33	55.9678	36.318295	-33.93280	2-May-13	8:26:16	1001	25072
OBS8	17-Apr-13	21:33:45	2117	36	21.0360	-33	53.2925	36.35060	-33.88821	8		36	20.9897	-33	53.4550	36.349829	-33.890916	2-May-13	10:02:39	1001	25072
OBS9	17-Apr-13	22:28:40	1823	36	23.2008	-33	50.2990	36.38668	-33.83832	9		36	23.1794	-33	50.5826	36.386324	-33.843043	2-May-13	11:37:22	1001	25072
OBS10	17-Apr-13	23:28:21	1693	36	25.7169	-33	46.7207	36.42862	-33.77868	10		36	25.7893	-33	47.0500	36.429821	-33.784167	2-May-13	13:10:53	1001	25072
OBS11	18-Apr-13	0:26:39	1908	36	28.6416	-33	42.9451	36.47736	-33.71575	11		36	28.8761	-33	43.1074	36.481268	-33.718457	2-May-13	15:20:41	1001	25072
OBS12	18-Apr-13	1:17:47	2534	36	25.8226	-33	39.7209	36.43038	-33.66202	12		36	26.0016	-33	39.7886	36.433360	-33.663144	2-May-13	16:57:05	1001	25072
OBS13	18-Apr-13	2:09:08	2751	36	22.8445	-33	43.6752	36.38074	-33.72792		6	36	22.8432	-33	43.9130	36.380720	-33.731884	13-May-13	18:22:31	1001	71137
OBS14	18-Apr-13	2:49:46	2865	36	20.4110	-33	47.1613	36.34018	-33.78602		7	36	20.4885	-33	47.5933	36.341475	-33.793222	13-May-13	20:11:15	1001	71137
OBS15	18-Apr-13	3:38:52	2871	36	18.2286	-33	50.1444	36.30381	-33.83574		8	36	18.2870	-33	50.8627	36.304784	-33.847711	13-May-13	21:55:49	1001	71137
OBS16	18-Apr-13	4:10:55	2475	36	16.4113	-33	52.6395	36.27352	-33.87733		9	36	16.5931	-33	53.2798	36.276551	-33.88800	13-May-13	23:55:10	1001	71137
OBS17	18-Apr-13	4:42:11	2141	36	14.6795	-33	52.0435	36.24466	-33.86739		10	36	14.7884	-33	52.4203	36.246473	-33.873671	14-May-13	1:29:16	1001	71137
OBS18	18-Apr-13	5:13:50	2721	36	14.9844	-33	54.6205	36.24974	-33.91034		11	36	15.0836	-33	54.9161	36.251393	-33.915269	14-May-13	2:53:23	1001	71137
OBS19	18-Apr-13	5:43:42	2452	36	12.8736	-33	54.5493	36.21456	-33.90916		12	36	12.8957	-33	54.8436	36.214928	-33.91406	14-May-13	4:21:32	1001	71137
OBS20	18-Apr-13	6:21:03	3219	36	13.5282	-33	56.5921	36.22547	-33.94320		13	36	13.4815	-33	57.0761	36.224691	-33.951268	14-May-13	6:05:10	1001	71137
OBS21	18-Apr-13	6:50:53	3035	36	11.7025	-33	59.0792	36.19504	-33.98465		14	36	11.6113	-33	59.4743	36.193521	-33.991239	14-May-13	7:43:07	1001	71137
OBS22	18-Apr-13	7:26:05	2231	36	09.5726	-34	02.0838	36.15954	-34.03473		15	36	9.3981	-34	2.3373	36.156635	-34.038955	14-May-13	9:08:10	1001	71137
OBS23	18-Apr-13	8:11:06	2506	36	07.0204	-34	05.5638	36.11701	-34.09273		16	36	6.8839	-34	5.7361	36.114732	-34.09560	14-May-13	10:41:33	1001	71137
OBS24	18-Apr-13	8:45:52	2321	36	04.1389	-34	09.5269	36.06898	-34.15878	26		36	4.0737	-34	9.5471	36.067895	-34.159118	3-May-13	15:36:44	1001	25072
OBS25	18-Apr-13	9:32:53	2268	36	01.7189	-34	06.8750	36.02865	-34.11458	25		36	1.6085	-34	6.8633	36.026809	-34.114388	3-May-13	14:17:30	1001	25072
OBS26	18-Apr-13	10:17:34	2620	36	04.6433	-34	02.9079	36.07739	-34.04847		17	36	4.5780	-34	2.9581	36.076300	-34.04930	14-May-13	12:34:04	1001	71137
OBS27	18-Apr-13	11:11:14	2801	36	07.1641	-33	59.4181	36.11940	-33.99030		18	36	7.3084	-33	59.6474	36.121807	-33.994123	14-May-13	14:14:47	1001	71137
OBS28	18-Apr-13	11:59:36	2693	36	09.3300	-33	56.4211	36.15550	-33.94035		19	36	9.3346	-33	56.7701	36.155576	-33.946169	14-May-13	16:06:40	1001	71137
OBS29	18-Apr-13	12:33:16	2219	36	11.1493	-33	53.9530	36.18582	-33.89922		20	36	11.1332	-33	54.3374	36.185554	-33.905623	14-May-13	17:41:08	1001	71137
OBS30	18-Apr-13	13:05:37	2071	36	12.5734	-33	51.9535	36.20956	-33.86589		1	36	12.5552	-33	52.3989	36.209254	-33.873315	13-May-13	9:40:13	1001	71137
OBS31	18-Apr-13	13:42:52	2736	36	14.0275	-33	49.9259	36.23379	-33.83210		2	36	14.0210	-33	50.3098	36.233683	-33.83850	13-May-13	11:12:11	1001	71137
OBS32	18-Apr-13	14:18:22	2836	36	15.8364	-33	47.4446	36.26394	-33.79074		3	36	15.8502	-33	47.7832	36.264170	-33.796386	13-May-13	12:53:53	1001	71137
OBS33	18-Apr-13	14:55:40	2547	36	18.0061	-33	44.5011	36.30010	-33.74169		4	36	18.0543	-33	44.8049	36.300905	-33.748052	13-May-13	14:36:35	1001	71137
OBS34	18-Apr-13	15:35:53	2786	36	20.6215	-33	41.0138	36.34203	-33.68356		5	36	20.4352	-33	41.2981	36.340587	-33.68830	13-May-13	16:38:47	1001	71137
OBS35	18-Apr-13	16:17:28	2212	36	23.4233	-33	37.0527	36.39039	-33.61755		13	36	23.6441	-33	37.0763	36.394068	-33.617939	2-May-13	18:26:44	1001	25072
OBS36	18-Apr-13	17:03:30	1918	36	20.6146	-33	33.9162	36.34358	-33.56527	14		36	20.6510	-33	33.8680	36.344183	-33.564467	2-May-13	20:13:04	1001	25072
OBS37	18-Apr-13	17:44:19	1966	36	17.7305	-33	37.8846	36.29551	-33.63141	15		36	17.7400	-33	37.8845	36.295666	-33.631408	2-May-13	21:55:30	1001	25072
OBS38	18-Apr-13	18:34:39	2277	36	15.2033	-33	41.3332	36.25339	-33.68889	16		36	15.0917	-33	41.3463	36.251528	-33.689105	2-May-13	23:35:58	1001	25072
OBS39	18-Apr-13	19:10:16	2435	36	13.0243	-33	44.3298	36.21707	-33.73883	17		36	13.0465	-33	44.4868	36.217441	-33.741447	3-May-13	1:04:33	1001	25072
OBS40	18-Apr-13	19:41:43	2087	36	11.2195	-33	46.8044	36.18699	-33.78007	18											
OBS41	18-Apr-13	20:10:06	1878	36	09.7721	-33	48.7933	36.16287	-33.81322	19		36	9.7483	-33	48.8041	36.162471	-33.81340	3-May-13	4:59:22	1001	25072
OBS42	18-Apr-13	20:41:46	2266	36	08.3316	-33	50.7770	36.13886	-33.84628	20		36	8.2300	-33	50.6824	36.137166	-33.844707	3-May-13	6:26:18		
OBS43	18-Apr-13	21:27:25	2147	36	06.5283	-33	53.2558	36.10881	-33.88760	21		36	6.5174	-33	53.1998	36.108623	-33.886664	3-May-13	7:52:41	1001	25072
OBS44	18-Apr-13	22:07:08	2315	36	04.3420	-33	56.2395	36.07237	-33.93733	22		36	4.2201	-33	56.0887	36.070335	-33.934812	3-May-13	9:24:14	1001	25072
OBS45	18-Apr-13	22:50:09	2234	36	01.8185	-33	59.8685	36.03031	-33.99781	23		36	1.6310	-33	59.7482	36.027184	-33.99580	3-May-13	11:02:18	1001	25072
OBS46	18-Apr-13	23:32:24	2422	35	58.9290	-34	03.7036	35.98215	-34.06173	24		35	58.8434	-34	3.6583	35.980723	-34.060972	3-May-13	12:47:43	1001	25072



OBS Shots and deployed active-source OBSs. Bold labels are OBS line numbers. Line number labels are located near the beginning of each profile.



MCS Shots and deployed OBSs during MCS operations. Light blue circles denote active-source OBSs that were recovered in this cruise. Yellow squares denote passive OBSs that will be recovered in January 2014. Bold labels are MCS line numbers. Labels are located near the beginning of each profile.

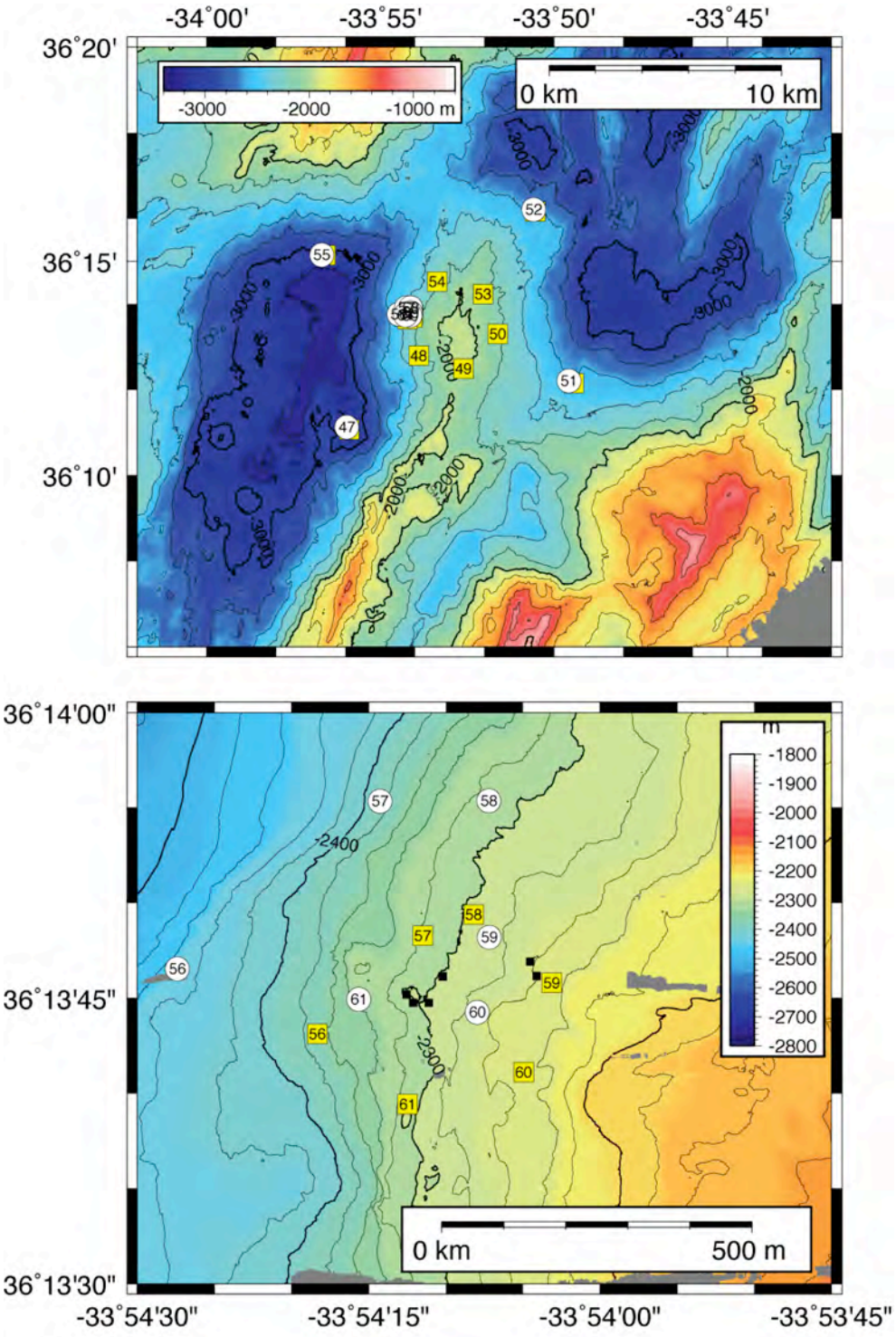
Station	S/N	Type	HYD Sensor	Geophone Sensor	Channel Quality:	0(X)	1(Y)	2(Z)	3(H)	Comments
OBS1	13005	3-comp lithium		L28		G	G	G	G	
OBS2	13007	3-comp lithium		L28		W	G	G	G	Almost no signal in x comp. Spiky noises in H comp (random large spaced)
OBS3	13008	3-comp lithium		L28		N	N	N	G	
OBS4	LP119	**2-comp**		**L22**				D	D	No data (hit the side of ship and cable unpluged)
OBS5	LP126	**2-comp**		**L22**				N	G	Spiky noises in H comp (random large spaced)
OBS6	13004	3-comp lithium		L28		N	N	N	G	Spiky noises in H comp (random large spaced)
OBS7	13003	3-comp lithium		L28		N	W	N	G	
OBS8	13001	3-comp lithium		L28		G	G	G	G	
OBS9	13015	3-comp lithium		L28		N	N	G	G	
OBS10	13014	3-comp lithium		L28		G	G	G	G	
OBS11	13002	3-comp lithium		L28		N	N	G	G	
OBS12	LP115	**2-comp**		**L22**				G	G	
OBS13	13021	3-comp alkaline		L28		G	G	G	G	
OBS14	13023	3-comp alkaline		L28		G	G	G	G	
OBS15	13024	3-comp alkaline		L28		G	G	G	G	
OBS16	13022	3-comp alkaline		L28		N	N	N	G	
OBS17	13020	3-comp alkaline		L28		N	N	N	D	
OBS18	13026	3-comp alkaline		L28		G	G	G	G	
OBS19	13025	3-comp alkaline		L28		G	G	G	G	
OBS20	13034	3-comp alkaline		L28		N	N	N	G	
OBS21	13035	3-comp alkaline		L28		G	G	G	G	
OBS22	13030	3-comp alkaline		L28		G	G	G	D	
OBS23	13019	3-comp alkaline		L28		G	G	G	G	
OBS24	LP117	**2-comp**		**L22**				G	G	
OBS25	LP113	**2-comp**		**L22**				G	G	
OBS26	13018	3-comp alkaline		L28		G	G	G	G	
OBS27	13031	3-comp alkaline		L28		N	N	N	G	
OBS28	13027	3-comp alkaline		L28		N	N	N	G	
OBS29	13029	3-comp alkaline		L28		G	G	G	G	
OBS30	13017	3-comp alkaline		L28		W	N	N	G	Almost no signal in x comp
OBS31	13028	3-comp alkaline		L28		N	N	N	G	
OBS32	13016	3-comp alkaline		L28		G	G	D	G	
OBS33	13036	3-comp alkaline		L28		G	G	G	G	
OBS34	13032	3-comp alkaline		L28		G	G	N	G	
OBS35	LP124	**2-comp**		**L22**				G	G	
OBS36	13013	3-comp lithium		L28		N	N	N	G	Spiky noises in H comp (random large spaced)
OBS37	13012	3-comp lithium		L28		N	N	N	G	
OBS38	LP129	**2-comp**		**L22**				N	G	
OBS39	LP130	**2-comp**		**L22**				G	G	
OBS40	13006	3-comp lithium		L28		D	D	D	D	No data (OBS not recovered)
OBS41	13010	3-comp lithium		L28		G	W	G	G	
OBS42	13009	3-comp lithium		L28		D	D	D	D	No data (flooded pressure case battery corrosion data logger thrown in the sea for safety)
OBS43	LP125	**2-comp**		**L22**				G	G	
OBS44	13011	3-comp lithium		L28		N	D	N	G	
OBS45	LP121	**2-comp**		**L22**				N	G	
OBS46	13033	3-comp alkaline		L28		G	G	G	G	
		G = Good	W = Weak	D = Dead - No Data	N = Noisy					91 % data recovery

A.6. Passive OBS Deployments: Table And Maps

MGL1305 Deployment of Passive OBS Network

Station	Datalogger SN	Drop Location		Seafloor (m)	Deployment time	Relocated Location			
		Latitude	Longitude		Julian Day, Date UTC Time	Latitude	Longitude	Dlat (m)	Dlon (m)
OBS 47	13023	36.184600	-33.931525	3158	134, 14 May 2013 19:09:26	36.18553	-33.93273	92.6	-190.9
OBS 48	13014	36.213327	-33.898227	2227	123, 03 May 2013 20:30:07				
OBS 49	13003	36.208282	-33.876709	2021	123, 03 May 2013 20:03:14				
OBS 50	13004	36.221843	-33.860324	2169	123, 03 May 2013 19:44:32				
OBS 51	13036	36.202506	-33.823695	2531 (a)	134, 14 May 2013 22:57:54	36.20354	-33.82603	103.6	-288.7
OBS 52	13021	36.269302	-33.842170	2588	135, 15 May 2013 02:30:18	36.27028	-33.84284	109	-60.2
OBS 53	13001	36.237229	-33.867382	2120	123, 03 May 2013 18:55:23				
OBS 54	13005	36.242191	-33.889423	2282	123, 03 May 2013 18:28:51				
OBS 55	13008	36.252463	-33.942908	3016	123, 03 May 2013 17:42:05	36.25266	-33.94462	18	-190.5
OBS 56	13012	36.228646	-33.905092	2384	135, 15 May 2013 06:36:29	36.22960	-33.90761	106.3	-226.5
OBS 57	13015	36.230077	-33.903190	2377	123, 03 May 2013 20:46:30	36.23204	-33.90396	196.3	-53.2
OBS 58	13033	36.230387	-33.902274	2297	135, 15 May 2013 05:40:33	36.23205	-33.90200	152.6	-44.9
OBS 59	13002	36.229386	-33.900869	2260	135, 15 May 2013 05:58:44	36.23006	-33.90199	25.2	-178.7
OBS 60	13010	36.228088	-33.901375	2240	135, 15 May 2013 06:13:10	36.22896	-33.90221	96.8	-74.6
OBS 61	13011	36.227617	-33.903467	2329	135, 15 May 2013 06:21:03	36.22915	-33.90434	170.3	-78.4

(a) Depth obtained from bathymetry grid.



Map of passive OBS deployment. Yellow squares are drop positions, white circles are relocated positions, and black squares are active hydrothermal vents.

A.7. Airgun Array and MCS Acquisition Parameters

	OBS Lines	MCS Lines
AcquisitionParameterID	MGL1305_ACQ02	MGL1305_ACQ02
FieldActivityID	MGL1305	MGL1305
ReceiverType	Ocean-Bottom Seismometer	Ocean-Bottom Seismometer/Sentry Solid Streamer
SourceType	Airgun	Airgun
Acquisition System Name	OBS	SIO OBS/Sercel Syntrack 960
Acquisition System Type	OBS	OBS/MCS
Seismic_Nav_System	C-Nav 3050 primary	C-Nav 3050 primary
Survey_datum	WGS84	WGS84
Navigation Reference Point (NRP)	Fore/Aft+29.5, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 200 calculated center of gravity) waterline	Fore/Aft+29.5, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 200 calculated center of gravity) waterline
NRP to source	214 m	214 m
Source_to_Near_Channel	N/A	210 m (reference for MCS only)
Number _of_channels_recorded	N/A	636
Number _of_cables	0	1
Number_of_channels_each _cable	N/A	636
Channel_length	N/A	12.5 m
Cable_length	N/A	8 km
Cable_spacing	N/A	NA
Near_Channel_Number	N/A	636
Cable_depth	N/A	12.0 m
Number_sources	1	1
Sub-arrays_per_source	4	4
Alternate_Shooting	No	No
Source_array_separation	N/A	N/A
Sub-array_separation	6.0 m	6.0 m
Source_volume	6600 cu in	6600 cu in
Source_pressure	2000 psi nominal	2000 psi nominal
Source_make,model	Bolt 1500LL & 1900LL	Bolt 1500LL & 1900LL
Source_number	36 + 4 spare	36 + 4 spare
Source_depth	12.0 m	12.0 m
Shot_control	Distance	Distance
Shot_Interval	450 m	37.5 m
Sample_interval	N/A	2 ms
Record_length	N/A	12 s
Compass_birds	N/A	30 Digicourse 5011
Recording_delay	N/A	N/A
Tail_buoy_Positioning	N/A	No

A.8. Table of Lines and Shots

OBS Lines

Line	Sequential#	Date	First Shot Time (UTC)	Shot#	Date	Last Shot Time (UTC)	Shot#	Files	Tapes	Shot Interval (m)
MGL1305OBS01	001	2013/04/19	10:57	988	2013/04/19	21:34	1181	N/A	N/A	450
MGL1305OBS01T	002	2013/04/19	21:49	1505	2013/04/19	21:59	1508	N/A	N/A	450
MGL1305OBS02	003	2013/04/19	22:07	2003	2013/04/20	07:51	2181	N/A	N/A	450
MGL1305OBS02T	004	2013/04/20	07:57	2502	2013/04/20	08:17	2508	N/A	N/A	450
MGL1305OBS03	005	2013/04/20	08:25	3003	2013/04/20	18:25	3181	N/A	N/A	450
MGL1305OBS03T	006	2013/04/20	18:34	3503	2013/04/20	18:49	3508	N/A	N/A	450
MGL1305OBS04	007	2013/04/20	18:57	4003	2013/04/21	04:42	4181	N/A	N/A	450
MGL1305OBS04T	008	2013/04/21	04:47	4502	2013/04/21	05:05	4507	N/A	N/A	450
MGL1305OBS05	009	2013/04/21	05:12	5002	2013/04/21	15:07	5180	N/A	N/A	450
MGL1305OBS05T	010	2013/04/21	15:18	5504	2013/04/21	15:37	5510	N/A	N/A	450
MGL1305OBS06	011	2013/04/21	15:39	6002	2013/04/22	01:17	6178	N/A	N/A	450
MGL1305OBS06T	012	2013/04/22	01:27	6503	2013/04/22	01:43	6507	N/A	N/A	450
MGL1305OBS07	013	2013/04/22	01:50	7002	2013/04/22	11:17	7174	N/A	N/A	450
MGL1305OBS07T	014	2013/04/22	11:25	7503	2013/04/22	11:45	7509	N/A	N/A	450
MGL1305OBS08	015	2013/04/22	11:50	8002	2013/04/22	21:08	8173	N/A	N/A	450
MGL1305OBS08T	016	2013/04/22	21:16	8503	2013/04/22	21:33	8508	N/A	N/A	450
MGL1305OBS10	018	2013/04/23	07:49	9994	2013/04/23	17:29	10171	N/A	N/A	450
MGL1305OBS10T	019	2013/04/23	17:38	10503	2013/04/23	17:54	10508	N/A	N/A	450
MGL1305OBS11	020	2013/04/23	18:02	11003	2013/04/24	03:27	11176	N/A	N/A	450
MGL1305OBS12	021	2013/04/27	11:03	11496	2013/04/27	21:07	11677	N/A	N/A	450
MGL1305OBS12T	022	2013/04/27	21:15	12003	2013/04/27	21:33	12008	N/A	N/A	450
MGL1305OBS13	023	2013/04/27	21:41	12503	2013/04/28	07:28	12608	N/A	N/A	450
MGL1305OBS13T	024	2013/04/28	07:34	13002	2013/04/28	07:50	13007	N/A	N/A	450
MGL1305OBS14	025	2013/04/28	08:00	13502	2013/04/28	17:47	13681	N/A	N/A	450
MGL1305OBS14T	026	2013/04/28	17:55	14003	2013/04/28	18:12	14008	N/A	N/A	450
MGL1305OBS15	027	2013/04/28	18:20	14503	2013/04/29	04:13	14681	N/A	N/A	450
MGL1305OBS15T	028	2013/04/29	04:18	15002	2013/04/29	04:38	15008	N/A	N/A	450
MGL1305OBS16	029	2013/04/29	04:42	15502	2013/04/29	14:28	15681	N/A	N/A	450
MGL1305OBS16T	030	2013/04/29	14:37	16003	2013/04/29	14:54	16007	N/A	N/A	450
MGL1305OBS17	031	2013/04/29	15:04	16504	2013/04/30	00:45	16681	N/A	N/A	450
MGL1305OBS19	032	2013/04/30	02:14	17001	2013/04/30	06:02	17070	N/A	N/A	450
MGL1305OBS20	033	2013/04/30	06:06	17502	2013/04/30	06:56	17517	N/A	N/A	450
MGL1305OBS21	034	2013/04/30	07:00	18002	2013/04/30	10:36	18068	N/A	N/A	450
MGL1305OBS22	035	2013/04/30	10:47	18502	2013/04/30	11:30	18515	N/A	N/A	450
MGL1305OBS23	036	2013/04/30	11:36	19003	2013/04/30	15:15	19070	N/A	N/A	450
MGL1305OBS24	037	2013/04/30	15:24	19503	2013/04/30	15:54	19512	N/A	N/A	450
MGL1305OBS25	038	2013/04/30	16:03	20003	2013/04/30	19:43	20070	N/A	N/A	450
MGL1305OBS29	040	2013/04/30	20:54	21004	2013/05/01	00:31	21070	N/A	N/A	450
MGL1305OBS30	041	2013/05/01	00:39	21503	2013/05/01	01:32	21591	N/A	N/A	450
MGL1305OBS33	042	2013/05/01	01:36	22002	2013/05/01	05:21	22070	N/A	N/A	450
MGL1305OBS34	043	2013/05/01	05:27	22502	2013/05/01	06:00	22512	N/A	N/A	450
MGL1305OBS35	044	2013/05/01	06:06	23002	2013/05/01	09:46	23070	N/A	N/A	450
MGL1305OBS36	045	2013/05/01	09:51	23502	2013/05/01	10:30	23514	N/A	N/A	450
MGL1305OBS37	046	2013/05/01	10:37	24002	2013/05/01	14:23	24070	N/A	N/A	450
MGL1305OBS38	047	2013/05/01	14:32	24503	2013/05/01	15:20	24517	N/A	N/A	450
MGL1305OBS39	048	2013/05/01	15:27	25003	2013/05/01	19:14	25072	N/A	N/A	450

MCS Lines

Line	Sequential#	First Shot Date	First Shot Time (UTC)	First Shot Shot#	Last Shot Date	Last Shot Time (UTC)	Last Shot Shot#	Files	Tapes	Shot Interval (m)
MGL1305MCS101	049	2013/05/04	12:12	25556	2013/05/04	23:27	28090	3 – 2539	1 – 2	37.5
MGL1305MCS102	050	2013/05/05	00:14	30052	2013/05/05	08:59	32263	1 – 2181	3 – 4	37.5
MGL1305MCS103	051	2013/05/05	11:45	33671	2013/05/05	23:23	36271	1 – 2601	5 – 9	37.5
MGL1305MCS104	052	2013/05/06	00:04	37030	2013/05/06	09:39	39226	1 – 2195	10 – 13	37.5
MGL1305MCS105	053	2013/05/06	10:52	40059	2013/05/06	21:43	42273	1 – 2214	14 – 17	37.5
MGL1305MCS106	054	2013/05/06	22:25	43039	2013/05/07	08:30	45256	1 – 2216	18 – 21	37.5
MGL1305MCS107	055	2013/05/07	09:33	46039	2013/05/07	21:03	48286	1 – 2248	22 – 25	37.5
MGL1305MCS107T	056	2013/05/07	22:00	48971	2013/05/08	02:30	49816	1 – 846	26 – 27	37.5
MGL1305MCS108	057	2013/05/08	02:38	52021	2013/05/08	07:31	53170	1 – 1148	28 – 29	37.5
MGL1305MCS109	058	2013/05/08	09:13	55024	2013/05/08	14:33	56153	1 – 1130	30 – 31	37.5
MGL1305MCS110	059	2013/05/08	16:24	58042	2013/05/08	21:03	29166	1 – 1125	32 – 33	37.5
MGL1305MCS111	060	2013/05/08	22:42	61040	2013/05/09	03:49	62152	1 – 1113	34 – 35	37.5
MGL1305MCS112	061	2013/05/09	05:37	64036	2013/05/09	11:50	65554	1 – 1517	36 – 38	37.5
MGL1305MCS112T	062	2013/05/09	12:35	67021	2013/05/09	15:26	67592	1 – 572	39	37.5
MGL1305MCS113	063	2013/05/09	15:31	70015	2013/05/09	21:11	71137	1 – 1123	40 – 41	37.5
MGL1305MCS114	064	2013/05/09	22:57	73041	2013/05/10	03:51	74156	1 – 1113	42 – 43	37.5
MGL1305MCS115	065	2013/05/10	05:43	76023	2013/05/10	11:27	77127	1 – 1105	44 – 45	37.5
MGL1305MCS116	066	2013/05/10	13:05	79018	2013/05/10	17:49	80149	1 – 1130	46 – 47	37.5
MGL1305MCS117	067	2013/05/10	19:48	82016	2013/05/11	01:24	83154	1 – 1139	48 – 49	37.5
MGL1305MCS118	068	2013/05/11	05:28	85018	2013/05/11	10:08	86146	1 – 1129	50 – 51	37.5
MGL1305MCS119	069	2013/05/11	11:54	88018	2013/05/11	17:35	89183	1 – 1166	52 – 53	37.5
MGL1305MCS119T	070	2013/05/11	18:05	91011	2013/05/11	18:51	91174	1 – 164	54	37.5
MGL1305MCS119T2	071	2013/05/11	19:08	94019	2013/05/11	02:53	94423	1 – 403	55	37.5
MGL1305MCS122	072	2013/05/11	21:09	96886	2013/05/12	03:00	98138	1 – 1252	56 – 57	37.5
MGL1305MCS123	073	2013/05/12	04:18	99771	2013/05/12	09:44	100992	1 – 1222	58 – 59	37.5
MGL1305MCS123T	074	2013/05/12	11:15	103065	2013/05/12	12:20	103271	13 – 219	60	37.5
MGL1305MCS115R	075	2013/05/12	12:24	76739	2013/05/12	14:27	76773	1 – 395	61	37.5
MGL1305MCS110R	076	2013/05/12	15:55	58425	2013/05/12	17:57	58927	1 – 503	62	37.5
MGL1305MCS113R	077	2013/05/12	19:23	70186	2013/05/13	00:42	71137	1 – 952	63 – 64	37.5

A.9. MCS Shot Coverage (Mitigation Gun/Rump-Up/Dead Shots)

Line	Sequential#	First SP	Last SP	Mitigation shots		Rump-up		Missing shots		Files	
				First	Last	First	Last	First SP	Last SP	First File #	Last File #
MGL1305MCS101	049	25556	28090	2672	26796	26819	26845	26780	26781	1229	1230
								26797	26818	1246	1267
MGL1305MCS102	050	30052	32263					30054	30054	2	2
								30058	30059	6	7
								30091	30091	39	39
								30093	30093	41	41
								30095	30095	43	43
								30097	30097	45	45
								30100	30100	48	48
								30124	30124	72	72
								30172	30172	120	120
								30176	30176	124	124
								30194	30194	142	142
								30206	30206	154	154
								30211	30211	159	159
								30213	30213	161	161
								30215	30215	163	163
								30314	30314	262	262
								30341	30341	289	289
								30425	30425	373	373
								30954	30954	902	902
								30956	30956	904	904
								31489	31490	1437	1438
MGL1305MCS103	051	33671	36271								
MGL1305MCS104	052	37030	39226	38767	38839						
				39121	39149						
MGL1305MCS105	053	40059	42273	40164	40207			41074	41074	1016	1016
				40460	40517			41097	41097	1039	1039
				41074	41097			41233	41233	1175	1175
				41404	41412						
MGL1305MCS106	54	43039	45256								
MGL1305MCS107	55	46039	48286	41842	48200			48199	48200	2161	2162
MGL1305MCS107T	56	48971	49816	49476	49478			49475	49475	505	505
				49531	49532			49528	49530	558	560

Line	Sequential#	First SP	Last SP	Mitigation shots		Rump-up		Missing shots		Files	
				First	Last	First	Last	First SP	Last SP	First File #	Last File #
MGL1305MCS108	57	52021	53170								
MGL1305MCS109	58	55024	56153								
MGL1305MCS110	59	58042	59166	58702	58730			58697	58697	656	656
								58701	58701	660	660
								58731	58731	690	690
MGL1305MCS111	60	61040	62512								
MGL1305MCS112	61	64036	65554	65004	65037						
MGL1305MCS112T	62	67021	67592					67467	67467	447	447
MGL1305MCS113	63	70015	71137	70190	70195			70196	70197	182	183
				70198	70214			70215	70216	201	202
				70566	70566			70567	70567	553	553
				70568	70618			70618	70618	604	604
MGL1305MCS114	64	73041	74156								
MGL1305MCS115	65	76023	77127	76675	76675			76673	76774	651	652
				76680	76700			76676	76679	654	657
MGL1305MCS116	66	79018	80149								
MGL1305MCS117	67	82016	83154								
MGL1305MCS118	68	85018	86146								
MGL1305MCS119	69	88018	89183								
MGL1305MCS119T	70	91011	91174								
MGL1305MCS119T2	71	94019	94423								
MGL1305MCS122	72	96886	98138					96888	96888	3	3
MGL1305MCS123	73	99771	100992								
MGL1305MCS123T	74	103065	103271								
MGL1305MCS115R	75	76379	76773								
MGL1305MCS110R	76	58425	58927								
MGL1305MCS113R	77	70186	71137								

A.10. MCS Processing

A.10.1. *sioseis* Processing.

We used a sioseis script to create a stack of the near ~2 km of the streamer using a velocity function derived from the ESP5 model of Vera et al. [1990] for Pacific crust. The script has the stacking velocity defined for several water depths. Since the center beam depth is stored in the SEG-D headers, then an interpolated stacking velocity function can be used automatically for every depth. After the tack was done, we use another sioseis script to do an *f-k* migration using water velocity. Here are the detailed indications for running these script, loading the results into *Echos*, and generating images of the sections for plotting.

1. Find the Tape numbers that correspond to the line to be processed. When a line is finished the first and last Tape numbers will be recorded in the observers log. For example, for line MGL1305MC103 the first Tape is "5" and the last Tape is "8".

2. Run the *sioseis* script to generate a brute stack of the line on computer *proc1*:

   Open a terminal on *proc1*: Right Click> "Konsole"

   Change Directories to `/data/seismic/MGL1305/sioseis`

   Run the *sioseis* script, which takes inputs: Line Name, First Reel, Last Reel. For example, for Line MGL1305MC103 execute:

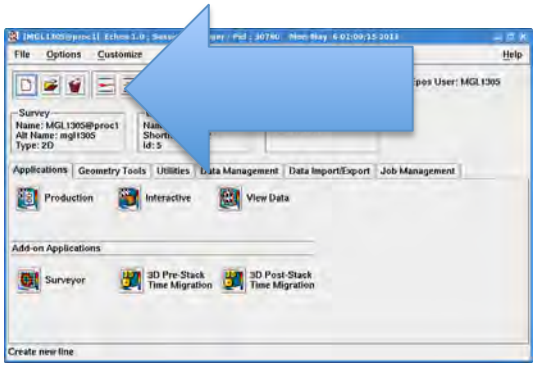
   ```
   brute_stackESP5.com 103 5 8
   ```

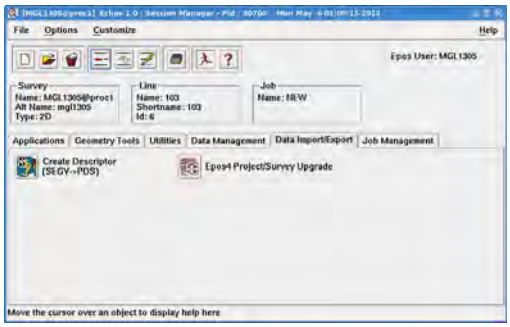
   The scripts will run and generate a SEGY file of the line. Many warnings will be generated and can be safely ignored. Processing time will be about 10 minutes depending on line length.

3. Load the brute stack SEGY file into *Echos:*

   Change directories to `/data/seismic/MGL1305/stacks`

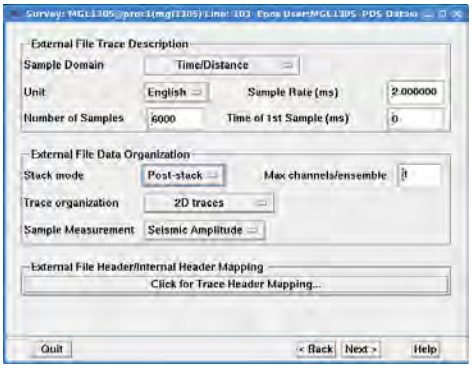
   Open the *Echos* software by executing `Echos` in the terminal. Create a new line by selecting the "New Line" button. Enter the line number: e.g. "103" for line MGL1305MC103. Load the brute stack into the new line by selecting the "Data Import/Export" tab on the *Echos* menu. Select the "Create Descriptor" button.

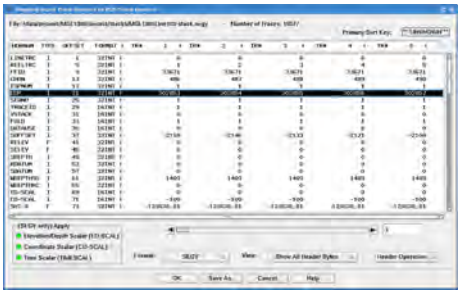




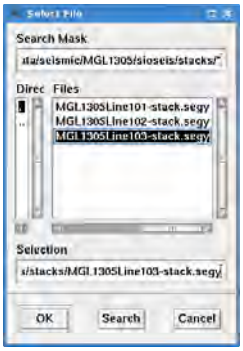
   Select the ellipses. In the directory window browse and select the brute stack file generated in step 2: e.g. `MGL1305Line103-stack.segy`. Select OK.

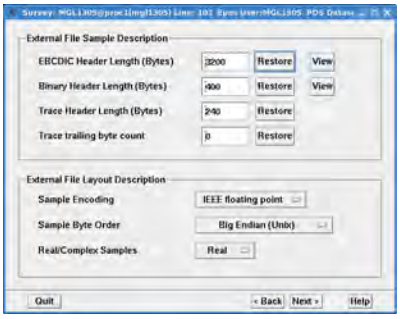
Enter "Sioseis-stack" into the Label field. Select Next. Leave all values at their defaults. Select Next. Change `Stack mode` to "Post-Stack".

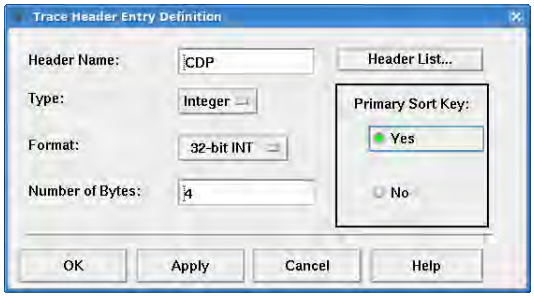




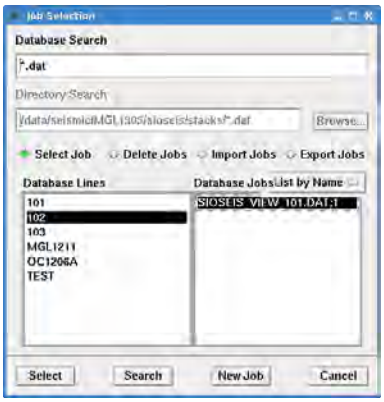
Select "Click for Trace Header Mapping…" button. Double click CDP. Change "`Primary sort Key`" from "No" to "Yes". Select OK. Select OK. Select 'Next'. Select 'Create'. Select 'Quit".

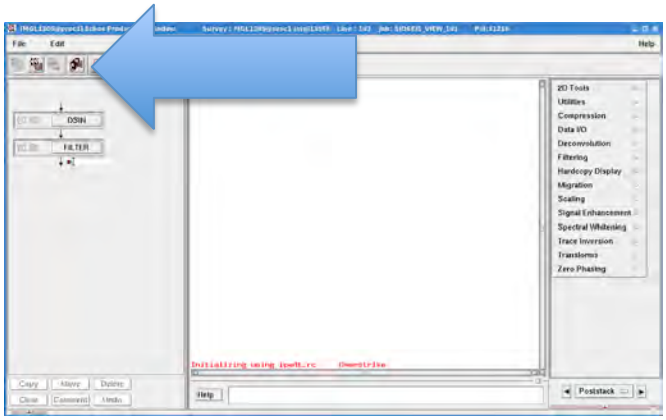




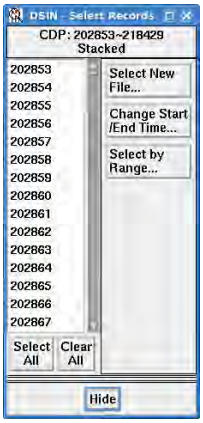


Return to the main *Echos* window and select the "Job" button. Select the Job "SIOSEIS_VIEW_101.DAT" from the previous line. Select the "Production" button on the *Echos* menu. Select the "Select Data" button.





Select the Select "All" button and "Hide".



Record the Start and End CDP numbers: e.g. 181139 and 194555.

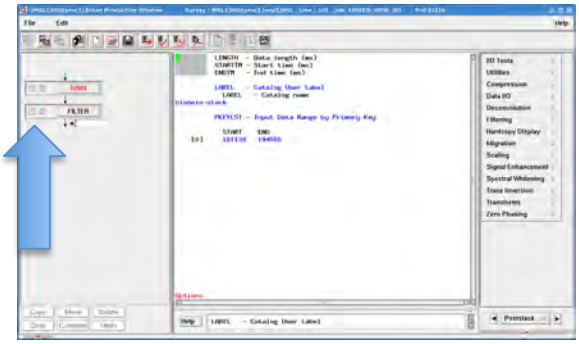
4. Create a Migrated stack with *sioseis*:

Open a new console window. Change directories to `/data/seismic/MGL1305/sioseis/` Run the script `fk_migration.com`, which takes the inputs Line Name, First CDP, Last CDP. For example:

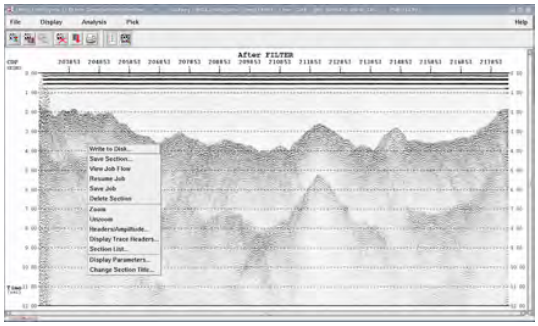
```
fk_migration.com 103 181139 194555
```

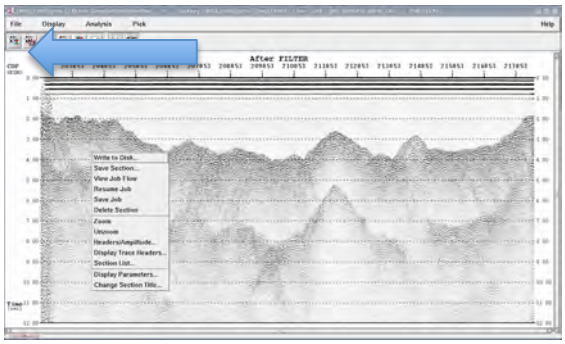
5. Load the migrated stack into *Echos* using the same procedure as for the stack. The migrated file is in the directory `/data/seismic/MGL1305/sioseis/migrated/`. The file name is `MGL1305Line103-mig.segy`. In *Echos* use the PDS label "Sioseis-migrated".

6. Create images of the stack and migrated sections. In the production window from Step 3 select the visualize button next to "Filter" (small arrow). Select the Run button.

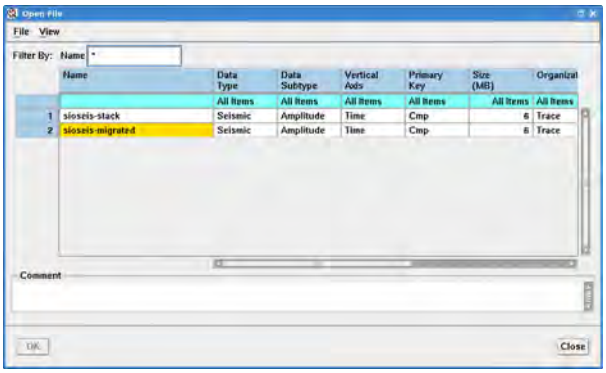


When the stack is displayed right click in the window and select "Save Section". Enter the line name into the Title box: e.g. `MGL1305MC103-stack` for this line. Select the "Production Window" button





In the production window Select the "Select Data" button. Select "Select New File" and select the migrated file.

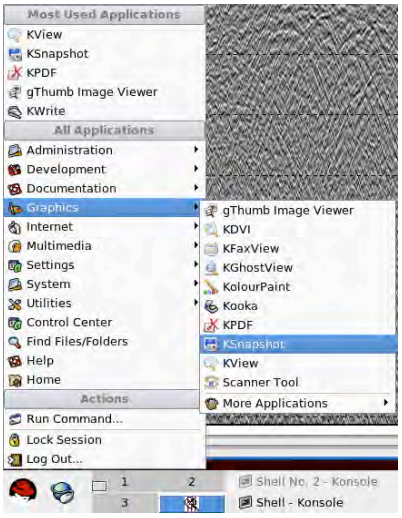


Select "Select All". Run the job. Right Click on the plot and select "Save Selection". Enter the Name of the Line for the Title (e.g. `MGL1305MC103-migrated`) and select OK.

Right click on the plot and select "Display Parameters". Change the `Scaling` to "AGC". Change the `SkeyLbl` to "FFID". Select the "More..." button. Change the "AGC window" to 500 ms.. Select Apply. Select the Colormap 1 (blue box with the number "1"). Set the gain to -3 db. Select Hide.

Extend the Plot so that it extends across both screens. Right Click on the plot and select zoom. Zoom in between ~1 to ~8 seconds vertically.

To grab the window, open the Program *Ksnapshot*:



Change the mode to Window. Select New Snapshot. Hover the mouse over the seismic image window. Save the snapshot to `/data/seismic/MGL1305/sioseis/postscripts` with the name of line and stack or migrated: e.g. "`103_stack.png`"

Back on the seismic image window, right Click on the window and select "Selection List". Select the other line (migrated) and repeat the screen shot process with *Ksnapshot* changing the filename appropriately.

Close the Plot window. A warning will appear: Select "Save" then select "Save to Line".

***sioseis* script `brute_stackESP5.com`**

```
#!/bin/csh -f

set LINENO=$1 # Line number
set FIRST_TAPE=$2 # First Tape number
set LAST_TAPE=$3 # Last Tape number

set LINENAME=MGL1305Line$LINENO
set SEGDDIR=/data/seismic/MGL1305-segd
set OUTDIR=/data/seismic/MGL1305/sioseis/stacks

set tape = $FIRST_TAPE
rm list

while ( $tape <= $LAST_TAPE )
set temp=$tape
  if ( $temp < 1000 && $temp >= 100 ) then
     set temp = '0'$temp
  else if ( $temp < 100 && $temp >= 10) then
     set temp = '00'$temp
  else if ( $temp < 10 ) then
     set temp = '000'$temp
  endif
  ls $SEGDDIR/TAPE$temp.REEL/R*.RAW >> list
  @ tape = $tape + 1
end

/lhome/pgadmin/sioseis/sioseis-2011.2.20/sioseis<<eof

procs segddin prout geom wbt gather nmo stack filter diskoa end

segddin
  ftr 486 ltr 636
  fcset 1 lcset 1
```

```
  secs 12
  listpath list
  logpath ./$LINENAME-stack.log
  end
end

prout
  fno 0 lno 9999999 ftr 1 ltr 1 noinc 10 end
end

geom
  type 2 # Fixed marine geometry
  fs 1 ls 999999 # all shot have the same parameters (preset)
  gxp 636 -210   # RESET the closest group only.
  ggx -12.5       # used to extrapolate gxp!
  dfls 37.5      # ignored with type 9
  dbrps 6.25
  rpadd 1000 end
end

wbt
   vel 1500 track .1 end
end

gather
   maxtrs 127 maxrps 686 END
end

nmo
# real time nmo, replace interpolation by RP to WB depth in meters.
# If water depth changes by >500 m, use previous value.  Water depth
# velocity functions derived from ESP5, interpolation by iso-velocity layering

   vtrkwb 500 stretc 1
   vintpl 1

   fno 1000 lno 1000
   vtp 1500 1.333
   1557 1.414
   1607 1.443
   1789 1.492
   2346 1.645
   2638 1.746
   2900 1.846
   2971 1.872
   3150 1.983
   3141 2.102
   3264 2.362
   4228 3.742
   4343 3.892
   4898 4.393
   7181 13.470 end

   fno 1500 lno 1500
   vtp 1500 2.0
   1539 2.081
   1574 2.110
   1705 2.159
   2137 2.312
   2379 2.413
   2603 2.513
   2665 2.539
   2827 2.650
   2834 2.769
   2967 3.029
   3939 4.409
   4053 4.559
   7181 13.470 end

   fno 2000 lno 2000
   vtp 1500 2.667
   1529 2.748
   1557 2.777
   1659 2.826
```

```
   2012 2.979
   2218 3.080
   2414 3.180
   2468 3.206
   2614 3.317
   2629 3.436
   2761 3.696
   3711 5.076
   3823 5.226
   4351 5.727
   7122 14.269 end

   fno 2500 lno 2500
   vtp 1500 3.333
   1524 3.414
   1546 3.443
   1629 3.492
   1928 3.645
   2108 3.746
   2282 3.846
   2330 3.872
   2463 3.983
   2481 4.102
   2608 4.362
   3526 5.742
   3636 5.892
   4146 6.393
   7244 13.829 end

   fno 3000 lno 3000
   vtp 1500 4.000
   1520 4.080
   1538 4.110
   1609 4.159
   1868 4.312
   2028 4.413
   2184 4.513
   2228 4.539
   2350 4.650
   2368 4.769
   2489 5.029
   3373 6.409
   3479 6.559
   3972 7.060
   7064 14.051 end

end

filter
  pass 3 60 ftype 0 dbdrop 48 minpha yes end
end

diskoa # Write out disk file
  opath $OUTDIR/$LINENAME-stack.segy
  end
end

end
eof
```

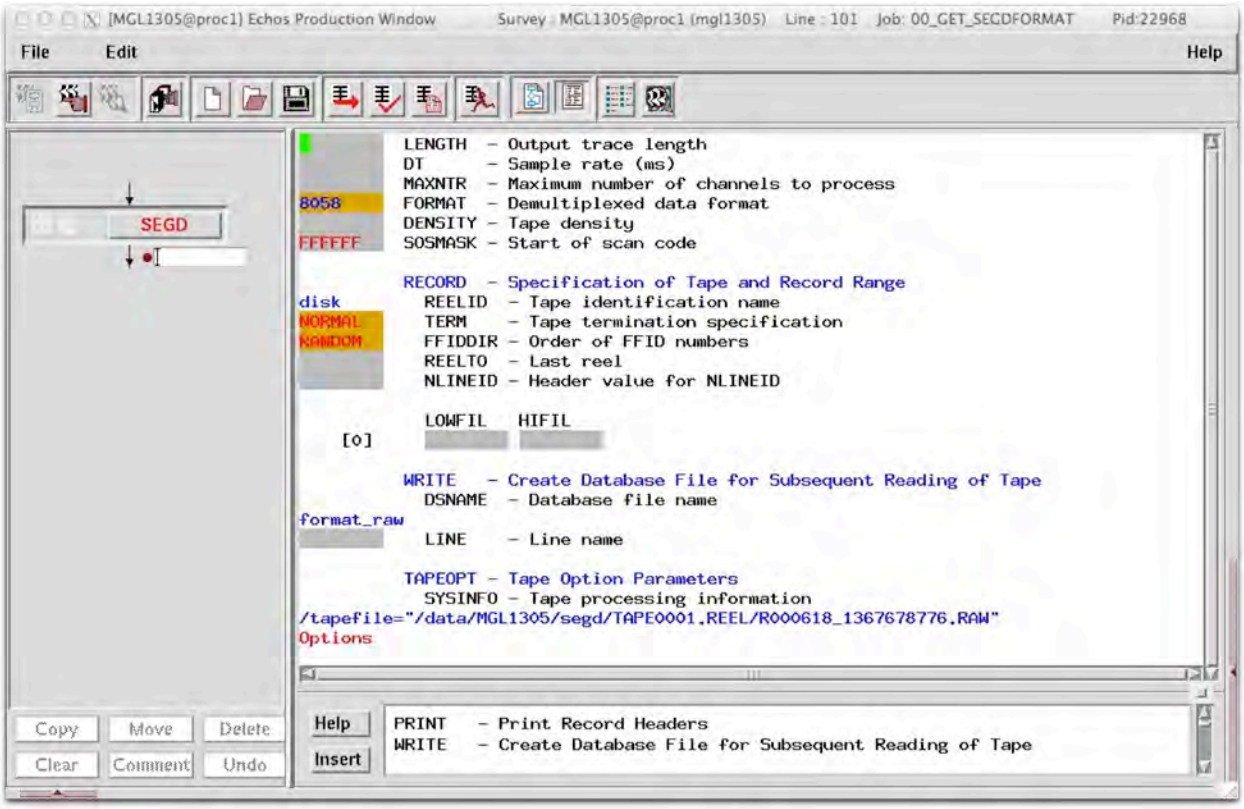
***sioseis* script `fk_migration.com`**

```
#!/bin/csh -f

set LINENO=$1 # Line number
set CDP_FIRST=$2 # First CDP#
set CDP_LAST=$2 # Last CDP#

set LINENAME=MGL1305Line$LINENO
set STACKDIR=/data/seismic/MGL1305/sioseis/stacks
set OUTDIR=/data/seismic/MGL1305/sioseis/migrated

/lhome/pgadmin/sioseis/sioseis-2011.2.20/sioseis<<eof

procs diskin tx2fk fkmigr fk2tx diskoa end

diskin
   ipath $STACKDIR/$LINENAME-stack.segy end
end

tx2fk
   nxpad 2000
   PATH1 ./dummy
   PATH2 ./dummy2 end
end

fkmigr
   vel 1500
   deltax 6.25
   deltat .002 end
end

fk2tx
   PATH1 ./dummy3
   PATH2 ./dummy4 end
end

diskoa  #Write out disk file
   opath $OUTDIR/$LINENAME-mig.segy
end end

end
eof
```

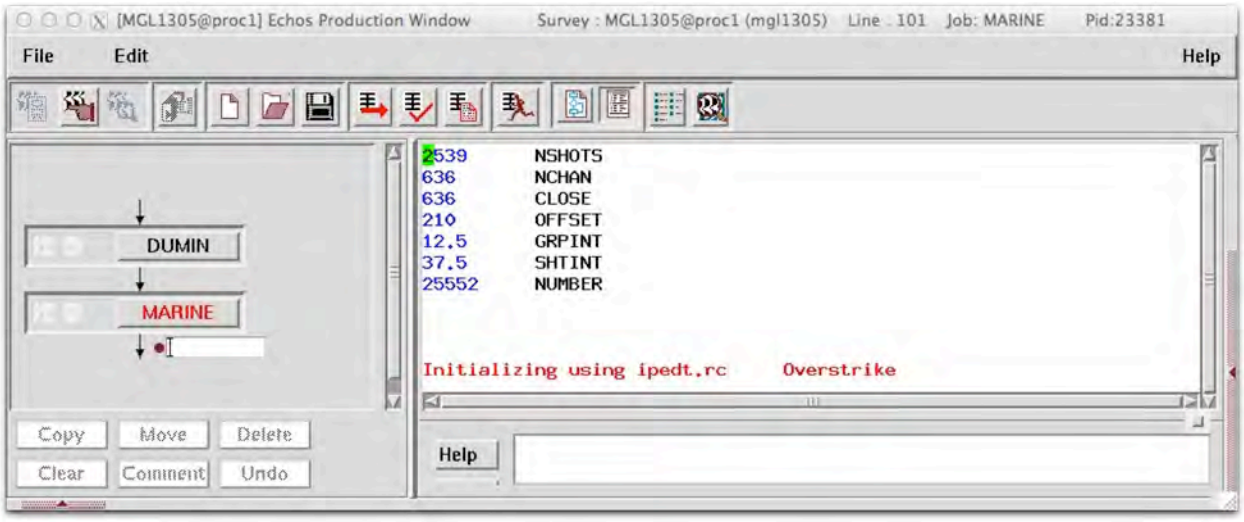
A.10.2. *Echos* Processing.

Step 1 was to create a database file containing the information of the SEG-D format. To do this we used the *Echos* job `00_GET_SEGDFORMAT.DAT`. The job used *Echos'* module `SEGD` to read one raw shot file (any) specified in the parameter `TAPEOPT` and write a database file `format_raw` with the format of the SEG-D header. This step was done only once for Line 101. Afterwards, the file `format_raw` was copied from one line to the next one using *Echo's* `SeisDataDB Utility (SDB)`.

Step 2 was to create a 2D geometry. Although later on we would merge the data with the true geometry from the P190 files, this step was convenient for more data QC analysis, displaying CDPs, and let watchstanders visualize the data and do some processing like water-column stacking or picking traveltimes of first arrivals. We used *Echos* module MARINE to define the 2D geometry. Number of shots and first shot number were retrieved from the Observer's log. All other geometry parameters were constant and taken from the MCS Acquisition parameter table (Appendix 7).



`00_GET_SEGDFORMAT` job for extracting the format of the raw SEG-D headers.



`MARINE` job for creating a 2D geometry.

Step 3 was to read all of the raw shot files from one line into *Echos*. This was done using the Echos job 01_READ_SEGD.DAT. This job read the raw SEG-D files, assigned them 2D geometry using the PROFILE Echos module, and save them to database with the name "shots". Module SEGD create a series of useful headers. This module require a list of the raw files. For example, for Line 101 this was created executing:

```
ls /data/seismic/MGL1305-segd/TAPE0001/R*.RAW /data/seismic/MGL1305-segd/TAPE0002/R*.RAW | awk '{print
NR,$0}' > list_101
```

In cases where there were missing shots or shots with bad headers, running the 01_READ_SEGD.DAT failed because of *Echos'* inability to skip shot files with bad headers. To overcome this, we inspected the partially created "shots" file in *Echos* database and took note of the last shot number written. We used this information to locate the file with bad shot headers. For example, in the case of Line 103 illustrated in the figures, the job crashed after reading file (REELTO) 2396. One can inspect the header for this file by executing:

```
strings `awk '($1==2396) {print $2}' list_103` | head
```

The result is an ascii string that contains the following:

```
13MCS103

0008            MGL1305         MARCUS LANGSETH

$11104000203222650.74189020130505UTC036066      MGL1305MC103    36.422104  -33.6060202336.7    36.421025  -
33.607988  58.0  48.7  4.4*GCS900988305MC10300000360660fE13/05/05:22:27:121440360002000070660 0  0.000.000
0000000000000000000000001AP1N 00014516000300002AP1N 00015316000000003AP1N
```

where the shot# is highlighted in yellow. If one executes the same for the following file (2397):

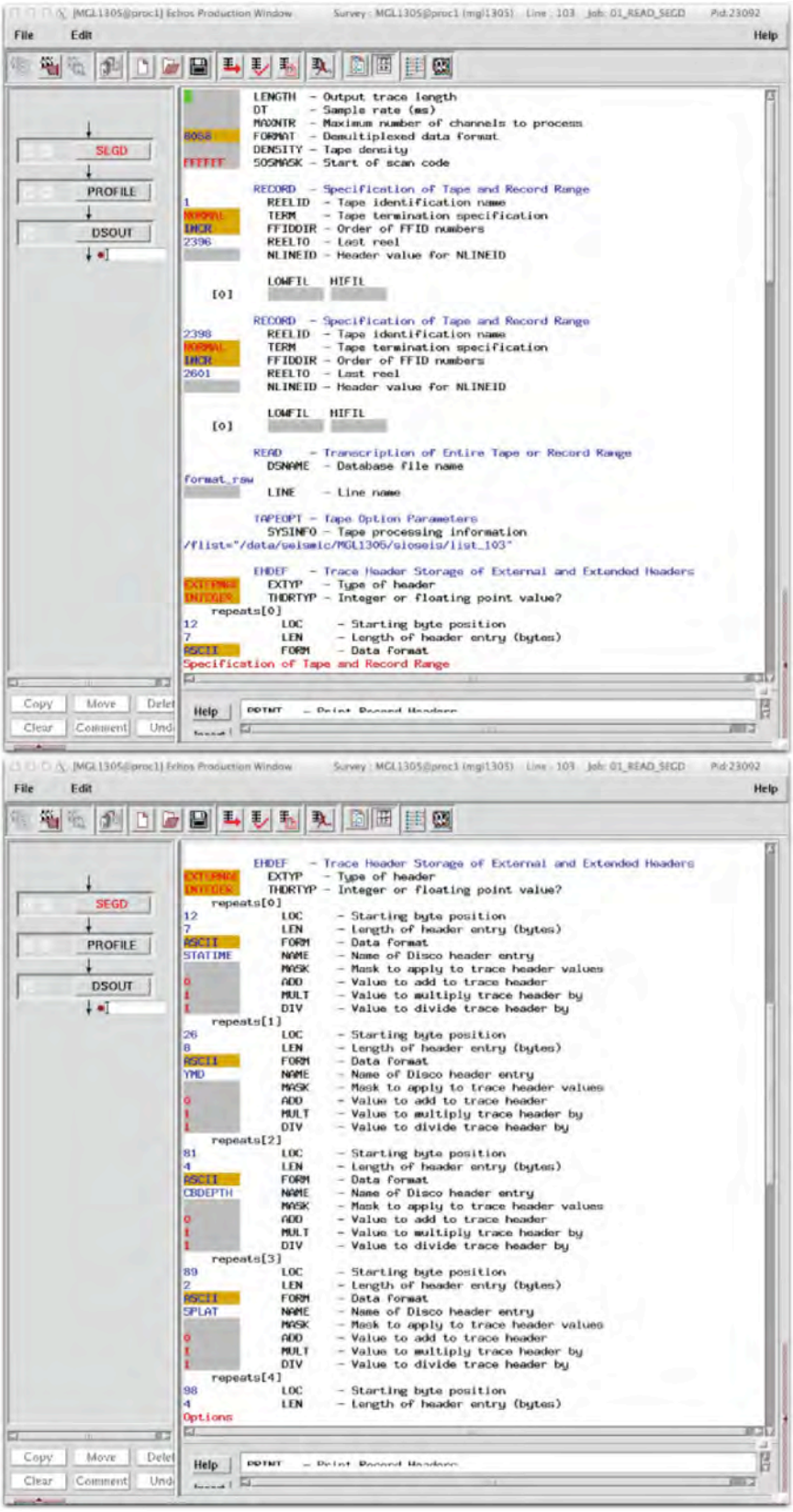
```
strings `awk '($1==2397) {print $2}' list_103` | head
```

The results i an ascii string that contains the following:

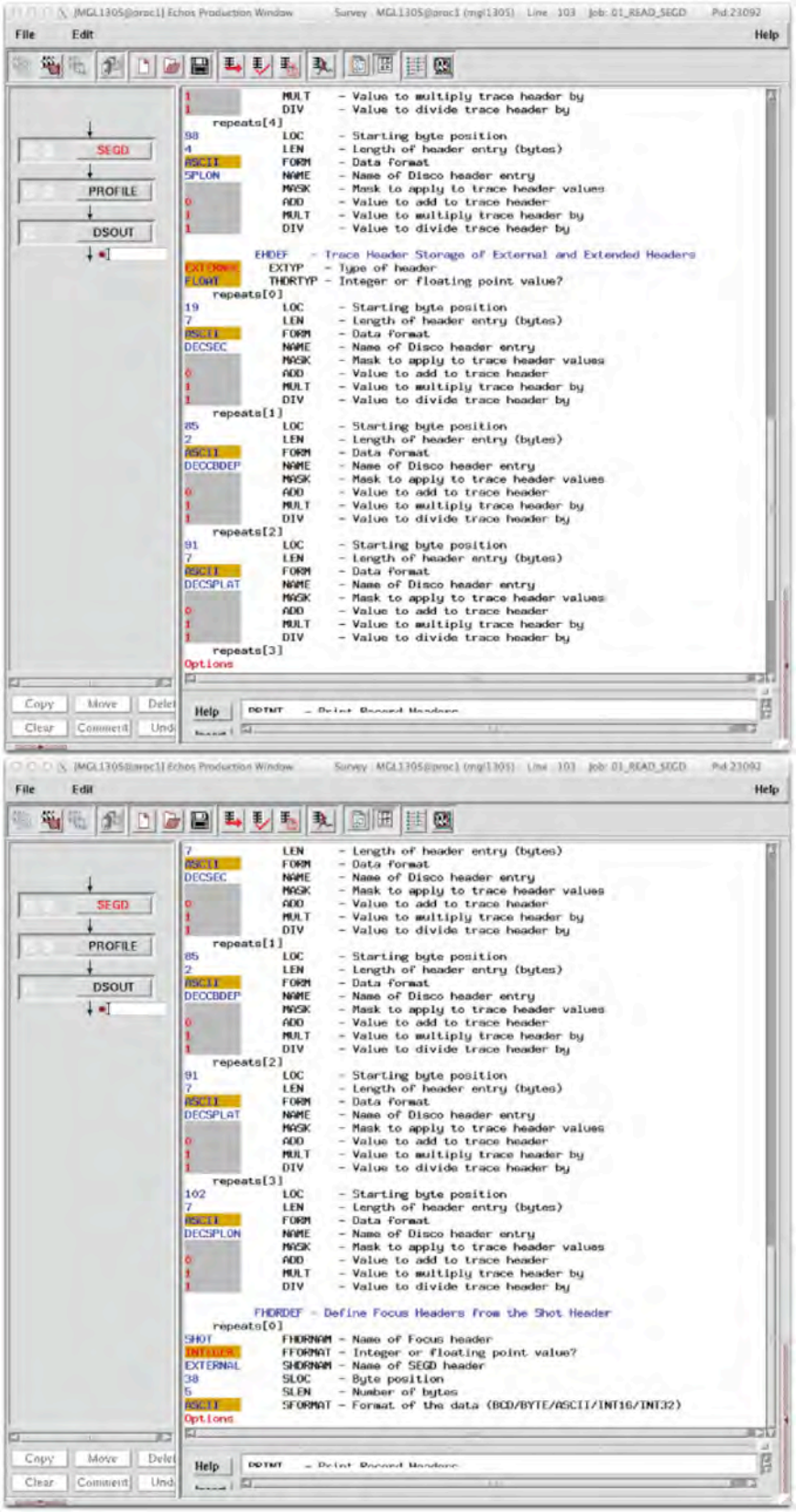
```
13MCS103

0008            MGL1305         MARCUS LANGSETH

>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
```

Therefore we modified the `SEGD` module to skip this bad file by adding a new `RECORD` parameter: the first `RECORD` reads from `REELID 1` to `REELTO 2396`, while the second `RECORD` reads from `REELID 2398` to `REELTO 2601`. This effectively skips file# 2397. In some cases we were able to read the whole line without skipping any files, while in some lines they required skipping a few files.

Another inconvenience was that SEGD cannot read shot numbers that start with "0". Thus, when reading raw files form Line 123, the 01_READ_SEGD.DAT had to be run twice for shot #s above and below 100,000, with DSOUT using option "APPEND" in the second run. For shot #s above 100,000 the parameters in FHDRDEF had to be change to SLOC=37, and SLEN=6.



01_READ_SEGD job for reading raw SEG-D files into *Echos* (cont. in next page).



01 READ SEGD job for reading raw SEG-D files into *Echos* (cont. from previous page).

A.10.3. Merging Data and Navigation, and Archiving.

P190 Navigation File

To avoid conflicts with the simple 2D geometry created by `MARINE` for QC, we made different lines in *Echos* for merging the data with the P190 geometry. Foe each line we created a "XXX_geom" line (where XXX is the line number, e.g., 101_geom). Within this lines, we simply linked the data from the database (database file "shots") for each corresponding line, using the "Data Management" application. The following described the steps taken after the data was linked.

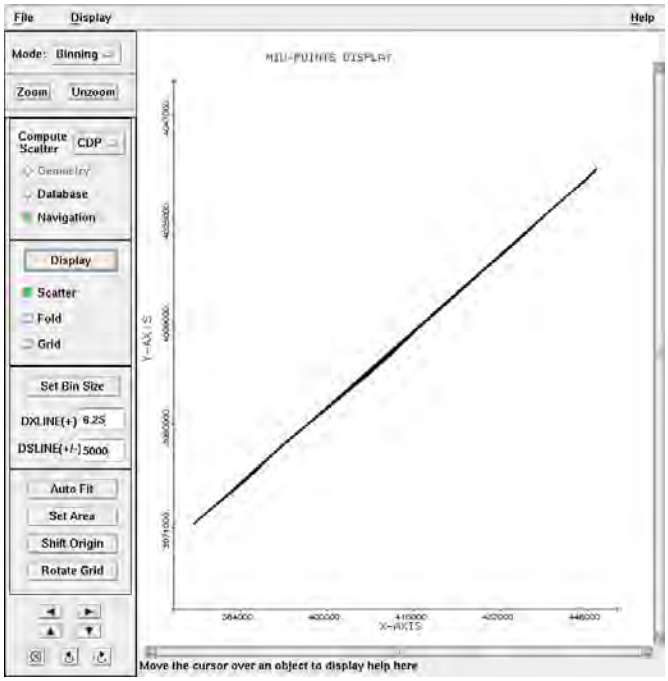
In *Echos* open a `02_NAVDISK_LineXXX.DAT` job. In the NAVDSK module, change the FILE parameter to the name of the P190 file. In the NAVWRT module, change the FILE parameter to the output *Echos* navigation file (keep the directory and extension, .fmt, unchanged): `/data/seismic/MGL1305/geometry/FMT/LineXXX.fmt`

Save and run the job.

Check the *Echos* Geometry. In the main *Echos* window, select the "Geometry Tools" tab and then "Geometry 3D". In the geometry window, change the button MODE to QC. Select "File > Select Navigation …", and choose the `LineXX.fmt` navigation file.

Click "Marine Display" button. You will see a display of the streamer and shot positions. Zoom in to check it out. Zoom out. Make sure it displays the line name correctly.

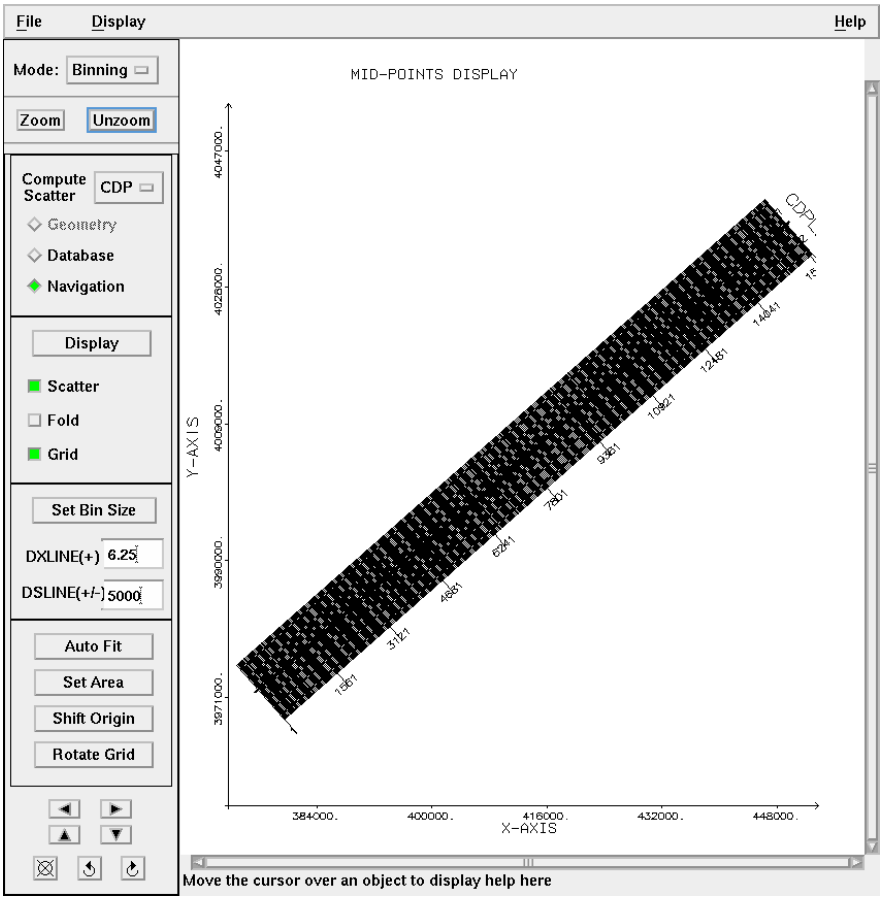
Select "Single Cable", then "Marine Display". Now select one shot and click Apply. Repeat this for more shots, approx. every 50 shots, to make sure that geometries look ok.



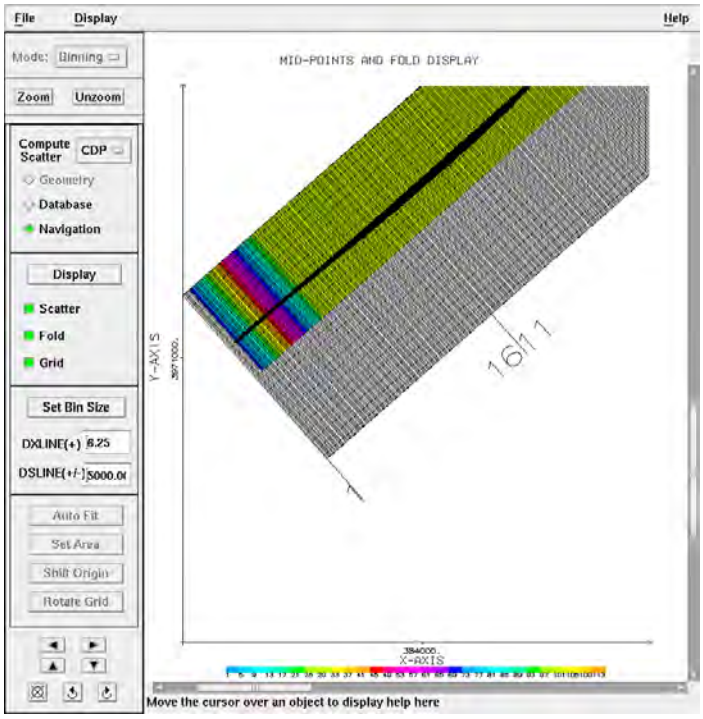
Create a CDP model. In the geometry window, change the button MODE to

BINNING. Set DXLINE to 6.25 and DSLINE to 5000. Select "Set Bin Size". Select CDP for "Compute Scatter."

Click the "Auto Fit" button. Select one point on the plot past the end of the displayed Line with the left mouse button, select another point past the other end of the displayed line with the right mouse button. The best grid will not include empty bins on the edges, but will not have any midpoints outside of the grid. Zoom in on the edges of the line and adjust the grid using the "Set Area", "Shift Origin", and "Rotate Grid" buttons until the grid looks good. Select Fold and then Display to aid in visualizing the fit of the grid.

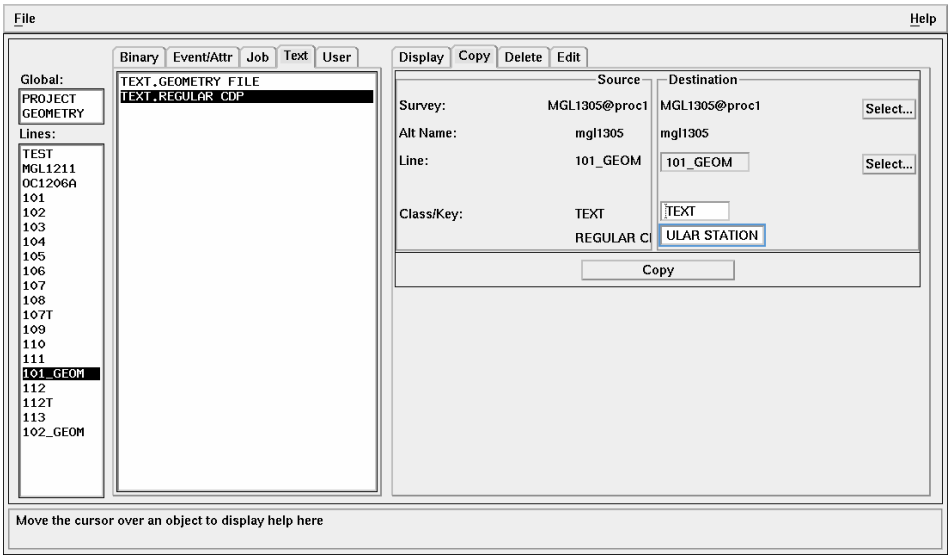


Once a suitable grid has been created select "Display > CDP Model Parameters" and change" Number of Slines" from 1 to 2. Zoom in on the grid and notice a second grid has been generated adjacent to the original. Verify that no points fall into the second grid using the Fold colors as a guide. Adjust the original grid if necessary.



Select File > Create CDP Model. Then File > Save Scatter data … . and File > Save Fold…

Duplicate the TEXT.REGULAR CDP to REGULAR.TEXT STATION in the SeisDataDB Utility. In the main *Echos* window select the "Data Management" tab and then the "SeisDataDb (SDB) Utility" button. Select the current line from the list. Click the "Text" tab. Select the "TEXT.REGULAR CDP" file then the "Copy" tab. Change the name field from REGULAR CDP to REGULAR STATION. Click "Copy".



Merging Data and Navigation, and Archiving .DSK and .SEGY Files

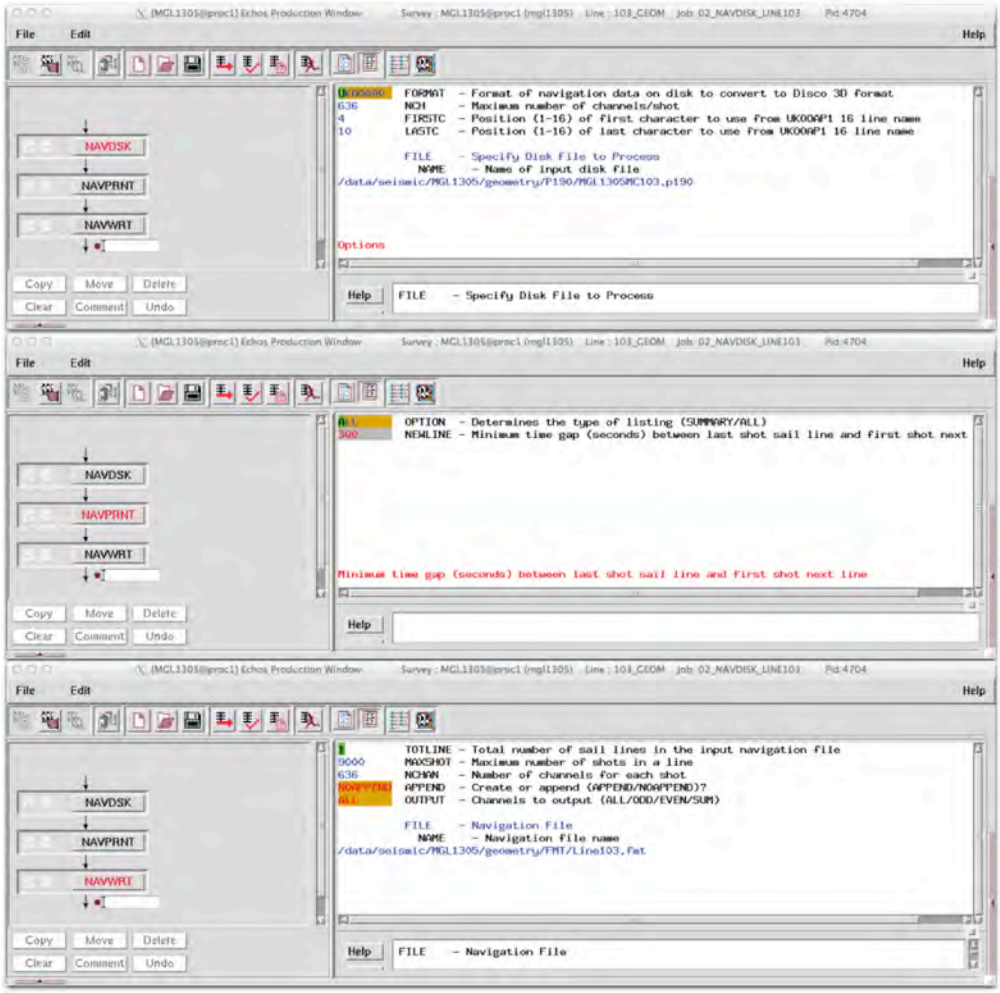
Open the job `03_MERGE_LINEXXX.DAT` in the production window. In the DSIN module select the data file, all records. Check that all shot numbers readable are consistent with the range of shots that were available in the geometry.

In the PROTAPE module, change the FILE parameter to the path and name of the navigation file in *Echos* format, for example: `/data/seismic/MGL1305/geometry/FMT/Line101.fmt`

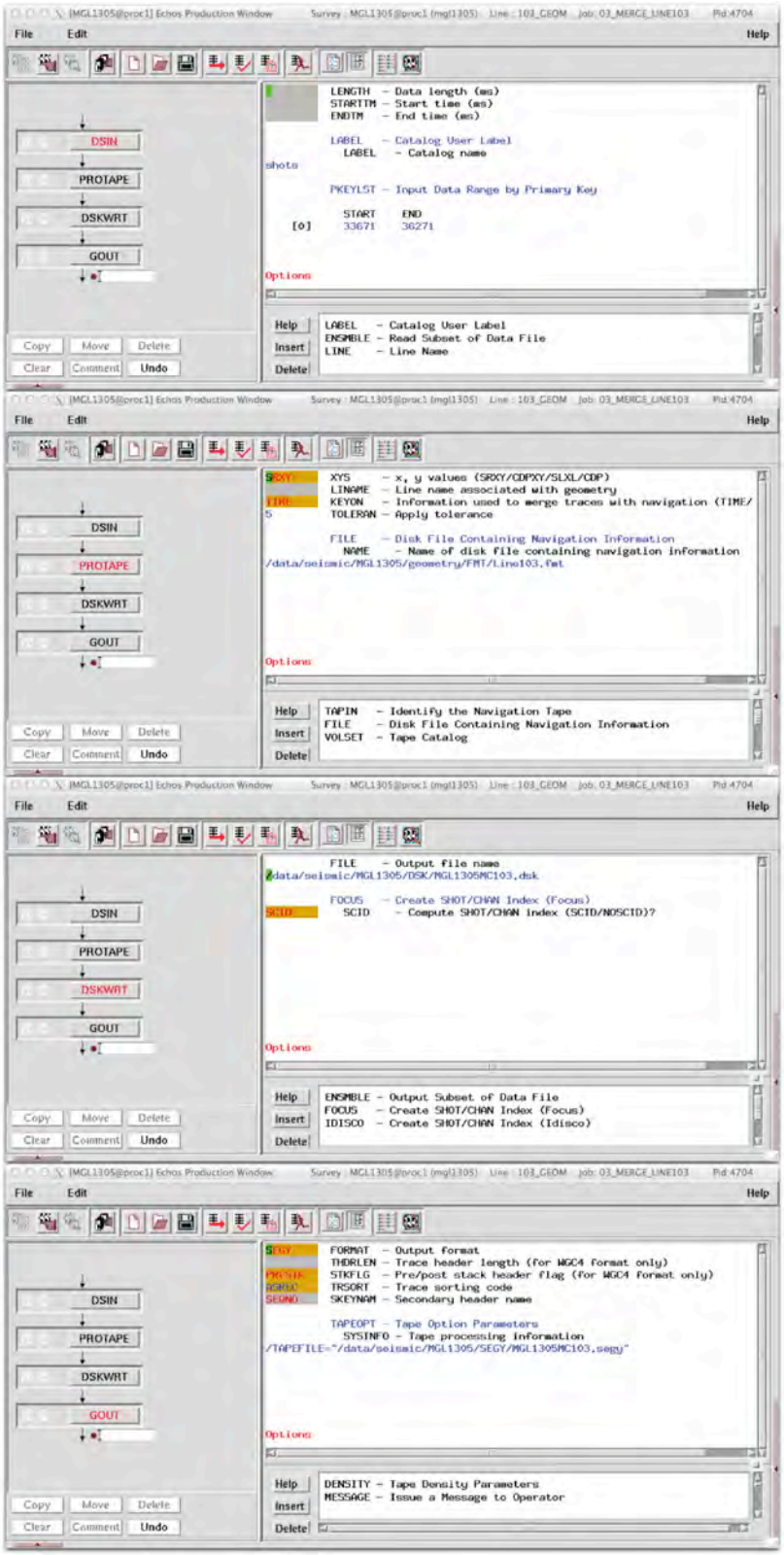
In the DSKWRT module set the File parameter for the output file. Keep the directory as it is: `/data/seismic/MGL1305/DSK/MGL1305MCXXX.dsk`

In the GOUT module set the /TAPEFILE parameter for the output SEGY file. Keep the directory as it is: `/data/seismic/MGL1305/SEGY/MGL1305MC102.segy`

Save job (with new name) and run.

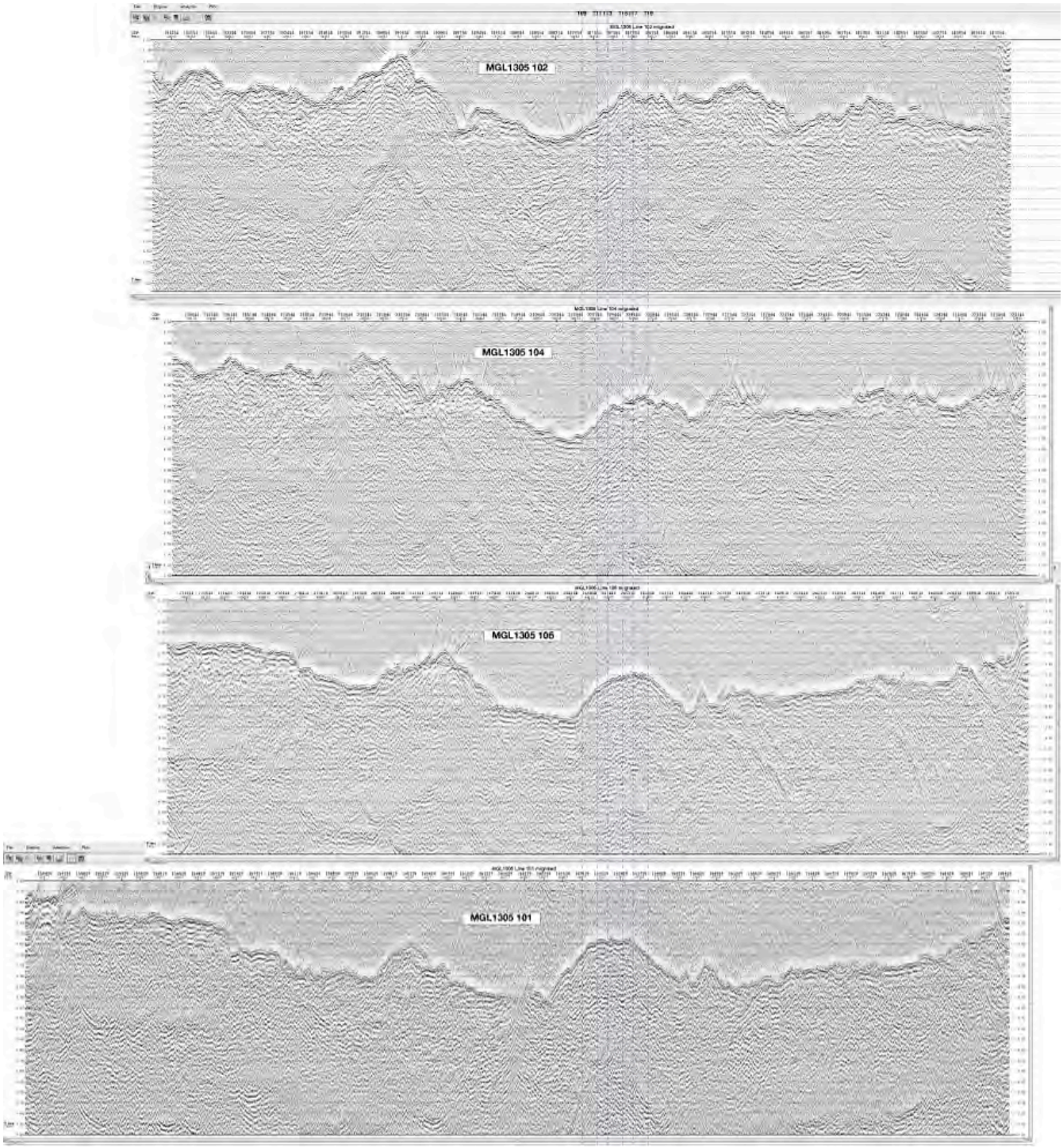


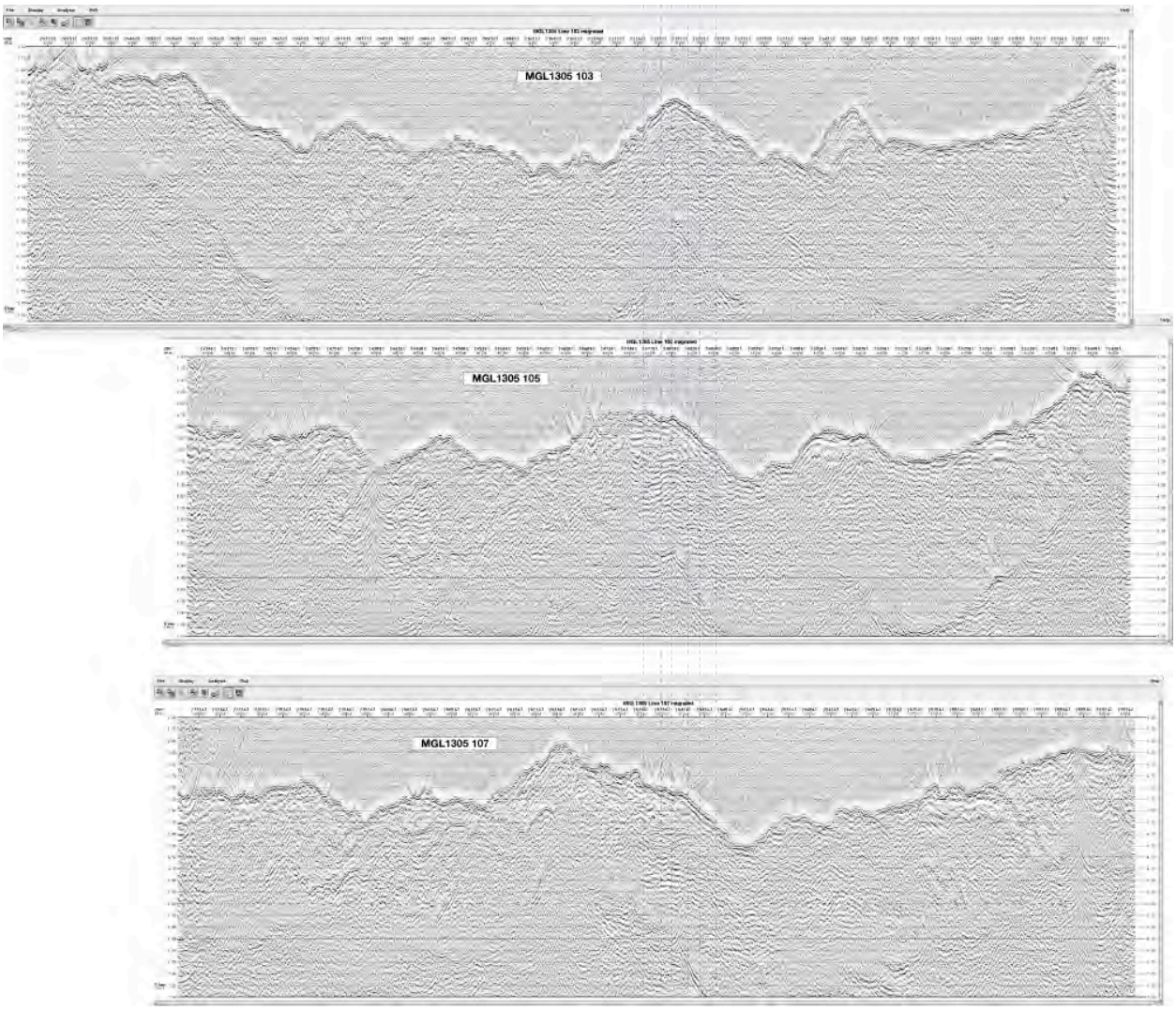
`02_NAVDISK_LineXXX.DAT` job for reading P190 files and converting them into *Echos* format.

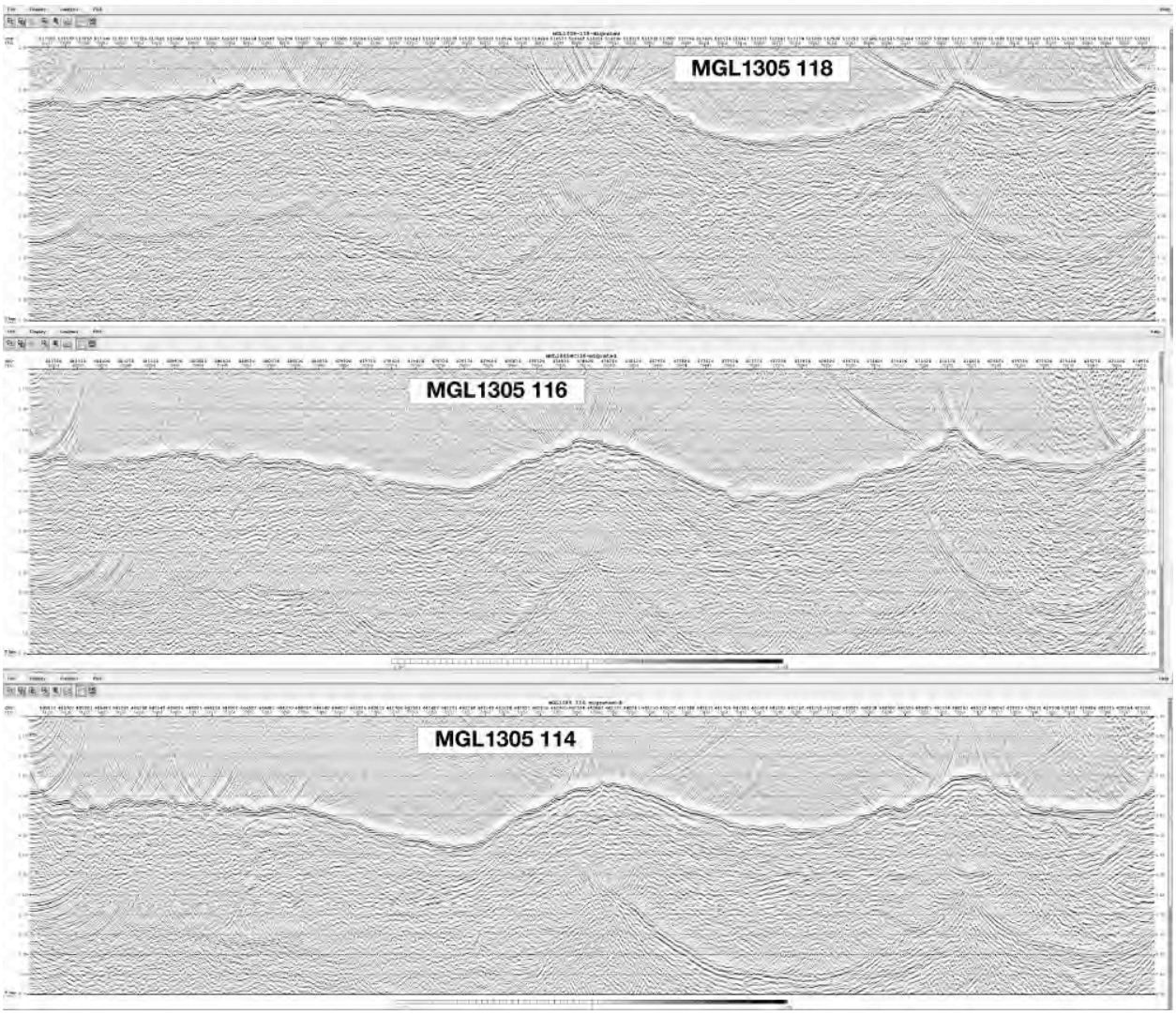


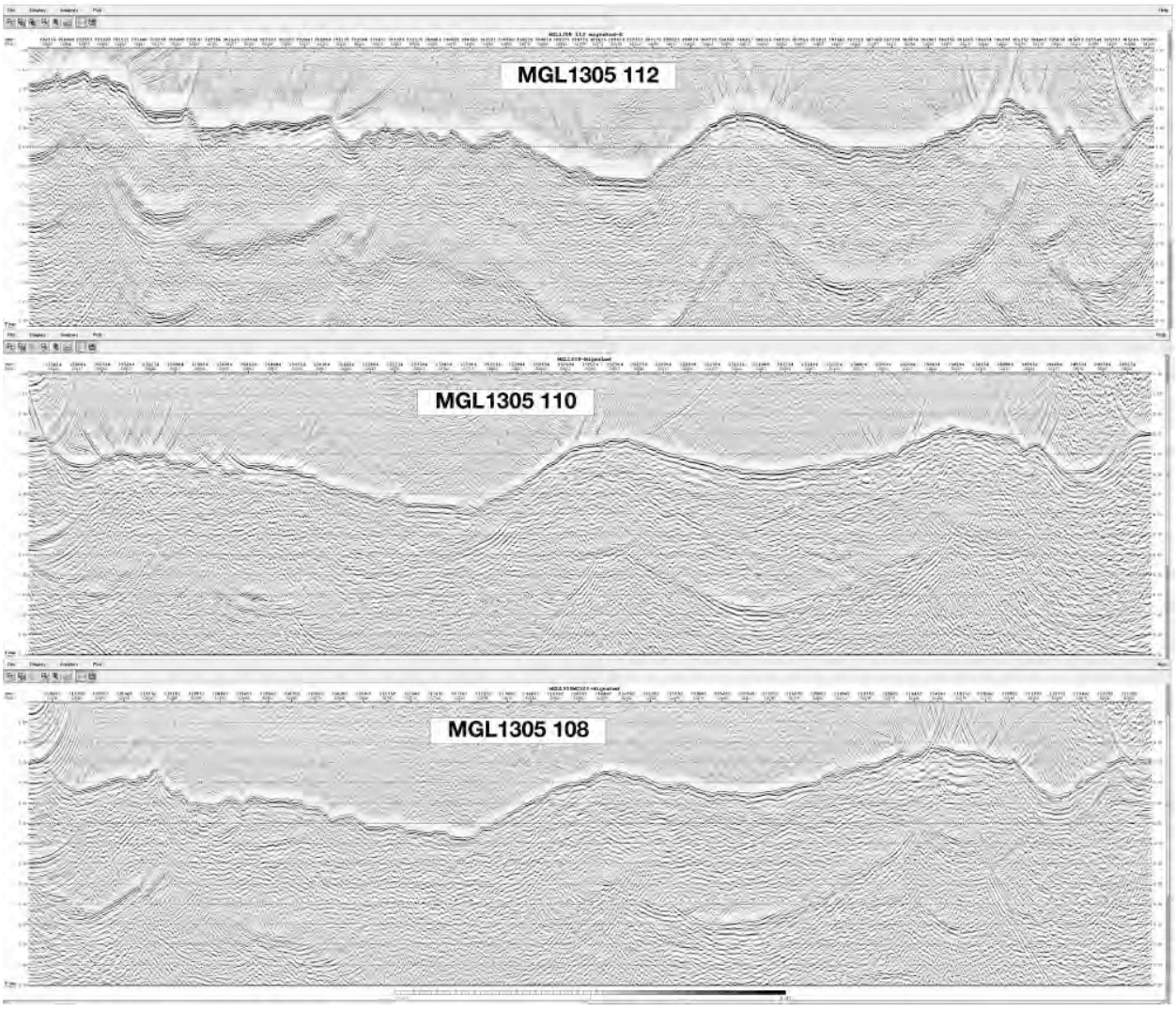
03_MERGE_LINEXXX.DAT job for merging shot gathers with geometry, and archiving in .dsk and .segy formats.

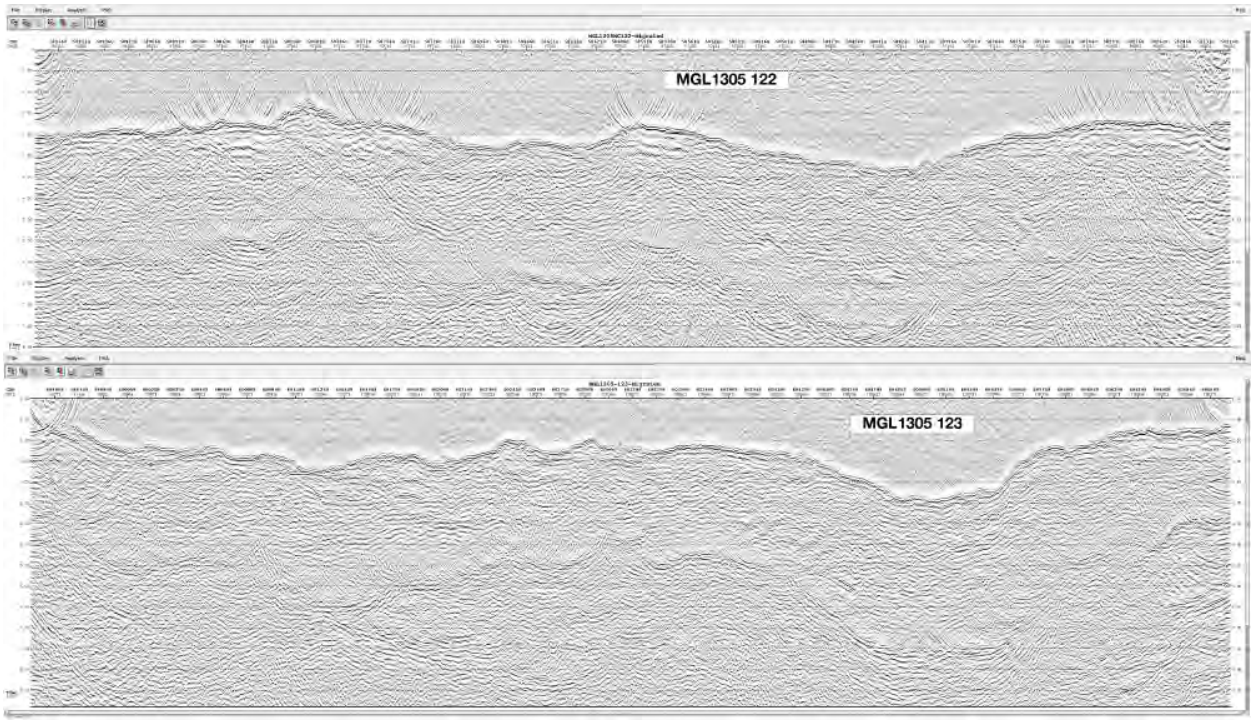
A.11. MCS Sections




MGL1305 103
MGL1305 105
MGL1305 107


MGL1305 118
MGL1305 116
MGL1305 114


MGL1305 112
MGL1305 110
MGL1305 108


MGL1305 122
MGL1305 123

A.12. Multibeam Bathymetry Edited Files and Processing Scripts

Summary of hand-edited multibeam bathymetry raw files		
Julian day	Date	Cleaned files
107	17/04/2013	199/232
108	18/04/2013	247/295
109	19/04/2013	296/343
110	20/04/2013	344/391
111	21/04/2013	392/439
112	22/04/2013	440/487
113	23/04/2013	488/005 + 010/014
114	24/04/2013	048/050
115	25/04/2013	no data
116	26/04/2013	051/052
117	27/04/2013	090/093
118	28/04/2013	136/138
119	29/04/2013	x
120	30/04/2013	229/276
121	01/05/2013	277/316 + 318
122	02/05/2013	x
123	03/05/2013	x
124	04/05/2013	022/029 + 041/044
125	05/05/2013	080/088
126	06/05/2013	152/156
127	07/05/2013	x
128	08/05/2013	207/211 + 221/224 + 235/239
129	09/05/2013	275/276
130	10/05/2013	x
131	11/05/2013	029 + 031
132	12/05/2013	x
133	13/05/2013	136/137
134	14/05/2013	x
135	15/05/2013	x
136	16/05/2013	x
137	17/05/2013	x

wrap.sh script

```
#! /bin/bash
# Wrapper script to automate copying multiple days
# worth of data using the script copy.sh
# Michele Paulatto - University of Oxford - 25/04/2013



month=05
for day in 11 12 13
do
  echo "Working on" $day
  ./copy.sh $day $month
  cd 2013/$month/$day
echo "** Runnin mbprocess to apply edits"
  mbprocess -Idatalist.mb-1
  cd ../../..
done
echo "*** All done ***"

exit
```

copy.sh script

```
#! /bin/bash
# Script to copy .all multibeam files from raw directory to working directory
# and convert them to .mb59 format used onboard RV Marcus Langseth
# during cruise MGL1305
# Input: day and month to copy
# Michele Paulatto - University of Oxford - 25/04/2013
##

COPY=1
LIST=1
CLEAN=1

day=$1
iday=`echo $day | awk '{printf "%2i",$1}'`
month=$2
imon=`echo $month | awk '{printf "%2i",$1}'`
echo $iday $imon

dir=`pwd`
arch=/data/MGL1305/Desktop/Rainbow/Bathy/mb/MGL1305/2013/${month}/${day}
cd ${arch}

if [ $COPY -eq 1 ]; then

  if [[ $imon -eq 4 && $iday -lt 23 ]]; then
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305/2013/${month}/${day}
### Copy files
    echo " Copying files from" $raw
    cp ${raw}/*.all $arch

  elif [[ $imon -eq 4 && $iday -eq 23 ]]; then
### Copy files
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305/2013/${month}/${day}
    cp ${raw}/*.all $arch
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305A/2013/${month}/${day}
    cp ${raw}/*.all $arch
    echo " Copying files from" $raw

  elif [[ $imon -eq 4 && $iday -gt 23 ]]; then
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305A/2013/${month}/${day}
### Copy files
    echo " Copying files from" $raw
    cp ${raw}/*.all $arch
```

```
  elif [[ $imon -eq 5 && $iday -le 2 ]]; then
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305A/2013/${month}/${day}
### Copy files
    echo " Copying files from" $raw
    cp ${raw}/*.all $arch
  elif [[ $imon -eq 05 && $iday -eq 3 ]]; then
### Copy files
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305A/2013/${month}/${day}
    cp ${raw}/*.all $arch
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305B/2013/${month}/${day}
    cp ${raw}/*.all $arch
    echo " Copying files from" $raw
  elif [[ $imon -eq 5 && $iday -gt 3 && $iday -lt 10 ]]; then
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305B/2013/${month}/${day}
### Copy files
    echo " Copying files from" $raw
    cp ${raw}/*.all $arch
  elif [[ $imon -eq 05 && $iday -eq 10 ]]; then
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305B/2013/${month}/${day}
    cp ${raw}/*.all $arch
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305C/2013/${month}/${day}
    cp ${raw}/*.all $arch
    echo " Copying files from" $raw
  elif [[ $imon -eq 5 && $iday -gt 10 ]]; then
    raw=/data/MGL1305/Cruisedata/raw/multibeam/MGL1305C/2013/${month}/${day}
### Copy files
    cp ${raw}/*.all $arch
    echo " Copying files from" $raw

  fi

### Now create datalist and convert to .mb59
  ls -1 *.all > list
  filelist=`cat list`
  for file in $filelist
  do
    suffix=`echo $file | awk '{ gsub(".all","_raw"); print $1}'`
    outfile="${suffix}.mb59"
    echo " Converting" $file "to" $outfile
# Use mbcopy to convert data format
#    mbcopy -I$file -F58/59 -O$outfile
# Use mbkongsebergpreprocess instead of mbcopy
    mbkongsbergpreprocess -I$file -O$outfile -F58 -S1/12 -S2/12 -S3/18
# Set parameter for recalculation of backscatter data
    mbset -I$outfile =PSSRECALCMODE:1
    rm $file
  done
  rm list
fi

### Generate datalist and create ancillary files
echo "** Generating datalist and creating ancillary files"
if [ $LIST -eq 1 ]; then
  ls -1 *Langseth_raw.mb59 > list
  mbdatalist -Ilist -F-1 > datalist.mb-1
  mbdatalist -Idatalist.mb-1 -O
  rm list
fi

### Run mbclean
if [ $CLEAN -eq 1 ]; then
  echo "** Running mbclean"
  mbclean -Idatalist.mb-1 -M1 -C86/2 -D0.01/0.20 -S55/3/2 -G0.80/1.20
  echo "** Automated cleaning done"
fi

cd $dir

echo "*** copy.sh done ***"
exit
```

`gridMGL1305.sh` shell script to grid the multibeam bathymetry data

```
#! /bin/bash
# Script to grid and plot cruises

area1=-R-34:30/-33:15/35:40/36:50 # area to grid and plot
area=-R-34:25/-33:20/35:45/36:45 # area to grid and plot
proj=-Jm20              # map projection for plotting
cpt=CPT/depth.cpt       # color palette
speed=4                 # minimum speed to output (km/h)
inc=0.00020

makecpt -Chaxby -T-3400/-400/100 -I > $cpt

LIST=1
GRIDGMT=1
STATS=1

set=unclean

xyz=XYZ/MGL1305_${set}.xyz
mean=XYZ/MGL1305_${set}_mean.xyz
surf=GRD/MGL1305_${set}_surf.grd
grid=GRD/MGL1305_${set}.grd

## Export xyz points using mblist
if [ $LIST == 1 ]; then
echo " Exporting mb data to xyz with mbgrid"

## MGL1305 clean data
echo "MGL1305 clean"
mblist -Idatalist_MGL1305_${set}.mb-1 $area1 -S$speed -D2 -A > $xyz

## MGL1305 semi-clean data
#echo "MGL1305 raw"
#mblist -Idatalist_MGL1305_semi.mb-1 $area1 -S$speed -D2  \
#| awk '{print $1,$2,$3,0.1}' > XYZ/MGL1305_semi.xyz
## MGL1305 unclean data
#echo "MGL1305 raw"
#mblist -Idatalist_MGL1305_unclean.mb-1 $area1 -S$speed -D2  \
#| awk '{print $1,$2,$3,0.01}' > XYZ/MGL1305_unclean.xyz
fi

# Grid point cloud
echo " Gridding exported point cloud ..."
if [ $GRIDGMT == 1 ]; then

  blockmedian $xyz -I$inc $area1 -V -bi3 -bo3 > $mean
  surface $mean $area1 -I6201+/5801+ -T0.5 -Gtemp.grd -V -bi3
  grdsample temp.grd $area -I$inc -G$surf

  echo " Calculating mask ..."
  grdmask $mean $area -I$inc -S0.080k -Gmask.grd -NNaN/1/1 -bi3
  grdmath $surf mask.grd MUL = $grid
fi

exit

# Calculate and grid standard deviation
if [ $STATS == 1 ]; then
  inc=100e
  blockmedian XYZ/all.xyz -I$inc $area1 -V -E -Wi > XYZ/all_std.xyz
  awk '{print $1,$2,$4}' XYZ/all_std.xyz /
| xyz2grd -I$inc $area -GGRD/rainbow_all_std.grd -V

fi

echo " Done"
exit
```

A.13. Multibeam Backscatter Processing Scripts

```
#!/bin/csh
######################################################################
######################################################################
# For Kongsberg EM122 data
#
#  reads data from a third generation Kongsberg multi-beam sonar
#  (e.g. EM122, EM302, EM710), interpolates the asynchronous navigation,
#  heading,  and  attitude onto the multibeam data, and writes a new
#  file with that information correctly  embedded  in  the  multibeam
#  survey data.
#
set VERSION = 0.1
#
# R Dunn - UH
#
######################################################################
######################################################################
echo " "
echo Script $0 version $VERSION at `date`
echo " "
######################################################################
######################################################################
set CRUISE_LIST = " MGL1305 "
set YEAR_LIST = " 2013 "
set MONTH_LIST = " 04 05 "
set DAY_LIST = " 01 02 03 04 17 18 19 20 21 22 23 24 26 27 28 29 30 "
set CONVERT = 1
set BASEDIR = /Users/RD/WORK/Research/MGL1305/MultiBeam/

######################################################################
######################################################################
if ($CONVERT) then
   /bin/rm -r datalist_raw.mb-1
   foreach CRUISE  ( `echo $CRUISE_LIST` )
   foreach YEAR    ( `echo $YEAR_LIST` )
   foreach MONTH   ( `echo $MONTH_LIST` )
   foreach DAY     ( `echo $DAY_LIST` )
      set DIR = $BASEDIR/$CRUISE/$YEAR/$MONTH/$DAY/
      if (-e $DIR) then
         echo $CRUISE $YEAR $MONTH $DAY
         foreach FILE ($DIR/*.all)
            if (-e $FILE) then
            if ($FILE != $DIR"/9999.all") then
                  echo $FILE 58 >> datalist_raw.mb-1
            endif
            endif
         end
      endif
   end
   end
   end
   end
   mbkongsbergpreprocess -F-1 -Idatalist_raw.mb-1 -V
endif
######################################################################
######################################################################
# To turn on sidescan re-calculation use this command:

/bin/rm -r datalist_59.mb-1
foreach CRUISE  ( `echo $CRUISE_LIST` )
foreach YEAR    ( `echo $YEAR_LIST` )
foreach MONTH   ( `echo $MONTH_LIST` )
foreach DAY     ( `echo $DAY_LIST` )

   set DIR = $BASEDIR/$CRUISE/$YEAR/$MONTH/$DAY/
   if (-e $DIR) then
      echo $CRUISE $YEAR $MONTH $DAY
      foreach FILE ($DIR/*Langseth.mb59)
         if (-e $FILE) then
             echo $FILE 59 1.0 >> datalist_59.mb-1
         endif
      end
```

```
   endif
end
end
end
end
mbset -F-1 -Idatalist_59.mb-1 =PSSRECALCMOD:1 -V
######################################################################
######################################################################
```

```
#!/bin/csh
# PROCESS AMPLITUDE DATA and OPTIONALLY GRID the DATA
#
set VERSION = 0.2
#
# R Dunn - UH
#
######################################################################
echo " "
echo Script $0 version $VERSION at `date`
echo " "
######################################################################
/bin/rm  datalist-mb59-1
/bin/rm  datalist-pmb59-1
######################################################################
set GFN  = mba.grd
set OFN  = survey_map.ps
set BASEDIR = "~/WORK/Research/MGL1305/MultiBeam/"
set CRUISE_LIST = " MGL1305 "
set YEAR_LIST = " 2013 "
set MONTH_LIST = " 04 05 "
set DAY_LIST = " 01 02 03 04 05 06 07 08 09 10 17 18 19 20 21 22 23 24 26 27 28 29 30 "
set RANGE = "-34:30/-33:24/35:45/36:45"
set SPEEDCUT = 4.5
set XINC  = 0.0010
set YINC  = 0.0010

set PREPROCESS_DATA = 1
set PROCESS_DATA    = 1
set EXPORT_DATA     = 1
set GRID_DATA       = 1
set MAP_DATA        = 1
######################################################################

echo "Filling the filename list"
foreach CRUISE  ( `echo $CRUISE_LIST` )
foreach YEAR    ( `echo $YEAR_LIST` )
foreach MONTH   ( `echo $MONTH_LIST` )
foreach DAY     ( `echo $DAY_LIST` )
   set DIR = $BASEDIR/$CRUISE/$YEAR/$MONTH/$DAY/
   if (-e $DIR) then
      echo $CRUISE $YEAR $MONTH $DAY
      foreach FILE ($DIR/*Langseth.mb59)
         if (-e $FILE) then
            echo $FILE 59 >> datalist-mb59-1
         endif
      end
   endif
end
end
end
end
######################################################################

if ($PREPROCESS_DATA) then

   echo "Pre-Processing Data"
#   echo "   Pre-Cleaning Data"
#   mbclean     -F-1 -Idatalist-mb59-1 -S65/2/2 -D0.001/1 -V
   echo "   Computing backangles"
   mbbackangle -F-1 -Idatalist-mb59-1 -N71/70.0 -P220 -V
#   echo "   Setting RE-CALC MODE"
#   mbset       -F-1 -Idatalist-mb59-1 =PSSRECALCMOD:1 -V
```

```
endif

#####################################################################
if ($PROCESS_DATA) then
   echo "Processing Data"
   #use -P with mbprocess to force rebuild.
   mbprocess -F-1 -Idatalist-mb59-1 -V -P
endif

#####################################################################
echo "Filling New File List"

foreach CRUISE  ( `echo $CRUISE_LIST` )
foreach YEAR    ( `echo $YEAR_LIST` )
foreach MONTH   ( `echo $MONTH_LIST` )
foreach DAY     ( `echo $DAY_LIST` )
   set DIR = $BASEDIR/$CRUISE/$YEAR/$MONTH/$DAY/
   if (-e $DIR) then
      echo $CRUISE $YEAR $MONTH $DAY
      foreach FILE ($DIR/*Langsethp.mb59)
         if (-e $FILE) then
            echo $FILE 59 1.0 >> datalist-pmb59-1
         endif
      end
   endif
end
end
end
end

#####################################################################
if($EXPORT_DATA) then
   echo "Exporting Data via Dump"
   if (-e mb.xya.bis) /bin/rm mb.xya.bis
   mblist -F-1 -Idatalist-pmb59-1 -R$RANGE -D4 -L0 -A -S$SPEEDCUT | gmtconvert -bi3 -bos3
>> mb.xya.bis
endif
#####################################################################

if ($GRID_DATA) then
   if (-e mb2.xya.bis) /bin/rm  mb2.xya.bis
   if (-e $GFN) /bin/rm $GFN
   echo "   Gridding Data"
   blockmedian mb.xya.bis -bis3 -R$RANGE -bos3 -I$XINC/$YINC  -V >! mb2.xya.bis
   xyz2grd mb2.xya.bis -bis3 -R$RANGE -G$GFN -I$XINC/$YINC -V
endif
#####################################################################
if ($MAP_DATA) then
   echo "   Mapping Data"
   # MAKE HISTOGRAM EQUALIZED GRAY CPT FILE
   grdhisteq mba.grd -D -C16 -V | \
      awk 'BEGIN {n=200;m=10}{print $1,n,n,n,$2,n-m,n-m,n-m}{n-=m}' >! ss_eq.cpt

#Make the figure
   gmtset PAPER_MEDIA letter
   set SCALE = 7
   set TIC   = a4mf4mWESN
   set OPT = "-R -V -O -K -P"
   gmtset PLOT_DEGREE_FORMAT -ddd:mm:ss
   gmtset ANOT_FONT_SIZE  8p
   gmtset HEADER_FONT_SIZE 12p
   psbasemap -JM$SCALE -R$RANGE -Yc -Xc -B$TIC/:."Wet Foot Survey": -V -K -P >! $OFN
   grdimage $GFN -JM $OPT -V  -Q -Css_eq.cpt -fg  -B$TIC                  >> $OFN
   psbasemap -JM -R -B$TIC -K -P -O  -Lfx0.75i/-0.5i/36.2/30k+lkm+jr          >> $OFN
   psbasemap -JM -R -B$TIC -K -P -O  -Lfx0.75i/-1.0i/36.2/16n+lnmile+jr       >> $OFN
   psscale -Css_eq.cpt -D4.6/-0.9/2.5/.125h -Ba10f10/:"Rel. Intensity": -O  >> $OFN
endif
exit
```

A.14. Gravity Data Processing Scripts, Tie Measurements, and Daily Plots

`get_data` shell script

```
#! /bin/bash

for i in {135..136}
do

indata="../../CruiseData/MGL1305/raw/serial/MGL-bath02.y2013d"$i
outdata="./BATH-FILES/MGL-bath02.y2013d"$i"_new"

awk '{ gsub("\t",",") ; gsub(","," ") ; print $0 }' $indata > tmp

awk '{print $2, $4}' tmp >> tmp2

awk '{ gsub(":","\t") ; print $0 }' tmp2 > $outdata

rm tmp*

indata="../../CruiseData/MGL1305/raw/serial/MGL-cnav.y2013d"$i
outdata="./CNAV-FILES/MGL-cnav.y2013d"$i"_new"

awk '{ gsub("\t",",") ; gsub(","," ") ; print $0 }' $indata > tmp

awk '($3 =="$GPVTG" ){print 1, $2, $4, $7}' tmp >> tmp2
awk '($3 =="$GPGGA" ){print 2, $2, $5, $7}' tmp >> tmp2

awk '{ gsub(":","\t") ; print $0 }' tmp2 > $outdata

rm tmp*

done
```

`mgl1305_grav.m` *matlab* script

```
% Script to process gravity data from RV Langseth gravimeter
%
% This scipt can not read the original files from the cruise data. The
% format has to be change by using the awk-script 'get_data'
%
%
%*************************************************************************
% The script applies the following processing steps:
% 0. Get DC factor from funtion get_dc
% 1. Read raw data files MGL-vc01* from raw/serial directory
% 2. Convert raw counts to mGals
% 3. Read navigation
% 4. Merge data and navigation
% 5. Load bathymetry data
% 6. Calculate Eotvos correction
% 7. Calculate latitude correction
% 8. Apply corrections and output free-air anomaly
% 9. Apply smoothing filter
%
% Note: BGM-3 gravimeter data does not require a cross-coupling
% error correction (see Bell and Watts, 1986)
%*************************************************************************

clear all; close all

datapath1 = '../../CruiseData/MGL1305/raw/serial';
datapath2 = 'CNAV-FILES';
datapath3 = 'BATH-FILES';
BGM3_conversion_factor = 5.0962178;

DC = get_dc;

for jj=35:36
```

```
    ii=100+jj;

    clear data1 file1 year day hour minute sec gcountraw output_freq sensor_status
    clear time samp_freq graw

    data1 = (strcat('/MGL-vc01.y2013d',num2str(ii)));
    file1 = {[datapath1 data1]};


    [year, day, hour, minute, sec, gcountraw, output_freq, sensor_status] =
read_vc01_Langseth(file1);

    time = day + (hour + minute/60 + sec/3600)/24;

    samp_freq = round(mean(output_freq));


    % Conversion of Bell BGM-3 counts to mGal: 5.0962178 mGal/PPS

    graw = gcountraw*BGM3_conversion_factor;


    %%% Nav

    %%% Read the cnav file, and extract time, latitude, course, and
    %%% speed

    clear data2 file2 A n j stime cr sp k ltime lt lo

    data2 = (strcat('/MGL-cnav.y2013d',num2str(ii)));
    file2 = (strcat(datapath2,data2,'_new'));

    A=load(file2);
    n=length(A);

    j=1;
    for i=1:n
    if A(i,1)==1
        stime(i) = A(i,3) + (A(i,4) + A(i,5)/60 + A(i,6)/3600)/24;
        cr(i)=A(i,7);
        sp(i)=A(i,8);
        k=i;
    end

    if  A(i,1)==2
        ltime(j) = A(i,3) + (A(i,4) + A(i,5)/60 + A(i,6)/3600)/24;
        lt(j)=A(i,7);
        lo(j)=A(i,8);
        j=j+1;
    end
    end



    %% Interpolate lat, course, speed at the same time values where we have gravity
values

    clear coure speed dg_lat mm_lat mmmm_lat lat dp_lo mm_lo mmmm_lo long

    course = interp1(stime,cr,time,'spline');
    sp = medfilt1(sp,41);
    speed = interp1(stime,sp,time,'spline');

    dg_lat=floor(lt/100)*100;
    mm_lat=floor(lt-dg_lat);
    mmmm_lat=(lt-dg_lat-mm_lat);

    lat_dg=dg_lat/100 + mm_lat/60 + mmmm_lat/60;

    lat = interp1(ltime,lat_dg,time,'spline');

    dg_lo=floor(lo/100)*100;
    mm_lo=floor(lo-dg_lo);
```

```
    mmmm_lo=(lo-dg_lo-mm_lo);

    long_dg = dg_lo/100 + mm_lo/60 + mmmm_lo/60;

    long = interp1(ltime,long_dg,time,'spline');

    % Read bathymetrie data

    clear data3 file3 B n btime bath

    data3 = (strcat('/MGL-bath02.y2013d',num2str(ii)));
    file3 = (strcat(datapath3,data3,'_new'));

    B=load(file3);
    n=length(B);

    for i=1:n
        btime(i) = B(i,2) + (B(i,3) + B(i,4)/60 + B(i,5)/3600)/24;
        bath(i)=B(i,6);
    end

    bath = medfilt1(bath,21);

    % Calculating Eotvos

    clear eotvos g0 faaraw ttime

    eotvos = 7.5038*speed.*sind(course).*cosd(lat) + 0.004154*speed;



    % Calculating the gravityfield by using IGRF

    g0 = 978032.68*(1+0.00193185138639*sind(lat).*sind(lat))./sqrt(1-
0.00669437999013*sind(lat).*sind(lat));


    % Calculate Free-air anomaly

    faaraw = graw + DC - g0 + eotvos;

    ttime = time;


    %% Filter the raw FAA (faaraw) as done above with a Gaussian filter

    filter_width = 900; % In seconds
    filtcoefs = gaussfiltcoef(samp_freq,1/filter_width);
    N = (length(filtcoefs)-1)/2;
    delay = (N/samp_freq)/3600/24;

    faarawf = filter(filtcoefs,1,faaraw);
    faarawf = faarawf-median(faarawf)+median(faaraw);
    faarawf = interp1(time-delay,faarawf,time);

    faaraw2 = flipud(faaraw);
    faarawf2 = filter(filtcoefs,1,faaraw2);
    faarawf2 = faarawf2-median(faarawf2)+median(faaraw2);
    faarawf2 = interp1(time-delay,faarawf2,time);
    faarawf2 = flipud(faarawf2);

    inan = find(~isnan(faarawf) & ~isnan(faarawf2));

    % These are your final FAA and time values:

    faarawf = faarawf(inan);
    time = time(inan);


    % Plot the different values

    subplot(3,2,1); plot(long,lat);
    title(strcat('Julienday ',num2str(ii),', Long/Lat'));
    set(gca,'YDir','reverse');
```

```
    xlabel('Long (deg)');
    ylabel('Lat (deg)');
    subplot(3,2,3); plot(ttime,graw);
    title(strcat('Julienday ',num2str(ii),', GRAW'));
    subplot(3,2,5); plot(time,faarawf);
    title(strcat('Julienday ',num2str(ii),', FreeAirAnomalie'));
    xlabel('Time (Julienday)');

    subplot(3,2,2); plot(btime,bath,':.');
    title(strcat('Julienday ',num2str(ii),', Bathiemetry'));
    subplot(3,2,4); plot(stime,sp);
    title(strcat('Julienday ',num2str(ii),', SOG'));
    subplot(3,2,6); plot(stime,cr);
    title(strcat('Julienday ',num2str(ii),', Course'));
    xlabel('Time (Julienday)');
    print (strcat('./fig-',num2str(ii)));
end
```

`get_dc` *matlab* function

```
% Calculates the DC shift for the gravitymeter for the cruise MGL1305

function [DC] = get_dc

clear all

BGM3_conversion_factor = 5.0962178;         % Convertion factor to get graw
datapath1 = '../../CruiseData/MGL1305/raw/serial';
data1 = (strcat('/MGL-vc01.y2013d099'));

Gt = 979808.43;                             % Gravity at Harbor in Bermuda

Tie_Point = [3405.94; 3405.99; 3406.19];    % Measurements at the tie point in Bermuda
LRt = mean(Tie_Point);                      % Mean of measurements
time_tie = 14;                              % Time of measurments at tie point

Pier_one = [3406.07; 3405.85; 3406.08];     % Measurements one at pier in Bermuda
Pier_two = [3405.85; 3405.98; 3406.05];     % Measurements two at pier in Bermuda
time_pier = [13 + 25/60; 14 + 56/60];       % Time for measurements at pier
LRpier = [mean(Pier_one); mean(Pier_two)];  % Mean of measurements
LRp = interp1(time_pier,LRpier,time_tie);   % Interpolation of pier values at time of
measurment at tie

Gp = Gt - (LRt - LRp);                      % Gravity in Bermuda - MISTIE

FAR = 0.3806;                               % Free air reduction factor
m = 2.51;                                   % Difference in altitude
Gs = Gp + m * FAR;                          % Free air reduction


file1 = {[datapath1 data1]};

[year, day, hour, minute, sec, gcountraw, output_freq, sensor_status] =
read_vc01_Langseth(file1);

% Conversion of Bell BGM-3 counts to mGal: 5.0962178 mGal/PPS

graw = gcountraw * BGM3_conversion_factor;

time = time_tie * 60 * 60;
DC = Gs - graw(time);

end
```

`read_vc01_Langseth` *matlab* function

```
function [year, day, hour, minute, sec, graw, output_freq, sensor_status] =
read_vc01_Langseth(vc01file,pl);

% usage: [year, day, hour, minute, sec, graw, output_freq, sensor_status] =
```

```
read_vc01_Langseth(vc01file,pl);
%
% This script reads a MGL-vc01.yYEARdJULIAN_DAY file from the Lanseth's serial database.
% These files contain the raw gravity counts from the BGM-3 gravimeter.
% Following is the information about the format:
%
% ------------------------------------------------------------------------------
%       ID     Time Stamp      Output_frequency (Hz):raw_counts  sensor_status
%         ------------------- ------ ------------ ------------- -------
%       vc01    2008:193:00:00:00.4752 01:024646 01
% ------------------------------------------------------------------------------
%
% vc01file should be a CELL structure that can contain many filenames.
% Example of a vc01file CELL with two filenames: vc01file={'MGL-vc01.y2008d193','MGL-
vc01.y2008d194'};
%
% pl = 1. Plots the gravity raw counts for QC. Default: no.
%
%                                     J. Pablo Canales, WHOI, January 2012
%
%  See also:
%

year=[]; day=[]; hour=[]; minute=[]; sec=[]; graw=[]; output_freq=[]; sensor_status=[];

whofile = whos('vc01file');
filetype = whofile.class;

if strcmp(filetype, 'char')
  vc01file = {vc01file};
end

nfiles = length(vc01file);

for n=1:nfiles

  file = deal(vc01file{n});

  if exist(file,'file')

    yr=[]; dy=[]; hr=[]; mi=[]; se=[]; g=[]; outf=[]; stat=[];
    kk = [];

    [kk yr dy hr mi se outf g stat] = textread(file,'%s%4d:%3d:%2d:%2d:%7f%2d:%6d%2d',-
1);

    year = [year; yr];
    day = [day; dy];
    hour = [hour; hr];
    minute = [minute; mi];
    sec = [sec; se];
    graw = [graw; g];
    output_freq = [output_freq; outf];
    sensor_status = [sensor_status; stat];

    time = dy + hr/24 + mi/60/24 + se/60/60/24;
    secs = hr*3600 + mi*60 + se;

    if (nargin>1 & pl==1)

      figurename = ['Data from Langseth''s file ' file];
      eval(['hand2fig_' num2str(n) ' = figure(''Name'',figurename);']);

      subplot(4,2,1)
      plot(yr,'-','linewidth',0.2); xlabel ('Record #'); ylabel('Year')
      title (under2text(figurename))

      subplot(4,2,2)
      plot(dy,'-','linewidth',0.2); xlabel ('Record #'); ylabel('Julian Day')

      subplot(4,2,3)
      plot(hr,'-','linewidth',0.2); xlabel ('Record #'); ylabel('Hour')

      subplot(4,2,4)
```

```
      plot(mi,'-','linewidth',0.2); xlabel ('Record #'); ylabel('Minute')

      subplot(4,2,5)
      plot(se,'-','linewidth',0.2); xlabel ('Record #'); ylabel('Second')

      subplot(4,2,6)
      plot(time,g,'-','linewidth',0.2); xlabel ('Time (days)'); ylabel('Gravity counts')

      subplot(4,2,7)
      plot(time(2:end),diff(secs),'-','linewidth',0.2); xlabel ('Time (days)');
ylabel('Calculated sampling rate (s)');

      subplot(4,2,8)
      plot(time,1./outf,'-','linewidth',0.2); xlabel ('Time (days)'); ylabel('Sampling
rate (s)');

      orient tall;
      eval (['print -dps2 ' file '.ps'])

    end

  end

end
```

`Gaussfiltcoef` *matlab* function

```
function b=gaussfiltcoef(SR,fco)
%GAUSSFILTCOEF  Return coefficients of Gaussian lowpass filter.
% SR=sampling rate, fco=cutoff (-3dB) freq, both in Hz.
% Coeffs for FIR filter of length L (L always odd) are computed.
% This symmetric FIR filter of length L=2N+1 has delay N/SR seconds.
% Examples of use
%    Compute Gaussian filter frequency response for SR=1000, fco=50 Hz:
%    freqz(gaussfiltcoef(1000,50),1,256,1000);
%    Filter signal X sampled at 5kHz with Gaussian filter with fco=500:
%    y=filter(gaussfiltcoef(5000,500),1,X);
% SR, fco are not sanity-checked.  WCR 2006-10-11.

b=0;
a=3.011*fco;
N=ceil(0.398*SR/fco);   %filter half-width, excluding midpoint
%Width N corresponds to at least +-3 sigma which captures at least 99.75%
%of area under Normal density function. sigma=1/(a*sqrt(2pi)).
L=2*N+1;                %full length of FIR filter
for k=-N:N
    b(k+N+1)=3.011*(fco/SR)*exp(-pi*(a*k/SR)^2);
end;
%b(k) coeffs computed above will add to almost exactly unity, but not
%quite exact due to finite sampling and truncation at +- 3 sigma.
%Next line adjusts to make coeffs b(k) sum to exactly unity.
b=b/sum(b);
```

RV Langseth Gravity Tie Form

CruiseID	MGL1304/1305	☑ PRE	☑ POST
Date	9 April 2013		
Port	Bermuda		
Operator	Bern McKiernan and Klayton Curtis		

Pier side Reading #1

Ship's position (C-Nav)	LAT 32 22.704 N	LONG 064 40.881 W	ALT
Shipboard BGM	Shipboard BGM reading (mGal) 979728	Height of Pier over Main Deck (m)[1] 0.2 m	
Portable GPS Time	TIME 13:25		
Portable GPS Position	LAT 32 22.731' N	LONG 064 40.887' W	ALT 62.5 ft.
L&R Readings	Reading 1 3406.07	Reading 2 3405.85	Reading 3 3406.08

Tie Point

Tie Point Description (also include relevant documentation/maps/pictures)	Next to the bollard between the two warehouses on Penno's Wharf. Handheld GPS reading differs from documented 1978 data. Bollard is the 4th from the SW corner of the pier.		
Portable GPS Time	TIME 14:00		
Portable GPS Position	LAT 32 22.731' N	LONG 064 40.827' W	ALT 51.8 ft
L&R Readings	Reading 1 3405.94	Reading 2 3405.99	Reading 3 3406.19

Pier side L&R reading #3

Shipboard BGM	Shipboard BGM reading (mGal) 979728	Height of Pier over Main Deck (m) 0.2 M	
Portable GPS Time	TIME 14:56		
Portable GPS Position	LAT 32 22.710 N	LONG 064 40.881 W	ALT 21.5 ft
L&R Readings	Reading 1 3405.85	Reading 2 3405.98	Reading 3 3406.05

Notes

Pier side readings was taken at forward A-frame leg.

1. Height of pier over main deck should be entered in meters. Use a negative value to indicate pier is below main deck.
Form v1.1 2008-08-18

GRAVITY STATION DESCRIPTION

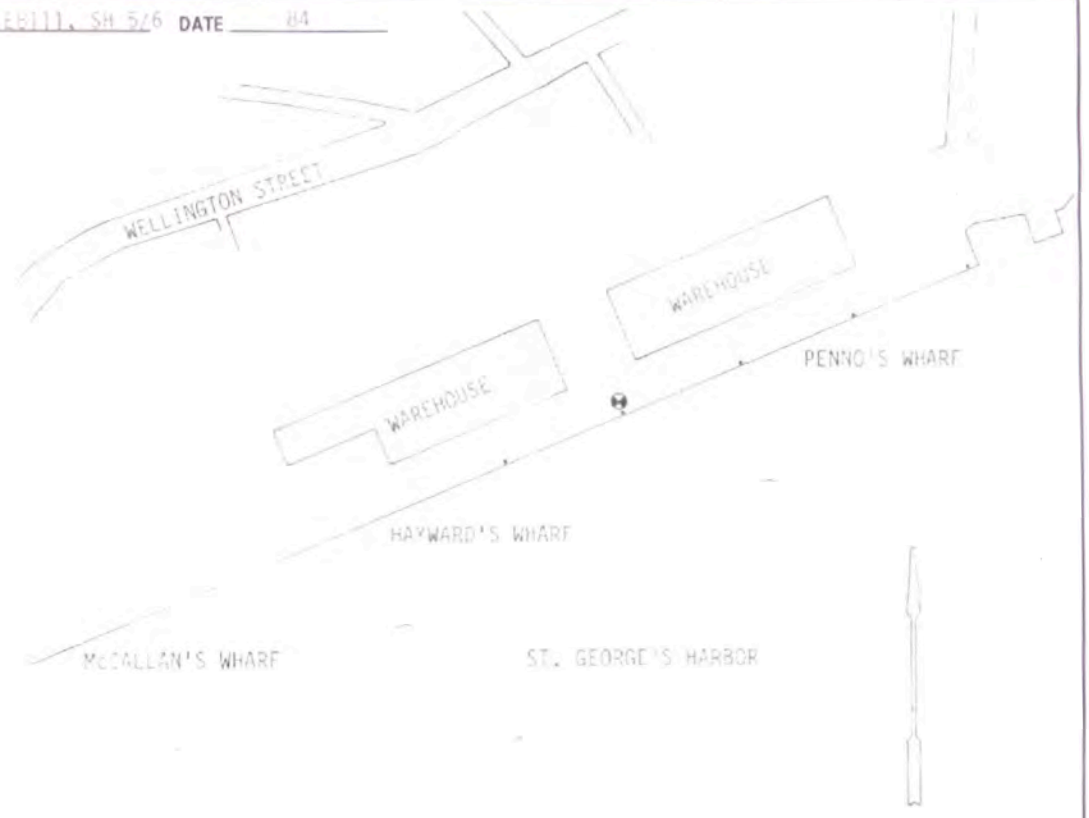
LAT. 32° 22' 43.5" N
LONG. 64° 40' 13.8" W
POSIT. REF. 26343, 17th Ed.
ELEV.
ELEV. REF.
TYPE HARBOR
CROSS REF. DoD 0227-9 = IGB 11524

STATION NO. 0054.05
COUNTRY BERMUDA
STATE ST. GEORGE'S
CITY ST. GEORGE
STATION NAME PENNO'S WHARF
1971 DATUM g 979,808.43 Mgals

REF. 53 DATE SEP 78

THE STATION IS LOCATED ON PENNO'S WHARF, ST. GEORGE, BERMUDA. IT IS IN FRONT OF THE THIRD BOLLARD FROM THE EAST END OF THE WHARF, WHICH IS BETWEEN THE TWO WAREHOUSES.

REF. EB111, SH 5/6 DATE 84



STATION NO. 0054.05 1971 DATUM g = 979,808.43 Mgals

DATE	OBSERVER	METER	SOURCE	STATION OF REF	1971 VALUE	Δg	TIE

RV Langseth Gravity Tie Form

CruiseID	MGL1305	☑ PRE	☐ POST
Date	19 May 2013		
Port	Azores Portugal		
Operator	Bern McKiernan		

Pier side Reading #1

Ship's position (C-Nav)	LAT 37 44.3219N	LONG 25 39.6415W	ALT 28.35M
Shipboard BGM	Shipboard BGM reading (mGal) 980033	Height of Pier over Main Deck (m)[1] -1	
Portable GPS Time	TIME 10:10		
Portable GPS Position	LAT 37 44.321N	LONG 025 39.648W	ALT 67.3
L&R Readings	Reading 1 3695.37	Reading 2 3695.23	Reading 3 3695.29

Tie Point

Tie Point Description (also include relevant documentation/maps/pictures)	Ponte Delgado Harbor. On "Molhe Salazar" in front of public Lavatories, ladis entrance. Situated four bollards (gun type) east of enlargement in pier. 120 meters west of bend.		
Portable GPS Time	TIME 10:46		
Portable GPS Position	LAT 37 44.065N	LONG 025 39.943W	ALT 20.6
L&R Readings	Reading 1 3695.58	Reading 2 3695.30	Reading 3 3695.51

Pier side L&R reading #3

Shipboard BGM	Shipboard BGM reading (mGal) 950033	Height of Pier over Main Deck (m) -.5	
Portable GPS Time	TIME 12:08		
Portable GPS Position	LAT 37 44.321N	LONG 025 39.943W	ALT 71ft
L&R Readings	Reading 1 3695.19	Reading 2 3695.26	Reading 3 3695.19

Notes

1. Height of pier over main deck should be entered in meters. Use a negative value to indicate pier is below main deck.
Form v1.1 2008-08-18

LOCKHEED MARTIN PROPRIETARY INFORMATION

LOCKHEED MARTIN
Lockheed Martin
2221 Niagara Falls Blvd., Niagara Falls, NY 14304

DOC. NO. 6109-928094
ISSUE : B
DATE : 5/00
PAGE : 5

DATA SHEET 1
BGM-3 SENSOR CALIBRATION USING AN ULTRADEX DIVIDING HEAD

S/N 213, P/N 6109-300503-1

DATE 3/30/04 TIME 1300 CALIBRATED BY DR STUBBS

TREND = _____ MGAL/DAY

(1) Output Pulses/400 Sync pulses at 0° 2507784 pulses

(2) Output Pulses/400 Sync pulses at 20° 1347620 pulses

(3) Output Pulses/400 Sync pulses at 340° 1347645 pulses

(4) (1) ÷ 100 = 25077.84 PPS

(5) (2) ÷ 100 = 13476.20 PPS

(6) (3) ÷ 100 = 13476.45 PPS

(7) ½[(5)+ (6)] = 13476.325 PPS

(8) {[(4) - (7)] x10^{-6}}/(1-cos(20°)) = 0.192373058 PPS/micro g

(9) 0.980375*/(8) = 5.0962178 mgal/PPS **Scale Factor** *(Spec: 4.0 to 6.0 mgal/PPS)*

(10) (4) x (9) x 10^{-3} = 127.8021 gals

(11) 980.375** - (10) = 852.5729 gals

(12) **CALIB** output pulses/400 sync pulses = 2500288 pulses

(13) **TEST** output pulses/400 sync pulses = 2500000 pulses

(14) **CALIB** equivalent = [(12) x (9)] ÷ 100,000 = 127.4201 gals

(15) **TEST** equivalent = [(13) x (9)] ÷ 100,000 = 127.4054 gals

(16) (11) x 1000 = 852572.9 mgals **Bias** *(Spec: (17) to (18))*

(17) 1000(977-25 x (9)) = 849594.6 mgals (lower limit)

(18) 1000(983-25 x (9)) = 855594.6 mgals (upper limit)

*local gravity at Wheatfield (980.375 gals) ÷ 1000. Value must be changed if Calibration is done elsewhere.
**local gravity at Wheatfield (980.375 gals). Value must be changed if Calibration is done elsewhere.

EXPORT CONTROLLED INFORMATION

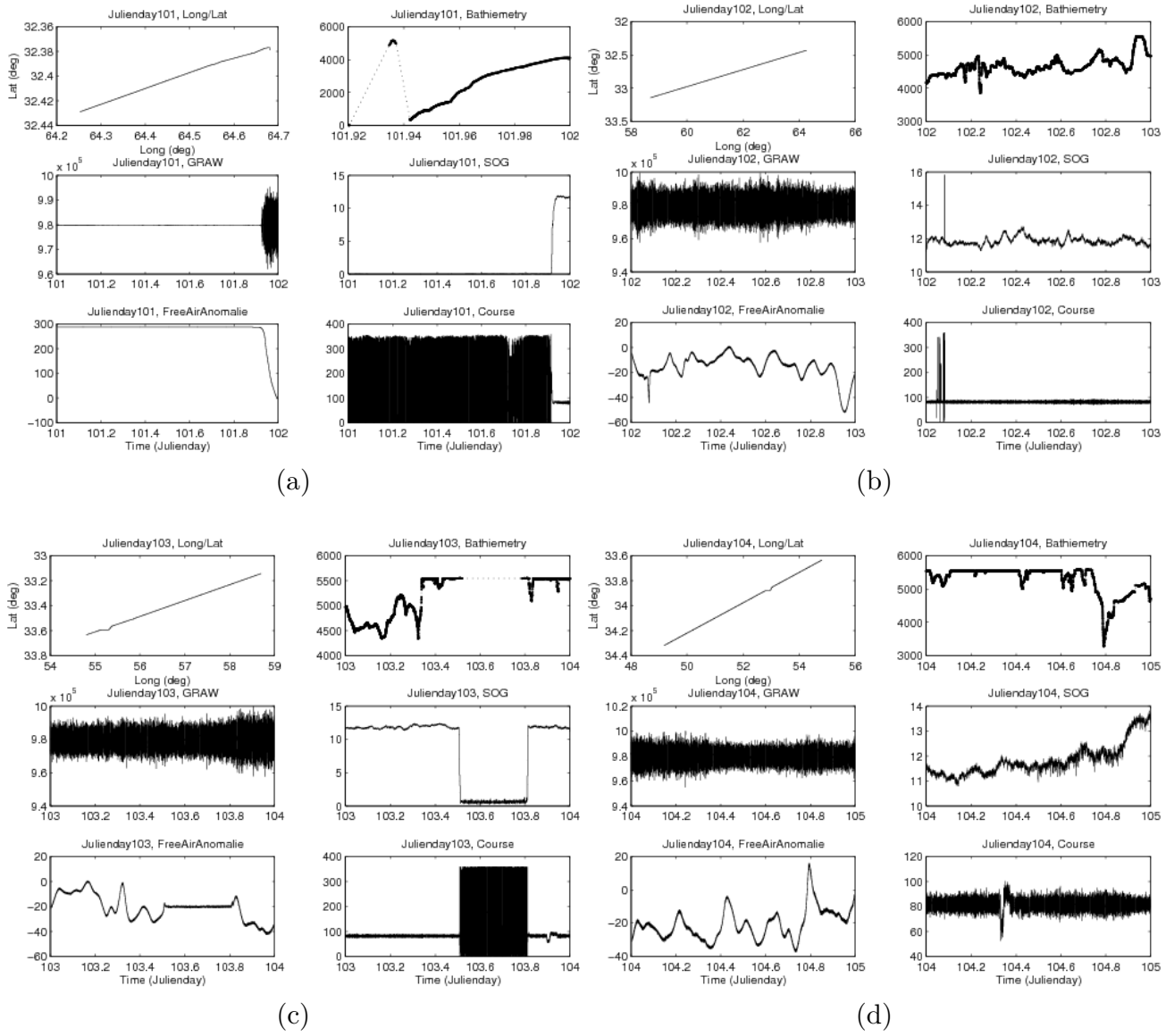


Figure 1: (a) day plot of day 101 (April, 11th), (b) day plot of day 102 (April, 12th), (c) day plot of day 103 (April, 13th), (d) day plot of day 104 (April, 14th)

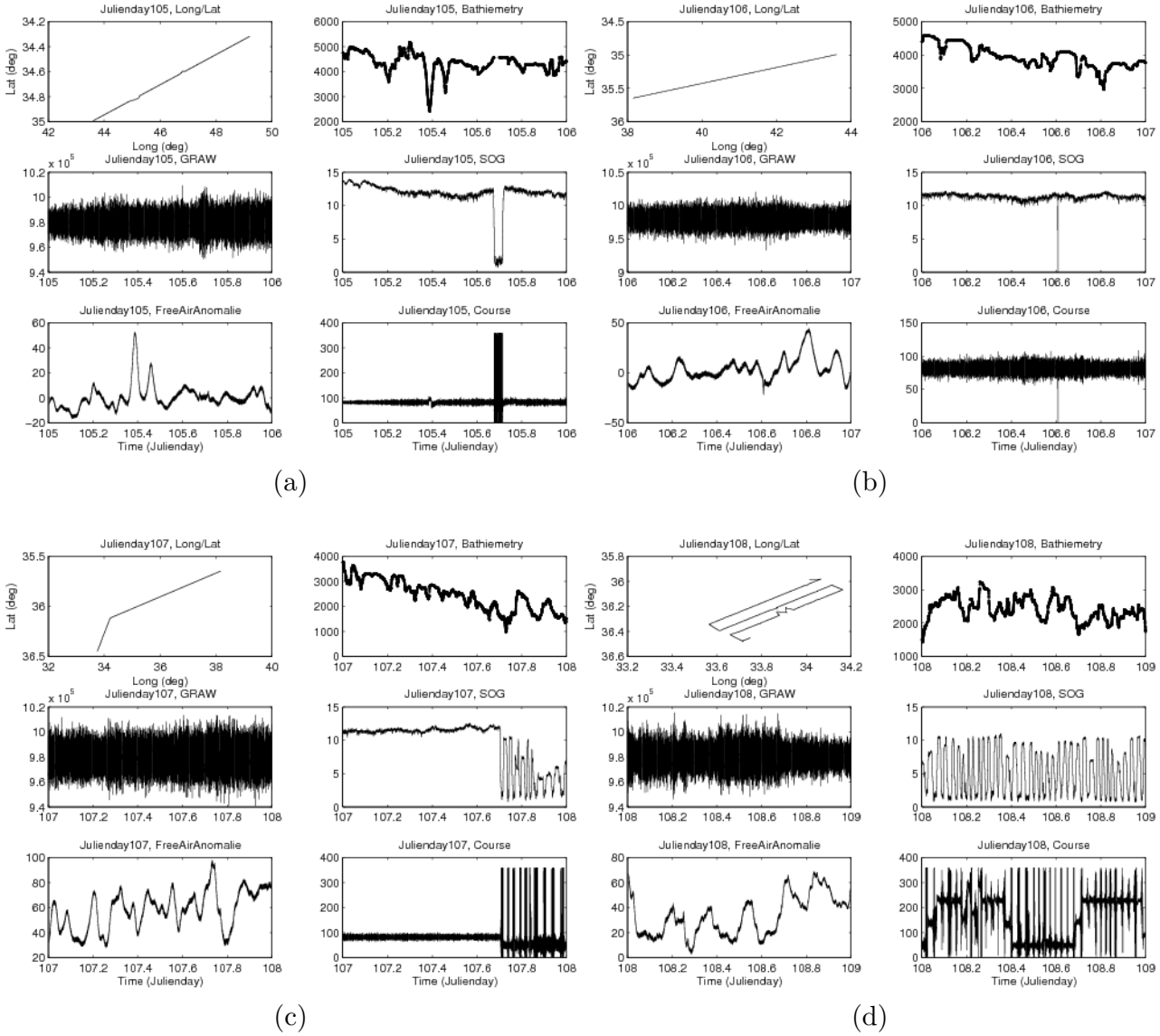


Figure 2: (a) day plot of day 105 (April, 15th), (b) day plot of day 106 (April, 16th), (c) day plot of day 107 (April, 17th), (d) day plot of day 108 (April, 18th)

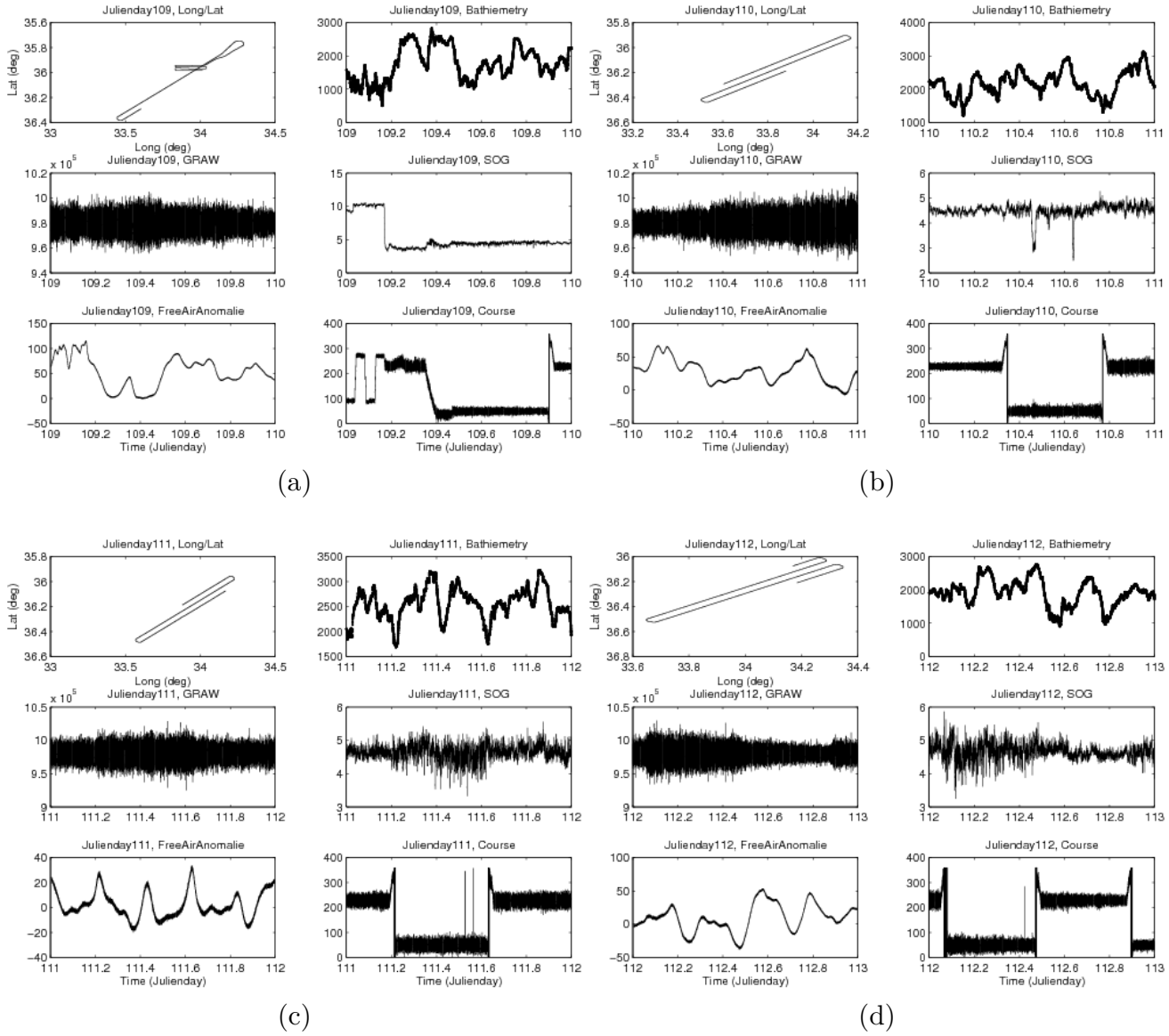


Figure 3: (a) day plot of day 109 (April, 19th), (b) day plot of day 110 (April, 20th), (c) day plot of day 111 (April, 21th), (d) day plot of day 112 (April, 22th)

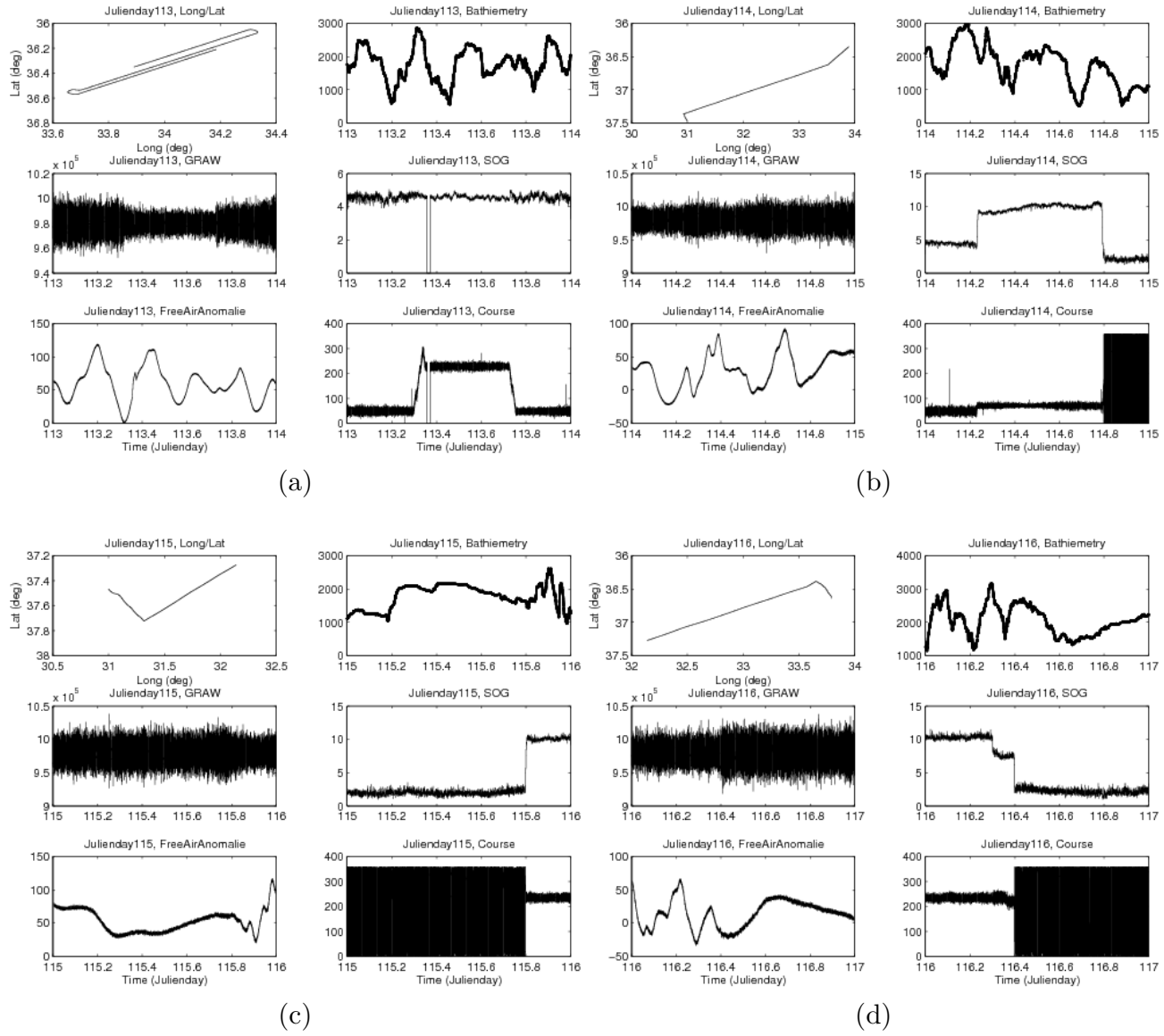


Figure 4: (a) day plot of day 113 (April, 23th), (b) day plot of day 114 (April, 24th), (c) day plot of day 115 (April, 25th), (d) day plot of day 116 (April, 26th)

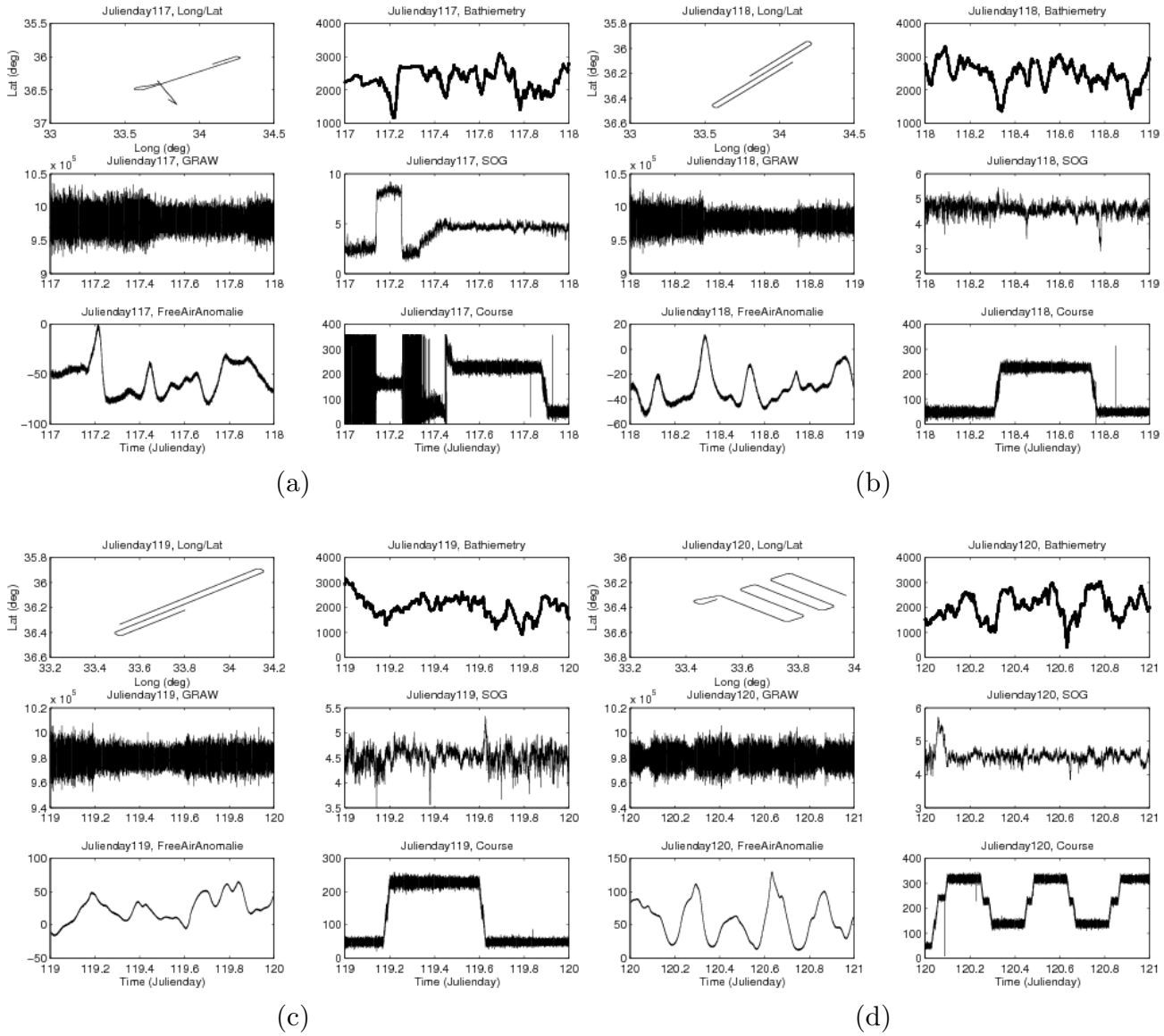


Figure 5: (a) day plot of day 117 (April, 27th), (b) day plot of day 118 (April, 28th), (c) day plot of day 119 (April, 29th), (d) day plot of day 120 (April, 30th)

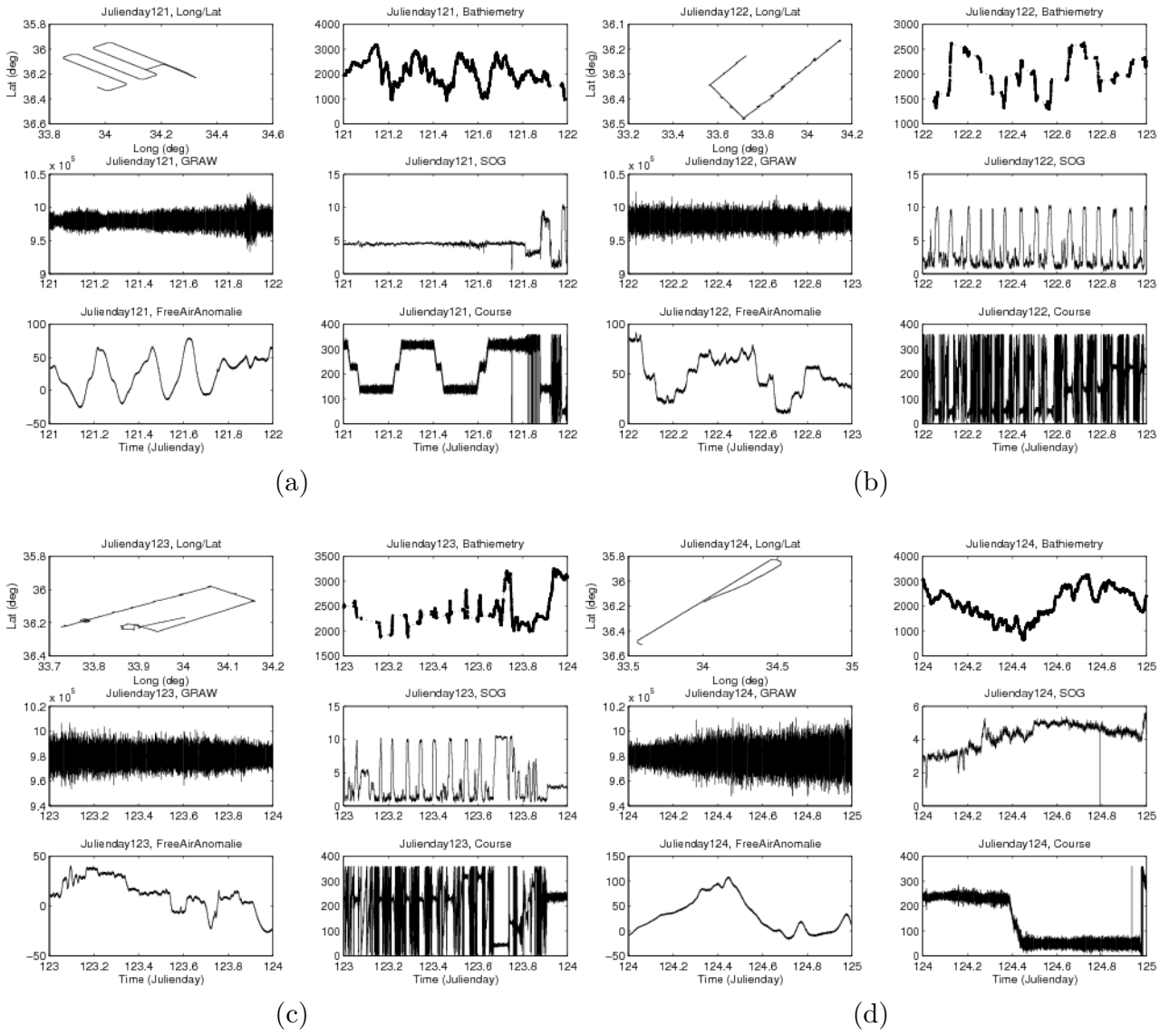


Figure 6: (a) day plot of day 121 (April, 1th), (b) day plot of day 122 (April, 2th), (c) day plot of day 123 (April, 3th), (d) day plot of day 124 (May, 4th)

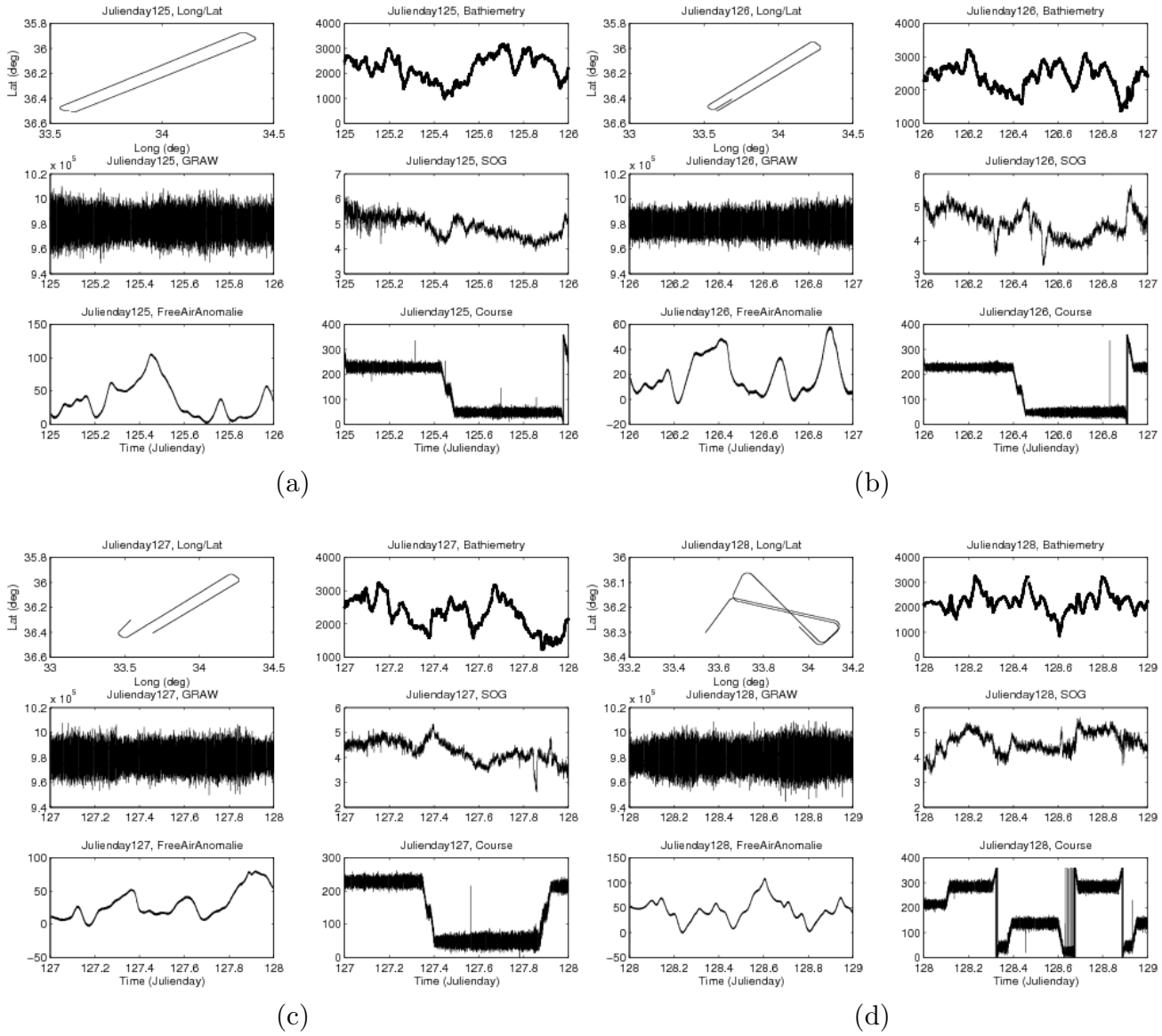


Figure 7: (a) day plot of day 125 (May, 5th), (b) day plot of day 126 (May, 6th), (c) day plot of day 127 (May, 7th), (d) day plot of day 128 (May, 8th)

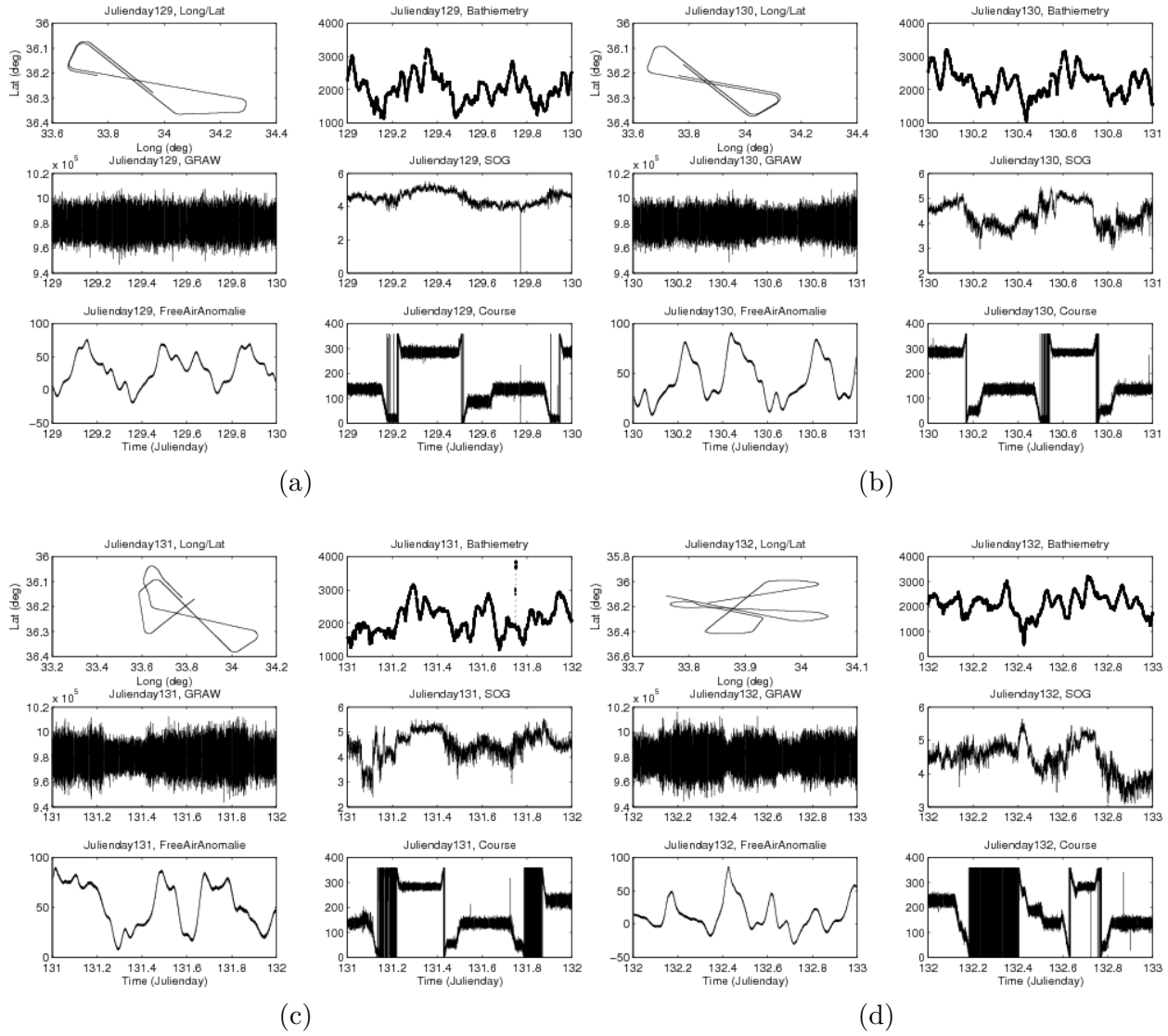
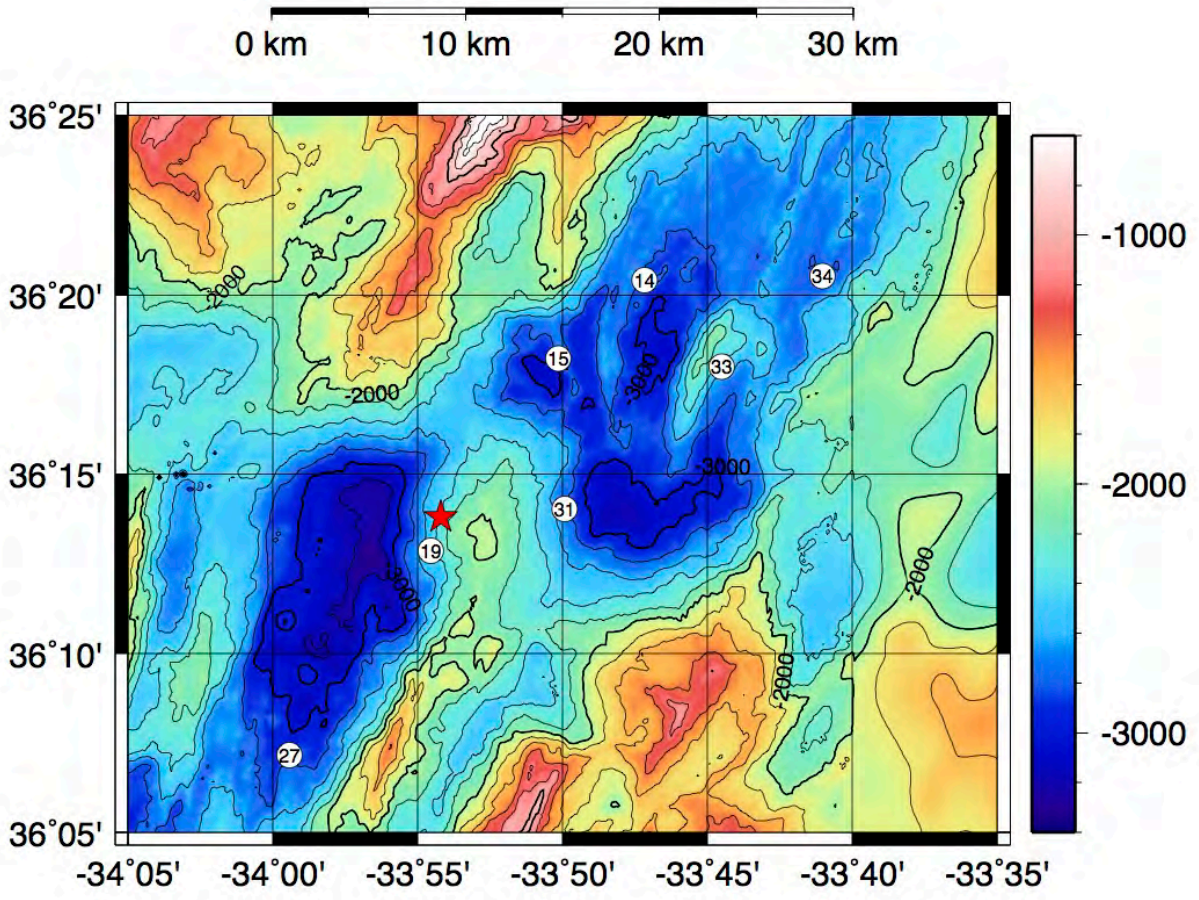


Figure 8: (a) day plot of day 129 (May, 9th), (b) day plot of day 130 (May, 10th), (c) day plot of day 131 (May, 11th), (d) day plot of day 132 (May, 12th)

A.15. Sediment Sample Locations

MGL1305 OBS Drop locations from which sediments were collected

Station	Depth (m)	Drop Latitude (dec. deg.)	Drop Longitude (dec. deg.)	Recover Date	Recover Time
OBS14	2865	36.34018	-33.78602	13-May-13	20:11:15
OBS15	2871	36.30381	-33.83574	13-May-13	21:55:49
OBS19	2452	36.21456	-33.90916	14-May-13	4:21:32
OBS27	2801	36.11940	-33.99030	14-May-13	14:14:47
OBS31	2736	36.23379	-33.83210	13-May-13	11:12:11
OBS33	2547	36.30010	-33.74169	13-May-13	14:36:35
OBS34	2786	36.34203	-33.68356	13-May-13	16:38:47



A.16. Electronic Cruise Log (ELOG)

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Thu 11 Apr 2013 21:32:45	Ship	other	NaN	NaN	NaN	NaN	NaN		At Bermuda pier getting ready for departure
Thu 11 Apr 2013 21:58:20	Ship	startCruise	NaN	NaN	NaN	NaN	NaN		underway -- leaving harbor elog feed still not working
Thu 11 Apr 2013 22:04:42	Ship	other	NaN	NaN	NaN	NaN	NaN		testing elog feed...
Thu 11 Apr 2013 22:34:53	Ship	other	NaN	NaN	NaN	NaN	NaN		
Fri 12 Apr 2013 09:31:42	Other	start	NaN	NaN	NaN	NaN	NaN		test again
Fri 12 Apr 2013 10:22:46	Other	start	NaN	NaN	NaN	NaN	NaN		test serial
Fri 12 Apr 2013 12:58:23	Other	start	NaN	NaN	NaN	32.81508	-61.24867		
Fri 12 Apr 2013 13:03:16	Ship	other	NaN	NaN	NaN	32.81750	-61.22970		seems that serial feed is working
Fri 12 Apr 2013 18:22:33	EM122	start	NaN	NaN	NaN	32.97577	-59.99506		Start Recording Multibeam bathymetry upon exit of economic zone at 15:11 UTC
Sat 13 Apr 2013 00:03:15	XBT	release	NaN	NaN	NaN	33.14381	-58.68128	4950	
Sat 13 Apr 2013 12:19:42	CTD911	deploy	NaN	1	NaN	33.50633	-55.85374	5551	accoustic release test
Sat 13 Apr 2013 12:27:57	EM122	stop	NaN	NaN	NaN	33.50543	-55.85376	5557	stop MB for communication with OBS releases
Sat 13 Apr 2013 12:37:16	Echosounder3.5	abortLine	NaN	NaN	NaN	33.50517	-55.85387	5557	Stop Knudsen for communication with OBS releases
Sat 13 Apr 2013 13:37:06	CTD911	maxDepth	NaN	NaN	NaN	33.50463	-55.85401	5557	max depth 3000 m
Sat 13 Apr 2013 13:53:06	EM122	other	NaN	NaN	NaN	33.50473	-55.85399	5557	BIST test start at 13:37 and ends at 13:45 (ok)
Sat 13 Apr 2013 15:58:28	CTD911	recover	NaN	1	NaN	33.50464	-55.85392	5557	First Acoustic release rosette recovered
Sat 13 Apr 2013 16:10:32	CTD911	deploy	NaN	2	NaN	33.50465	-55.85391	5557	Second Acoustic release rosette deploment
Sat 13 Apr 2013 17:18:01	CTD911	maxDepth	NaN	2	NaN	33.50463	-55.85389	5557	Max depth 3000 m
Sat 13 Apr 2013 19:03:18	CTD911	recover	NaN	1	2	33.50531	-55.85406		Second Acoustic release rosette recovered
Sat 13 Apr 2013 19:27:15	Ship	other	NaN	NaN	NaN	33.50680	-55.85403		Testing of minivane done, ready to set off again
Sat 13 Apr 2013 19:31:06	EM122	start	NaN	NaN	NaN	33.50816	-55.84256		EM122 back on after acoustic release testing
Sat 13 Apr 2013 19:31:55	Echosounder3.5	startLine	NaN	NaN	NaN	33.50843	-55.83933	5555	Echosounder back on after acoustic release testing
Sun 14 Apr 2013 18:12:44	EM122	stop	NaN	NaN	NaN	34.14089	-50.64509		Stop MB for reboot
Sun 14 Apr 2013 18:14:27	Other	end	NaN	NaN	NaN	34.14171	-50.63829		Reboot Seapath 200 navigation system
Sun 14 Apr 2013 18:16:19	Other	start	NaN	NaN	NaN	34.14264	-50.63082		Seapath 200 back online
Sun 14 Apr 2013 18:18:32	EM122	start	NaN	NaN	NaN	34.14367	-50.62202		MB system online, pinging and logging
Sun 14 Apr 2013 18:24:00	EM122	other	NaN	NaN	NaN	34.14633	-50.60025		MB logging off and on
Sun 14 Apr 2013 20:12:39	XBT	release	NaN	NaN	3	34.19894	-50.16754	4633	XBT launched measured to 850 m
Sun 14 Apr 2013 21:04:51	EM122	other	NaN	NaN	NaN	34.22445	-49.95775	4644	Some problems with the GPS caused system to loose heave/pitvly/roll info for a minute
Sun 14 Apr 2013 21:06:26	Other	start	NaN	NaN	NaN	34.22526	-49.95124	4657	Problem with GPS system not using dGPS mode. Dave is investigating

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sun 14 Apr 2013 21:16:43	EM122	other	NaN	NaN	NaN	34.23045	-49.90861	4748	EM122 loosing navigation information because Dave is fiddling with navigation system
Sun 14 Apr 2013 22:19:26	EM122	start	NaN	NaN	NaN	34.26350	-49.63678	4770	MBES reboot
Sun 14 Apr 2013 22:30:09	EM122	stop	NaN	NaN	NaN	34.26923	-49.58922	5120	MBES succesfully rebooted
Mon 15 Apr 2013 11:57:06	Other	end	NaN	NaN	NaN	34.67528	-46.23831	4466	SVPod speed of sound Profiler value erratis
Mon 15 Apr 2013 13:19:05	XBT	release	NaN	NaN	4	34.71236	-45.93114	4238	XBT successful launch to 893m
Mon 15 Apr 2013 15:43:14	CTD911	deploy	NaN	NaN	3	34.78023	-45.36924		Preparing to deploy acoustic release rosette to test acoustic unit which failed during previoud test
Mon 15 Apr 2013 16:29:19	CTD911	deploy	NaN	NaN	NaN	34.79865	-45.24750		Deploy of accoustic rosette
Mon 15 Apr 2013 16:41:26	CTD911	abort	NaN	NaN	NaN	34.79882	-45.24738	4588	Recovering Acoustic rosette as test failed
Mon 15 Apr 2013 16:54:31	CTD911	recover	NaN	NaN	NaN	34.80243	-45.24690	4579	Rosette back on board after failed test
Mon 15 Apr 2013 16:55:36	EM122	start	NaN	NaN	NaN	34.80271	-45.24686	4578	EM122 system back on after acoustic test
Mon 15 Apr 2013 16:56:08	Echosounder3.5	startLine	NaN	NaN	NaN	34.80284	-45.24686	4577	Echosounder back on after acoustic release testing
Tue 16 Apr 2013 12:56:52	XBT	release	NaN	NaN	5	35.34501	40.67384	3686.26	XBT launched measured to 880M
Tue 16 Apr 2013 13:54:43	EM122	other	NaN	NaN	NaN	35.37092	-40.45795	3574	Sound speed at transducer set back to "sensor" since the pod sensor is working again
Tue 16 Apr 2013 15:02:26	Other	start	NaN	NaN	NaN	35.40194	-40.19922		Reboot Seapath 200 navigation system
Wed 17 Apr 2013 17:04:49	OBS	deploy	NaN	OBS01	SN13005	36.11773	-34.21014	1513	Deployed about 200 m NNE of site to avoid steep cliff
Wed 17 Apr 2013 17:41:38	OBS	deploy	NaN	OBS02	SN13007	36.16373	-34.14484	1543	Deployed OBS02
Wed 17 Apr 2013 18:17:10	OBS	deploy	NaN	OBS03	SN13008	36.20410	-34.08957	1687	Deployed 350 m early- OBS03
Wed 17 Apr 2013 18:24:35	XBT	release	NaN	NaN	6	36.20509	-34.08926	1714	XBT launched from stationery ship to bottom at 1700m
Wed 17 Apr 2013 19:01:09	OBS	deploy	NaN	OBS04	SNLP119	36.24211	-34.03751	2511	Deployed OBS04- Hit side of ship while being deployed
Wed 17 Apr 2013 19:36:18	OBS	deploy	NaN	OBS05	SNLP126	36.27236	-33.99554	2412	Deploy OBS05- hit side of ship while being deployed
Wed 17 Apr 2013 20:05:03	OBS	deploy	NaN	OBS06	SN13004	36.29637	-33.96278	1901	Deployed OBS06
Wed 17 Apr 2013 20:40:55	OBS	deploy	NaN	OBS07	SN13003	36.31852	-33.92970	1624	Deployed OBS07
Wed 17 Apr 2013 21:33:45	OBS	deploy	NaN	OBS08	SN13001	36.35044	-33.88832	2127	Deployed OBS08
Wed 17 Apr 2013 22:28:40	OBS	deploy	NaN	OBS09	SN13015	36.38650	-33.83846	1856	Deployed OBS09
Wed 17 Apr 2013 23:28:21	OBS	deploy	NaN	OBS10	SN13014	36.42855	-33.77885	1697	Deployed OBS10 150 m east of site
Thu 18 Apr 2013 00:26:39	OBS	deploy	NaN	OBS11	SN13002	36.47718	-33.71570	1934	Deployed OBS11 170 m west of site
Thu 18 Apr 2013 01:17:47	OBS	deploy	NaN	OBS12	SNLP115	36.43033	-33.66222	2534	Deployed OBS12
Thu 18 Apr 2013 02:09:08	OBS	deploy	NaN	OBS13	SN13021	36.38160	-33.72792	2751	Deployed OBS13 130 m south of site
Thu 18 Apr 2013 02:49:46	OBS	deploy	NaN	OBS14	SN13023	36.34037	-33.78609	2865	Deployed OBS14
Thu 18 Apr 2013 03:38:52	OBS	deploy	NaN	OBS15	SN13024	36.30397	-33.83586	2871	Deployed OBS15
Thu 18 Apr 2013 04:10:55	OBS	deploy	NaN	OBS16	SN13022	36.27367	-33.87748	2475	Deployed OBS16
Thu 18 Apr 2013 04:42:11	OBS	deploy	NaN	OBS17	SN13020	36.24475	-33.86759	2141	Deployed OBS17

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Thu 18 Apr 2013 05:13:50	OBS	deploy	NaN	OBS 18	SN13026	36.24957	-33.91030	2728	
Thu 18 Apr 2013 05:43:42	OBS	deploy	NaN	OBS 19	SN13025	36.21466	-33.90933	2460	
Thu 18 Apr 2013 06:21:03	OBS	deploy	NaN	OBS 20	SN 13034	36.22532	-33.94309	3219	Deploy OBS 20
Thu 18 Apr 2013 06:50:53	OBS	deploy	NaN	OBS 21	SN13035	36.19520	-33.98474	3035	Deploy OBS 21
Thu 18 Apr 2013 07:26:05	OBS	deploy	NaN	OBS 22	SN 13030	36.15970	-34.03475	2231	Deploy OBS 22
Thu 18 Apr 2013 08:11:06	OBS	deploy	NaN	OBS 23	SN 13019	36.11715	-34.09286	2506	Deploy OBS 23
Thu 18 Apr 2013 08:45:52	OBS	deploy	NaN	OBS 24	LP 117	36.06915	-34.15890	2321	Deploy OBS 24
Thu 18 Apr 2013 09:32:53	OBS	deploy	NaN	OBS 25	LP113	36.02861	-34.11482	2269	Deploy OBS 25
Thu 18 Apr 2013 10:17:34	OBS	deploy	NaN	OBS 26	13018	36.07729	-34.04867	2620	Deploy OBS 26
Thu 18 Apr 2013 11:11:14	OBS	deploy	NaN	OBS 27	13031	36.11932	-33.99052	2807	Deploy OBS 27
Thu 18 Apr 2013 11:59:36	OBS	deploy	NaN	OBS 28	13027	36.15541	-33.94056	2693	Deploy OBS 28
Thu 18 Apr 2013 12:33:16	OBS	deploy	NaN	OBS 29	13029	36.18579	-33.89947	2216	Deploy OBS 29
Thu 18 Apr 2013 13:05:37	OBS	deploy	NaN	OBS 30	SN13017	36.20944	-33.86608	2075	Deploy OBS 30
Thu 18 Apr 2013 13:42:52	OBS	deploy	NaN	OBS 31	SN 13028	36.23373	-33.83230	2676	Deploy OBS 31
Thu 18 Apr 2013 14:18:22	OBS	deploy	NaN	OBS 32	SN 13016	36.26366	-33.79085	2846	Deploy OBS 32
Thu 18 Apr 2013 14:55:40	OBS	deploy	NaN	OBS 33	SN 13036	36.29990	-33.74165	2561	Deploy OBS 33
Thu 18 Apr 2013 15:35:53	OBS	deploy	NaN	OBS 34	SN 13032	36.34198	-33.68370	2791	Deploy OBS 34
Thu 18 Apr 2013 15:46:56	EM122	start	NaN	NaN	NaN	36.34822	-33.67586	2700	Stop and start of EM122
Thu 18 Apr 2013 16:17:28	OBS	deploy	NaN	OBS 35	LP 124	36.39059	-33.61766	2215	Deploy OBS 35
Thu 18 Apr 2013 16:28:54	XBT	release	NaN	NaN	NaN	36.39267	-33.61199		XBT launched from stationery ship to 2150m
Thu 18 Apr 2013 17:03:30	OBS	deploy	NaN	OBS 36	SN 13013	36.34354	-33.56527	1923	Deploy OBS 36
Thu 18 Apr 2013 17:44:19	OBS	deploy	NaN	OBS 37	SN 13012	36.29555	-33.63121	1945	Deploy OBS 37
Thu 18 Apr 2013 18:34:39	OBS	deploy	NaN	OBS 38	LP 129	36.25332	-33.68917	2321	Deploy OBS 38
Thu 18 Apr 2013 19:10:16	OBS	deploy	NaN	OBS 39	LP 130	36.21731	-33.73866	2496	Deploy OBS 39
Thu 18 Apr 2013 19:41:43	OBS	deploy	NaN	OBS 40	SN 13006	36.18714	-33.78025	2110	Deploy OBS 40
Thu 18 Apr 2013 20:10:06	OBS	deploy	NaN	OBS 41	SN 13010	36.16306	-33.81331	1900	Deploy OBS 41
Thu 18 Apr 2013 20:41:46	OBS	deploy	NaN	OBS 42	SN 13009	36.13904	-33.84639	2282	Deploy OBS 42
Thu 18 Apr 2013 21:27:25	OBS	deploy	NaN	OBS43	SN LP125	36.10893	-33.88773	2155	OBS43 deployment
Thu 18 Apr 2013 22:07:08	OBS	deploy	NaN	OBS44	SN13011	36.07254	-33.93718	2319	Deploy OBS44
Thu 18 Apr 2013 22:50:09	OBS	deploy	NaN	OBS45	SN LP121	36.03014	-33.99785	2242	Deploy OBS45 100m W from the original position
Thu 18 Apr 2013 23:32:24	OBS	deploy	NaN	OBS46	SN 13033	35.98228	-34.06171	2439	Deploy OBS46
Fri 19 Apr 2013 04:14:02	Airgun:Array	deploy	NaN	NaN	NaN	35.93430	-34.04068	1228	Start of deployment operations.
Fri 19 Apr 2013 04:32:17	Airgun:Array	deploy	NaN	NaN	NaN	35.92296	-34.05746	1050	begin deployment of gun string 1
Fri 19 Apr 2013 05:55:45	Airgun:Array	deploy	NaN	NaN	NaN	35.87592	-34.14585	2467	airgun array 1: end deployment as full pressure
Fri 19 Apr 2013 05:59:29	Airgun:Array	deploy	NaN	NaN	NaN	35.87448	-34.14973	2487	deployment of airgun array 2 (500 psi)
Fri 19 Apr 2013 07:56:42	Airgun:Array	deploy	NaN	NaN	NaN	35.80047	-34.25804	1986	deployment of airgun array 3
Fri 19 Apr 2013 09:56:58	Airgun:Array	deploy	NaN	NaN	NaN	35.77880	-34.20592	2475	deployment of gun array 4
Fri 19 Apr 2013 10:17:42	ObserverMammals	other	NaN	NaN	NaN	35.79709	-34.18979	2348	ask for permission to MMO to start test shooting -> answer: All clear
Fri 19 Apr 2013 10:20:00	Airgun:Array	other	NaN	NaN	NaN	35.79912	-34.18789	2438	ramp-up (test)

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Fri 19 Apr 2013 10:33:24	Airgun:Array	other	NaN	NaN	NaN	35.81096	-34.17722	2388	2 (40 in^3) not working in string 3 and 4, we turned off other 40 in^3 and turn on a 90 in^3 in string xx
Fri 19 Apr 2013 10:52:35	Airgun:Array	other	NaN	NaN	NaN	35.82795	-34.16187	2453	final volum of airguns (36 guns) is: 6520 in^3
Fri 19 Apr 2013 11:02:17	Airgun:Array	startLine	MGL1305OBS01	NaN	NaN	35.83673	-34.15401	2489	shot # 989
Fri 19 Apr 2013 11:22:17	Airgun:Array	other	MGL1305OBS01	NaN	NaN	35.85537	-34.13487	2368	we just joined the actual line MGL1305OBS01 at shot # 994
Fri 19 Apr 2013 12:13:21	magnetometer	start	MGL1305OBS01	NaN	NaN	35.89734	-34.07795	1152	magnetometer started onboard
Fri 19 Apr 2013 12:18:39	magnetometer	start	MGL1305OBS01	NaN	NaN	35.90165	-34.07205	1292	magnetometer deployed
Fri 19 Apr 2013 12:25:54	magnetometer	stop	MGL1305OBS01	NaN	NaN	35.90764	-34.06399	1182	magnetometer back onboard and preparing another deployment plan
Fri 19 Apr 2013 16:12:14	magnetometer	start	MGL1305OBS01	NaN	NaN	36.09045	-33.81391	1854	magnetometer deployed
Fri 19 Apr 2013 16:28:47	magnetometer	start	MGL1305OBS01	NaN	NaN	36.10374	-33.79572	1731	magnetometer in position and start logging
Fri 19 Apr 2013 18:14:00	Airgun:Array	other	MGL1305OBS01	NaN	NaN	36.19115	-33.67524	2523	change Airgun array volume to 6570
Fri 19 Apr 2013 19:04:31	Airgun:Array	service	1	NaN	NaN	36.23368	-33.61672	1969	Gun array adjusted from digishot by Bern and Robbie
Fri 19 Apr 2013 21:29:33	Ship	other	NaN	NaN	NaN	36.35529	-33.44827		Start of turn
Fri 19 Apr 2013 21:34:38	Ship	other	NaN	NaN	NaN	36.36083	-33.44439	1607.08	End of line M1305OBS01
Fri 19 Apr 2013 21:48:17	Ship	other	NaN	NaN	NaN	36.37604	-33.45077	1551.35	New line M1305OBS01T
Fri 19 Apr 2013 22:00:02	Ship	other	NaN	NaN	NaN	36.38451	-33.46427	1460	End of line M1305OBS01T
Fri 19 Apr 2013 22:06:58	Ship	other	NaN	NaN	NaN	36.38383	-33.47452	1450.2	New line M1305OBS02
Sat 20 Apr 2013 01:32:01	Echosounder3.5	endLine	NaN	NaN	NaN	36.21508	-33.70905		knudsen system down at 01:25 UTC
Sat 20 Apr 2013 01:51:17	Echosounder3.5	startLine	NaN	NaN	NaN	36.19950	-33.73063		knudsen back online 1:50 UTC
Sat 20 Apr 2013 02:20:23	Airgun:Array	other	NaN	NaN	NaN	36.17540	-33.76378	1588.56	Reducing sensor gain from 4 to 3 for S3G07
Sat 20 Apr 2013 02:37:41	Airgun:Array	other	NaN	NaN	NaN	36.16145	-33.78298	1550.3	Reducing sensor gain from 3 to 2 for S3G07
Sat 20 Apr 2013 04:40:48	Echosounder3.5	abortLine	NaN	NaN	NaN	36.06041	-33.92136		reset knudsen due to loss of data
Sat 20 Apr 2013 04:56:33	Echosounder3.5	endLine	NaN	NaN	NaN	36.04774	-33.93887		knudsen system down 04:55 UTC
Sat 20 Apr 2013 05:08:36	Echosounder3.5	abortLine	NaN	NaN	NaN	36.03773	-33.95265	2454.3	knudsen system down at 04:53 UTC
Sat 20 Apr 2013 05:23:40	Echosounder3.5	startLine	NaN	NaN	NaN	36.02496	-33.97021	2357.25	knudsen back online 0522 UTC (Had to restart system)
Sat 20 Apr 2013 07:48:57	Ship	other	NaN	NaN	NaN	35.90366	-34.13610	2389.29	Ship made starboard turn to start new line at 0747
Sat 20 Apr 2013 07:52:14	Airgun:Array	endLine	MGL1305OBS02	NaN	NaN	35.90243	-34.14063	2327.93	End of line M1305OBS02 at 0751 UTC LSP 2181
Sat 20 Apr 2013 07:53:48	Airgun:Array	startLine	MGL1305OBS02T	NaN	NaN	35 54.182	34 08.957	2348.12	Start of line MGL1305OBS02T at 0757 UTC
Sat 20 Apr 2013 08:22:49	Airgun:Array	endLine	MGL1305OBS02T	NaN	NaN	35.92724	-34.16679	2450.34	End of line M1305OBS02T at 0817 UTC LSP 2508
Sat 20 Apr 2013 08:26:16	Airgun:Array	startLine	MGL1305OBS03	NaN	NaN	35.93111	-34.16412	2490.04	Start of line MGL1305OBS03 at 0825 UTC First Shot Point 3003

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sat 20 Apr 2013 08:30:03	Ship	other	NaN	NaN	NaN	35.93448	-34.15979	2486.09	End of starboard turn at 0829
Sat 20 Apr 2013 10:50:00	Airgun:Array	other	MGL1305OBS03	NaN	NaN	36.05045	-34.00155	2166.02	Power down at 1045 UTC for MMO LS 3046. Mitigation gun fired at 1050 UTC
Sat 20 Apr 2013 10:54:44	Ship	other	MGL1305OBS03	NaN	NaN	36.05433	-33.99631	2204.33	Ship slowed to 3 knots for marine mammal at 1054 UTC
Sat 20 Apr 2013 11:18:29	Airgun:Array	other	MGL1305OBS03	NaN	NaN	36.06828	-33.97750	2158.06	Ramping up to full power to resume shooting at 1118 UTC FSP 3054
Sat 20 Apr 2013 11:27:24	Ship	other	MGL1305OBS03	NaN	NaN	35 06.8277	33 97.7500		Ship increased speed back to 4 knots at 1120 UTC
Sat 20 Apr 2013 12:41:35	Airgun:Array	other	MGL1305OBS03	NaN	NaN	36.13492	-33.88563	2414.88	Power down at 1236 UTC LS 3078 for MMO. Mitigation shot at 1239 UTC
Sat 20 Apr 2013 12:43:27	Ship	other	MGL1305OBS03	NaN	NaN	36.13631	-33.88380	2429	Slowed to 2.5 Kn for MMO
Sat 20 Apr 2013 12:47:36	Ship	other	MGL1305OBS03	NaN	NaN	36.13917	-33.87967	2452.61	Ship resumed speed at 4 knots at 1146 UTC
Sat 20 Apr 2013 12:52:28	Airgun:Array	other	MGL1305OBS03	NaN	NaN	36.14295	-33.87452	2479.82	Ramp up to full power to resume shooting at 1250 UTC FSP 3081
Sat 20 Apr 2013 13:04:23	Airgun:Array	passingOverStation	MGL1305OBS03	OBS042	NaN	36.15272	-33.86108	2352	passing OBS042 between SP3085 and SP3086
Sat 20 Apr 2013 13:34:36	Airgun:Array	passingOverStation	MGL1305OBS03	OBS041	NaN	36.17714	-33.82764	2115	passing OBS041 at SP3094
Sat 20 Apr 2013 14:04:24	Airgun:Array	passingOverStation	MGL1305OBS03	OBS040	NaN	36.20152	-33.79435	2580	passing OBS040 at SP3103
Sat 20 Apr 2013 14:40:42	Airgun:Array	passingOverStation	MGL1305OBS03	OBS 39	NaN	36.23134	-33.75342	2900	passing OBS039 at SP3114
Sat 20 Apr 2013 15:13:14	ObserverMammals	other	MGL1305OBS03	NaN	NaN	36.25775	-33.71704	2412	Turtle
Sat 20 Apr 2013 15:14:37	Airgun:Array	other	MGL1305OBS03	NaN	NaN	36.25889	-33.71549	2422	Power down at 1510 UTC for MMO last full shot 3123
Sat 20 Apr 2013 15:16:44	Ship	other	MGL1305OBS03	NaN	NaN	36.26053	-33.71337	2392	Slowed down while shooting mitigation gun
Sat 20 Apr 2013 15:23:12	Airgun:Array	other	MGL1305OBS03	NaN	NaN	36.26398	-33.70890	2349	Restart full array after turtle SP 3126
Sat 20 Apr 2013 15:24:47	Ship	other	MGL1305OBS03	NaN	NaN	36.26485	-33.70769	2295	Back to cruising speed
Sat 20 Apr 2013 15:30:51	Airgun:Array	passingOverStation	MGL1305OBS03	OBS038	NaN	36.26922	-33.70130	2199	Crossing OBS038 SP 3128
Sat 20 Apr 2013 16:21:35	Airgun:Array	passingOverStation	MGL1305OBS03	OBS037	NaN	36.30974	-33.64526	2095	Crossing OBS037 SP 3143
Sat 20 Apr 2013 17:21:24	Airgun:Array	passingOverStation	MGL1305OBS03	OBS036	NaN	36.35847	-33.57766	1707	Crossing OBS036 SP3161
Sat 20 Apr 2013 18:24:30	Airgun:Array	other	MGL1305OBS03	NaN	NaN	36.41205	-33.50502		Start of turn
Sat 20 Apr 2013 18:26:03	Airgun:Array	endLine	MGL1305OBS03	NaN	NaN	36.41394	-33.50410	1504	Last shot SP 3181 18:25 GMT
Sat 20 Apr 2013 18:28:21	Airgun:Array	other	turn to MGL1305OBS03T	NaN	NaN	36.41695	-33.50334	1409	Shooting guns at 17 s intervals
Sat 20 Apr 2013 18:34:15	Airgun:Array	startLine	MGL1305OBS03T	NaN	NaN	36.42430	-33.50527	1350	First shot SP3503 18:34
Sat 20 Apr 2013 18:47:27	Airgun:Array	other	MGL1305OBS03T	NaN	NaN	36.43666	-33.51973	1787	Start of turn SP3507
Sat 20 Apr 2013 18:51:30	Airgun:Array	endLine	MGL1305OBS03T	NaN	NaN	36.43829	-33.52597	1675	Last shot SP3508 18:49
Sat 20 Apr 2013 18:58:01	Airgun:Array	startLine	MGL1305OBS04	NaN	NaN	36.43684	-33.53571	1594	First shot SP4003 18:57
Sat 20 Apr 2013 19:02:57	Ship	other	MGL1305OBS04	NaN	NaN	36.43298	-33.54163	1588	End of port turn at 19:01
Sat 20 Apr 2013 20:02:43	Airgun:Array	passingOverStation	MGL1305OBS04	OBS035	NaN	36.38317	-33.61040	2225	Crossing OBS035 SP4023
Sat 20 Apr 2013 21:01:16	Airgun:Array	passingOverStation	MGL1305OBS04	OBS034	NaN	36.33432	-33.67760	2527.38	passing OBS034 at SP4041
Sat 20 Apr 2013 22:15:36	OBS	other	NaN	NaN	NaN	36.27284	-33.76251	2769	Passing OBS033 at 21:53 SP 4057 Lat: 36.17.27.594 N Long: 33.44.14.449 W

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sat 20 Apr 2013 22:36:22	OBS	other	NaN	NaN	NaN	36.25583	-33.78587	2932	Passing OBS032 at SP 4070
Sat 20 Apr 2013 23:11:00	OBS	other	NaN	NaN	NaN	36.22729	-33.82523	2789	Passing OBS031at SP 4081
Sat 20 Apr 2013 23:42:16	OBS	other	NaN	NaN	NaN	36.20177	-33.86026	2258	Passing OBS030 at SP 4090
Sun 21 Apr 2013 00:12:06	OBS	other	NaN	NaN	NaN	36.17741	-33.89386	1894	Passing OBS029 at SP 4099
Sun 21 Apr 2013 01:15:15	EM122	other	NaN	NaN	NaN	36.12501	-33.96603	2752	Maximum angle change from 65 to 60 deg
Sun 21 Apr 2013 01:17:08	OBS	other	NaN	NaN	NaN	36.12342	-33.96813	2428	Crossing OBS028 SP 4110 at 00:47 Lat: 36.08.51.402N Long: 33.56.05.765 W
Sun 21 Apr 2013 01:30:55	OBS	other	NaN	NaN	NaN	36.11214	-33.98344	2756	Passing OBS027 at SP 4123
Sun 21 Apr 2013 01:46:24	EM122	stop	NaN	NaN	NaN	36.09935	-34.00109	2853.76	MBES crash
Sun 21 Apr 2013 01:49:23	EM122	start	NaN	NaN	NaN	36.09692	-34.00442	2765.24	MBES back
Sun 21 Apr 2013 02:27:12	Airgun:Array	passingOverStation	MGL1305OBS04	OBS 26	NaN	36.06586	-34.04645	2489.5	nearest shot 4139
Sun 21 Apr 2013 03:22:45	Airgun:Array	passingOverStation	MGL1305OBS04	OBS 25	NaN	36.02002	-34.10944	2283	nearest shot 4157
Sun 21 Apr 2013 04:43:34	Airgun:Array	endLine	MGL1305OBS04	NaN	NaN	35.95584	-34.20129	2322	Last shot 4181
Sun 21 Apr 2013 04:48:58	Airgun:Array	startLine	MGL1305OBS4T	NaN	NaN	35.95650	-34.20930	2337	First shot SP4502
Sun 21 Apr 2013 05:09:27	Airgun:Array	endLine	MGL1305OBS04T	NaN	NaN	35.97529	-34.22782	1807.5	End of line MGL1305OBS04T at 0505 UTC LSP 4507
Sun 21 Apr 2013 05:13:55	Airgun:Array	startLine	MGL1305OBS05	NaN	NaN	35.98063	-34.22687	1770.2	Start of line MGL1305OBS05 FSP 5002 at 0512 UTC
Sun 21 Apr 2013 05:45:48	EM122	stop	MGL1305OBS05	NaN	NaN	36.00756	-34.19251	2414.23	Mutli-beam system crashed had to restart at 0542 UTC
Sun 21 Apr 2013 06:41:56	OBS	other	MGL1305OBS05	NaN	NaN	36.05349	-34.12986	2600.03	Passing OBS024 and OBS025 at 0639 UTC SP5028
Sun 21 Apr 2013 07:35:19	OBS	other	MGL1305OBS05	NaN	NaN	36.09852	-34.06816	2733.5	Passing OBS023 and OBS026 at 0734 UTC SP5046
Sun 21 Apr 2013 08:26:02	OBS	other	MGL1305OBS05	NaN	NaN	36.14180	-34.00919	2861.2	Passing OBS022 and OBS027 at 0825 UTC SP5061
Sun 21 Apr 2013 09:08:18	OBS	other	MGL1305OBS05	NaN	NaN	36.17782	-33.95983	3146.5	Passing OBS021 and OBS028 at 0906 UTC SP5074
Sun 21 Apr 2013 09:33:22	EM122	other	MGL1305OBS05	NaN	NaN	36.19826	-33.93169		Multi-beam data is choppy because of weather
Sun 21 Apr 2013 09:40:16	Airgun:Array	other	MGL1305OBS05	NaN	NaN	36.20389	-33.92414	3641.02	Power down at 0937 UTC for Sea Turtle LS5083
Sun 21 Apr 2013 09:48:40	Airgun:Array	other	MGL1305OBS05	NaN	NaN	36.21062	-33.91466	2551.68	Guns turned back on at 0948 UTC FSP5087
Sun 21 Apr 2013 09:58:14	OBS	other	MGL1305OBS05	NaN	NaN	36.21827	-33.90418	2374.8	Passed Over OBS019 at 0956 UTC SP5089
Sun 21 Apr 2013 10:07:47	XBT	release	MGL1305OBS05	NaN	NaN	36.22541	-33.89437	2363	Two launches of XBT T-5 failed at 0950
Sun 21 Apr 2013 10:09:29	XBT	release	MGL1305OBS05	NaN	NaN	36.22663	-33.89265	2072.77	Launched off of Main Deck due to Guns. Only hit 350 m
Sun 21 Apr 2013 10:18:18	Ship	other	MGL1305OBS05	NaN	NaN	36.23365	-33.88308	2111	Just passed over Rainbow hydrothermal site, about 2 km to port
Sun 21 Apr 2013 10:27:19	OBS	other	MGL1305OBS05	NaN	NaN	36.24088	-33.87301	2059.2	Passing OBS018 and OBS030 at 1014 UTC SP5094
Sun 21 Apr 2013 10:35:38	OBS	other	MGL1305OBS05	NaN	NaN	36.24756	-33.86383	2175.3	Passed Over OBS017 at 1034 UTC

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sun 21 Apr 2013 11:22:43	OBS	other	MGL1305OBS05	NaN	NaN	36.28526	-33.81191	2840.1	Passing OBS015 and OBS032 at 1122 UTC SP5114
Sun 21 Apr 2013 11:29:49	Airgun:Array	other	MGL1305OBS05	NaN	NaN	36.29088	-33.80418	2794.17	Power down at 1128 for Sea Turtle resuming power at 1139 UTC LSP5115 first full power SP5118
Sun 21 Apr 2013 12:07:55	OBS	other	MGL1305OBS05	NaN	NaN	36.32068	-33.76325	2814.1	Passing OBS014 and OBS033 at 1206 UTC SP5127
Sun 21 Apr 2013 12:18:15	EM122	other	MGL1305OBS05	NaN	NaN	36.32877	-33.75205	2873	Ran a BIST (self-test) on the multi-beam system at 1217 UTC
Sun 21 Apr 2013 13:01:41	Airgun:Array	passingOverStation	MGL1305OBS05	OBS013 OBS034	5143	36.36339	-33.70451	2556	Passing OBS014 and OBS034 at 13:01 UTC SP5143
Sun 21 Apr 2013 13:22:58	ObserverMammals	other	MGL1305OBS05	NaN	NaN	36.38093	-33.68123	2681	PAM turned off
Sun 21 Apr 2013 13:24:12	EM122	other	MGL1305OBS05	NaN	NaN	36.38191	-33.67984	2659	Some errors every now and then on the parameters SV profile and SV used
Sun 21 Apr 2013 13:42:58	EM122	other	MGL1305OBS05	NaN	NaN	36.39610	-33.66028	2608	SV at sensor changed to "profile" as it was giving error (444)
Sun 21 Apr 2013 13:45:07	ObserverMammals	other	MGL1305OBS05	NaN	NaN	36.39758	-33.65792	2570	PAM on
Sun 21 Apr 2013 14:03:45	Airgun:Array	passingOverStation	MGL1305OBS05	OBS012 OBS035	SP5161	36.41198	-33.63770	2502	Passing OBS012 and OBS035 at 14:03 UTC SP5161
Sun 21 Apr 2013 14:38:00	Airgun:Array	other	MGL1305OBS05	NaN	NaN	36.43889	-33.59988	2260	Shots 5169 5170 fired but not located
Sun 21 Apr 2013 14:59:41	EM122	other	MGL1305OBS05	NaN	NaN	36.45680	-33.57536	1884	SV at sensor changed back to "sensor"
Sun 21 Apr 2013 15:03:52	Ship	other	MGL1305OBS05	NaN	NaN	36.46084	-33.57068	1796	Start of turn to port
Sun 21 Apr 2013 15:07:10	Airgun:Array	endLine	MGL1305OBS05	NaN	NaN	36.46490	-33.56863	1771	Last shot SP 5180 at 15:07
Sun 21 Apr 2013 15:08:33	Airgun:Array	other	turn to MGL1305OBS05T	NaN	NaN	36.46654	-33.56837	1786	Internal shhoting at 17 s intervals
Sun 21 Apr 2013 15:18:43	Airgun:Array	startLine	MGL1305OBS05T	NaN	NaN	36.47816	-33.57367	1940	First shot SP 5504 at 15:17
Sun 21 Apr 2013 15:35:14	Airgun:Array	endLine	MGL1305OBS05T	NaN	NaN	36.48674	-33.59562	2346	Last shot SP 5510 at 15:35
Sun 21 Apr 2013 15:39:35	Airgun:Array	startLine	MGL1305OBS06	NaN	NaN	36.48529	-33.60212	2529	First SP 6002
Sun 21 Apr 2013 15:48:00	Other	end	NaN	NaN	NaN	36.47919	-33.61178		PAM on board at 15:32
Sun 21 Apr 2013 16:13:52	Airgun:Array	other	MGL1305OBS06	NaN	NaN	36.45755	-33.64156	2597	Shut down at 16:13 UTC for Turtle, last full volume SP 6009
Sun 21 Apr 2013 16:14:50	Airgun:Array	other	MGL1305OBS06	NaN	NaN	36.45675	-33.64261	2591	One gun turned on
Sun 21 Apr 2013 16:22:32	Airgun:Array	other	MGL1305OBS06	NaN	NaN	36.45060	-33.65125	2588	Guns turned back on at 16:21 UTC FSP6015
Sun 21 Apr 2013 16:39:00	Airgun:Array	passingOverStation	MGL1305OBS06	OBS 012	NaN	36.43716	-33.66989	2553	Passing OBS011 and OBS012 16:39 UTC SP6020
Sun 21 Apr 2013 17:45:51	Airgun:Array	passingOverStation	MGL1305OBS06	OBS14	NaN	36.38208	-33.74592	2670	Passing OBS14 SP6039 UTC17:42
Sun 21 Apr 2013 18:31:35	Airgun:Array	passingOverStation	MGL1305OBS06	OBS014	SP6054	36.34491	-33.79733	2681	Passing OBS14 at 18:31 UTC SP6054
Sun 21 Apr 2013 19:13:21	Airgun:Array	passingOverStation	MGL1305OBS06	OBS015	6067	36.30996	-33.84493	2912	Passing OBS13 at 19:13 UTC SP6067
Sun 21 Apr 2013 19:49:18	Airgun:Array	passingOverStation	MGL1305OBS06	OBS016	SP6078	36.27931	-33.88568	2519	Passing OBS16 at 19:49 UTC SP6078
Sun 21 Apr 2013 20:18:25	Airgun:Array	passingOverStation	MGL1305OBS06	OBS018 OBS006	NaN	36.25575	-33.91986	2873	Passing OBS018 and OBS0006 20:18 UTC SP6087
Sun 21 Apr 2013 20:47:07	Airgun:Array	passingOverStation	MGL1305OBS06	NaN	NaN	36.23115	-33.95350	3078	Passing OBS020 and OBS005 20:47 SP6096

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sun 21 Apr 2013 21:22:59	Airgun:Array	passingOverStation	MGL1305OBS06	OBS 004	NaN	36.20154	-33.99403	2922	Passing OBS004 at SP 6107
Sun 21 Apr 2013 22:06:47	Airgun:Array	passingOverStation	MGL1305OBS06	OBS003	NaN	36.16620	-34.04273	2113	Passing OBS 003 & OBS002 at SP 6120
Sun 21 Apr 2013 22:59:25	Airgun:Array	passingOverStation	MGL1305OBS06	)BS023	NaN	36.12306	-34.10198	2453	Passing OBS023 at SP 6136
Sun 21 Apr 2013 23:01:09	Airgun:Array	passingOverStation	MGL1305OBS06	OBS002	NaN	36.12167	-34.10379	2342	Passing OBS002 at SP 6136
Mon 22 Apr 2013 00:01:14	Airgun:Array	passingOverStation	MGL1305OBS06	OBS001	NaN	36.07329	-34.16974	1921	Passing OBS001 at SP6154
Mon 22 Apr 2013 00:03:07	Airgun:Array	passingOverStation	MGL1305OBS06	OBS024	NaN	36.07170	-34.17190	1921	Passing OBS024 at SP 6154
Mon 22 Apr 2013 01:18:13	Airgun:Array	endLine	MGL1305OBS06	NaN	NaN	36.00970	-34.25917	1979	End of line MGL1305OBS06 at SP 6178
Mon 22 Apr 2013 01:27:25	Airgun:Array	startLine	MGL1305OBS06T	NaN	NaN	36.01112	-34.27231	1813	Start of line MGL1305OBS06T FSP 6503
Mon 22 Apr 2013 01:44:19	Airgun:Array	endLine	MGL1305OBS06T	NaN	NaN	36.02637	-34.28756	1835	End of line MGL1305OBS06T LSP 6507
Mon 22 Apr 2013 01:50:46	Airgun:Array	startLine	MGL1305OBS07	NaN	NaN	36.03355	-34.28735	2010	Start of line MGL1305OBS07 FSP 7002
Mon 22 Apr 2013 03:18:40	Airgun:Array	passingOverStation	MGL1305OBS07	OBS 01	NaN	36.10523	-34.19225	1949	by: kCurtis
Mon 22 Apr 2013 04:21:22	Airgun:Array	passingOverStation	MGL1305OBS07	OBS 02	NaN	36.15511	-34.12473	1528	SP 7045 by: kCurtis
Mon 22 Apr 2013 05:12:58	Airgun:Array	passingOverStation	MGL1305OBS07	OBS003	NaN	36.19591	-34.06839	2393.46	Passing OBS003 at SP7060 on Port side (North) at 0511 UTC
Mon 22 Apr 2013 05:55:17	Airgun:Array	passingOverStation	MGL1305OBS07	OBS004	NaN	36.23091	-34.02047	2503.8	Passing OBS004 at SP7074 on Port side (North) at 0553 UTC
Mon 22 Apr 2013 06:30:22	Airgun:Array	passingOverStation	MGL1305OBS07	OBS005	NaN	36.26125	-33.97889	2568.1	Passing OBS005 at SP7085 on Port side (North) at 0628 UTC
Mon 22 Apr 2013 06:58:51	Airgun:Array	passingOverStation	MGL1305OBS07	OBS006	NaN	36.28545	-33.94540	2157	Passing OBS006 at SP7094 on Port side (North) at 0657 UTC
Mon 22 Apr 2013 07:29:40	Airgun:Array	passingOverStation	MGL1305OBS07	OBS007	NaN	36.30977	-33.91191	1853.4	Passing OBS007 at SP7103 on Port side (North) at 0727 UTC
Mon 22 Apr 2013 08:05:29	Airgun:Array	passingOverStation	MGL1305OBS07	OBS008	NaN	36.33922	-33.87100	2128.3	Passing OBS008 at SP7114 on Port side (North) at 0803 UTC
Mon 22 Apr 2013 08:46:59	Airgun:Array	passingOverStation	MGL1305OBS07	OBS009	NaN	36.37506	-33.82194	1969.2	Passing OBS009 at SP7127 on Port side (North) at 0844 UTC
Mon 22 Apr 2013 09:37:36	Airgun:Array	passingOverStation	MGL1305OBS07	OBS010	NaN	36.41733	-33.76318	2227	Passing OBS010 at SP7143 on Port side (North) at 0936 UTC
Mon 22 Apr 2013 10:22:05	XBT	release	MGL1305OBS07	NaN	NaN	36.45462	-33.71273	2123	XBT successful launch to 795.9m
Mon 22 Apr 2013 10:36:38	Airgun:Array	passingOverStation	MGL1305OBS07	OBS011	NaN	36.46626	-33.69633	2527.6	Passing OBS011 at SP7161 on Port side (North) at 1035 UTC
Mon 22 Apr 2013 11:15:03	Ship	other	MGL1305OBS07	NaN	NaN	36.49866	-33.65151	2709.47	Startigt port side turn to begin MGL1305OBS07T at 1114 UTC LSP7174
Mon 22 Apr 2013 11:26:04	Airgun:Array	endLine	MGL1305OBS07	NaN	NaN	36.51221	-33.64975	2726.9	End of line MGL1305OBS07 at SP 7174 at 1117UTC
Mon 22 Apr 2013 11:28:28	Airgun:Array	startLine	MGL1305OBS07T	NaN	NaN	36.51497	-33.65156	2778.4	Start of line MGL1305OBS07T FSP 6503 at 1125 UTC
Mon 22 Apr 2013 11:47:27	Airgun:Array	endLine	MGL1305OBS07T	NaN	NaN	36.52487	-33.67809	2558.7	End of line MGL1305OBS07T at SP 7509 at 1145 UTC
Mon 22 Apr 2013 11:51:05	Airgun:Array	startLine	MGL1305OBS08	NaN	NaN	36.52332	-33.68339	2390	Start of line MGL1305OBS08 FSP 8002 at 1150 UTC
Mon 22 Apr 2013 11:55:01	Ship	other	MGL1305OBS08	NaN	NaN	36.52030	-33.68824	2369.42	End of port turn at 1154 UTC
Mon 22 Apr 2013 13:30:31	Airgun:Array	passingOverStation	MGL1305OBS08	OBS010	SP8033	36.44063	-33.79893	1090	Passing OBS010 at SP8033 13:30
Mon 22 Apr 2013 14:17:56	Airgun:Array	passingOverStation	MGL1305OBS08	OBS009	SP8048	36.39954	-33.85489	1728	Passing OBS009 at SP8048 14:17

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Mon 22 Apr 2013 15:00:32	Airgun:Array	passingOverStation	MGL1305OBS08	OBS008	SP8061	36.36426	-33.90363	1511	Passing OBS008 between SP8061 and SP8062 at 1500
Mon 22 Apr 2013 15:40:26	Airgun:Array	passingOverStation	MGL1305OBS08	OBS007	SP8073	36.33220	-33.94805	1605	Passing OBS007 at SP8073 15:40
Mon 22 Apr 2013 16:40:12	Airgun:Array	passingOverStation	MGL1305OBS08	OBS005	SP8090	36.28293	-34.01544	2145	Passing OBS005 at SP8090 16:36
Mon 22 Apr 2013 17:16:11	Airgun:Array	passingOverStation	MGL1305OBS08	OBS004	SP8102	36.25336	-34.05638	2374	Passing OBS004 at SP8102 17:16
Mon 22 Apr 2013 17:57:56	Airgun:Array	passingOverStation	MGL1305OBS08	OBS003	SP8115	36.21797	-34.10505	1972	Passing OBS003 at SP8115 17:57
Mon 22 Apr 2013 18:51:20	Airgun:Array	passingOverStation	MGL1305OBS08	OBS002	SP8130	36.17439	-34.16397	1076	Passing OBS002 at SP8130 18:47
Mon 22 Apr 2013 19:46:51	Airgun:Array	passingOverStation	MGL1305OBS08	OBS001	SP8146	36.12821	-34.22724	1458	Passing OBS001 at SP8146 19:46
Mon 22 Apr 2013 21:11:25	Airgun:Array	endLine	MGL1305OBS08	NaN	NaN	36.06261	-34.32576	1926	Last Shot SP 8173 at 21:08 UTC
Mon 22 Apr 2013 21:16:17	Airgun:Array	startLine	MGL1305OBS08T	NaN	NaN	36.06465	-34.33239		First shot SP 8503 at 21:16
Mon 22 Apr 2013 21:33:26	Airgun:Array	endLine	MGL1305OBS08T	NaN	NaN	36.08114	-34.34724	2062	End of line MGL1305OBS08T LSP 8508
Mon 22 Apr 2013 21:41:19	Airgun:Array	startLine	MGL1305OBS09	NaN	NaN	36.09039	-34.34471	2113	Start of line MGL1305OBS09 FSP 9003
Mon 22 Apr 2013 22:58:42	Airgun:Array	passingOverStation	MGL1305OBS09	OBS001	NaN	36.15616	-34.25562	1926	Passing OBS001 at SP9028
Mon 22 Apr 2013 23:55:40	Airgun:Array	passingOverStation	MGL1305OBS09	OBS002	NaN	36.20477	-34.18918	1865	Passing OBS002 at SP9045
Tue 23 Apr 2013 00:47:42	Airgun:Array	passingOverStation	MGL1305OBS09	OBS003	NaN	36.24812	-34.12933	1712	Passing OBS003 at SP9061
Tue 23 Apr 2013 01:29:13	Airgun:Array	passingOverStation	MGL1305OBS09	OBS004	NaN	36.28392	-34.08134	2431	Passing OBS004 at SP9074
Tue 23 Apr 2013 02:05:32	Airgun:Array	passingOverStation	MGL1305OBS09	OBS005	NaN	36.31371	-34.04033	2475	Passing OBS005 at SP9085
Tue 23 Apr 2013 02:35:25	Airgun:Array	passingOverStation	MGL1305OBS09	OBS006	NaN	36.33788	-34.00678	1971.1	SP 9094 by: kCurtis
Tue 23 Apr 2013 03:05:26	Airgun:Array	passingOverStation	MGL1305OBS09	OBS007	NaN	36.36270	-33.97264	1940	SP 9103 by: kCurtis
Tue 23 Apr 2013 03:40:40	Airgun:Array	passingOverStation	MGL1305OBS09	OBS 08	NaN	36.39199	-33.93186	1855	SP 9114 by: kCurtis
Tue 23 Apr 2013 04:04:56	EM122	start	NaN	NaN	NaN	36.41116	-33.90586		Start new multibeam survey MGL1305A due to running out of memory
Tue 23 Apr 2013 04:11:05	Echosounder3.5	startLine	NaN	NaN	NaN	36.41606	-33.89907		restarted knudsen
Tue 23 Apr 2013 04:30:49	Airgun:Array	passingOverStation	MGL1305OBS09	OBS 09	NaN	36.43212	-33.87684	1031	SP 9127 by: kCurtis
Tue 23 Apr 2013 05:19:52	Airgun:Array	passingOverStation	MGL1305OBS09	OBS010	NaN	36.47237	-33.82126	1134.7	Passing OBS010 at SP9143 on starboard side (Southeast) at 0517 UTC
Tue 23 Apr 2013 06:15:41	Airgun:Array	passingOverStation	MGL1305OBS09	OBS011	NaN	36.51957	-33.75593	1369.3	Passing OBS011 at SP9161 on starboard side (Southeast) at 0615 UTC
Tue 23 Apr 2013 07:13:02	Ship	other	MGL1305OBS09	NaN	NaN	36.56713	-33.68871	2440.12	Start of starboard turn at 0710 UTC
Tue 23 Apr 2013 07:15:20	Airgun:Array	endLine	MGL1305OBS09	NaN	NaN	36.56794	-33.68522	2531.8	End of line MGL1305OBS09 LSP9179 at 0712UTC
Tue 23 Apr 2013 07:50:47	Airgun:Array	startLine	MGL1305OBS010	NaN	NaN	36.54026	-33.65976	2763.4	Start of line MGL1305OBS010 FSP 9994 at 0749 UTC. FSP on straight away gridded line is 100
Tue 23 Apr 2013 08:24:47	Ship	other	MGL1305OBS010	NaN	NaN	36.53090	-33.70687	1958.21	End of starboard turn at 0823 UTC
Tue 23 Apr 2013 09:00:54	Airgun:Array	passingOverStation	MGL1305OBS10	OBS 11	NaN	36.50070	-33.74809	1350	SP 10014 by: kCurtis
Tue 23 Apr 2013 09:55:51	Airgun:Array	passingOverStation	MGL1305OBS010	OBS010	NaN	36.45506	-33.81121	1152.1	Passing OBS010 on port side (Southeast) at SP10031 at 0955 UTC
Tue 23 Apr 2013 10:47:34	Airgun:Array	passingOverStation	MGL1305OBS010	OBS009	NaN	36.41142	-33.87152	741.2	Passing OBS009 at SP10047 at 1046
Tue 23 Apr 2013 11:28:56	Airgun:Array	passingOverStation	MGL1305OBS010	OBS008	NaN	36.37655	-33.91952	1523	Passing OBS008 at SP10060 at 1128 UTC
Tue 23 Apr 2013 12:03:38	Airgun:Array	passingOverStation	MGL1305OBS010	OBS007	NaN	36.34662	-33.96080	2012.1	Passing OBS007 at SP10071 at 1203 UTC
Tue 23 Apr 2013 12:32:13	Airgun:Array	passingOverStation	MGL1305OBS010	OBS006	NaN	36.32250	-33.99457	2153.7	Passing OBS006 at SP10080 at 1231 UTC
Tue 23 Apr 2013 13:01:06	Airgun:Array	passingOverStation	MGL1305OBS10	OBS005	SP10089	36.29827	-34.02798	2389	Passing OBS005 at SP10089 at 13:00
Tue 23 Apr 2013 15:24:11	Airgun:Array	passingOverStation	MGL1305OBS10	OBS004	NaN			2328	Passing OBS004 at SP10100 UTC13:37

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Tue 23 Apr 2013 15:27:16	Airgun:Array	passingOverStation	MGL1305OBS10	OBS003	NaN			2169	Passing OBS003 at SP10113 UTC14:19
Tue 23 Apr 2013 15:29:02	Airgun:Array	passingOverStation	MGL1305OBS10	OBS002	NaN			1484	Passing OBS002 at SP10129 UTC15:11
Tue 23 Apr 2013 16:10:31	Airgun:Array	passingOverStation	MGL1305OBS010	OBS001	SP10147	36.14068	-34.24359	1750	Passing OBS002 at SP10147 UTC16:10
Tue 23 Apr 2013 17:25:41	Ship	other	MGL1305OBS10	NaN	NaN	36.07861	-34.32848	2018	Start of turn
Tue 23 Apr 2013 17:29:32	Airgun:Array	endLine	MGL1305OBS010	NaN	NaN	36.07454	-34.33168	1983	Last shot SP10171
Tue 23 Apr 2013 17:30:25	Airgun:Array	other	turn to MGL1305OBS10T	NaN	NaN	36.07344	-34.33217	2013	Shooting guns at 17 s intervals
Tue 23 Apr 2013 17:38:24	Airgun:Array	startLine	MGL1305OBS010T	NaN	NaN	36.06304	-34.33077	1918	First shot SP10503 at 17:38
Tue 23 Apr 2013 17:41:33	Ship	other	MGL1305OBS010T	NaN	NaN	36.05963	-34.32782	1929	End of turn
Tue 23 Apr 2013 17:53:02	Ship	other	MGL1305OBS010T	NaN	NaN	36.04972	-34.31441	1785	Start of turn
Tue 23 Apr 2013 17:54:19	Airgun:Array	endLine	MGL1305OBS010T	NaN	NaN	36.04922	-34.31250	1744	Last shot SP10508
Tue 23 Apr 2013 17:55:22	Airgun:Array	other	turn to MGL1305OBS11	NaN	NaN	36.04894	-34.31087		Shooting guns at 17 s intervals
Tue 23 Apr 2013 18:02:20	Airgun:Array	startLine	MGL1305OBS11	NaN	NaN	36.05041	-34.30037	1654	First shot SP11003 at 18:02
Tue 23 Apr 2013 18:20:41	EM122	other	MGL1305OBS11	NaN	NaN	36.06532	-34.27967		Logging briefly stopped to restart SVP server
Tue 23 Apr 2013 19:24:15	Airgun:Array	passingOverStation	MGL1305OBS11	OBS001	SP11028	36.11815	-34.20665	1633	Passing OBS001 at SP110028 UTC19:24
Tue 23 Apr 2013 20:22:19	Airgun:Array	passingOverStation	MGL1305OBS11	OBS002	SP11045	36.16799	-34.13982	1395	Passing OBS002 at SP11045 UTC20:17
Tue 23 Apr 2013 21:09:03	Airgun:Array	passingOverStation	MGL1305OBS11	OBS003	SP 11061	36.20794	-34.08480	1709	Passing OBS003 at SP 11061
Tue 23 Apr 2013 21:48:22	Airgun:Array	passingOverStation	MGL1305OBS11	OBS004	SP 11074	36.24083	-34.03975	2500	Passing OBS004 at SP 11074 at 21:51 UTC
Tue 23 Apr 2013 22:28:21	Airgun:Array	passingOverStation	MGL1305OBS11	OBS005	SP 11085	36.27354	-33.99542	2320	Passing OBS005 at SP 11085
Tue 23 Apr 2013 22:57:23	Airgun:Array	passingOverStation	MGL1305OBS11	OBS006	SP 11094	36.29799	-33.96175	1852	Passing OBS006 at SP11094
Tue 23 Apr 2013 23:27:02	Airgun:Array	passingOverStation	MGL1305OBS11	OBS007	SP 11103	36.32256	-33.92723	1515	Passing OBS007 at SP 11103
Wed 24 Apr 2013 00:02:46	Airgun:Array	passingOverStation	MGL1305OBS11	OBS008	SP 11114	36.35173	-33.88756	2139	Passing OBS008 at SP 11114
Wed 24 Apr 2013 00:48:10	Airgun:Array	passingOverStation	MGL1305OBS11	OBS009	SP 11128	36.38965	-33.83463	1733	Passing OBS009 at SP 11128
Wed 24 Apr 2013 01:38:12	Airgun:Array	passingOverStation	MGL1305OBS11	OBS010	SP 11143	36.43069	-33.77863	1631	by: kCurtis
Wed 24 Apr 2013 01:46:00	Echosounder3.5	abortLine	NaN	NaN	NaN	36.43739	-33.76968		Knudsend failure at UTC 1:40, restarted at 01:46
Wed 24 Apr 2013 02:37:01	Airgun:Array	passingOverStation	MGL1305OBS11	OBS011	SP 11161	36.47894	-33.71170	2184	by: kCurtis
Wed 24 Apr 2013 03:27:44	Airgun:Array	endLine	MGL1305OBS11		SP 11176	36.51944	-33.65546	2784	by: kCurtis
Wed 24 Apr 2013 03:35:24	magnetometer	stop	MGL1305OBS11	NaN	NaN	36.52546	-33.64711		
Wed 24 Apr 2013 03:54:35	Airgun:Array	recover	NaN	NaN	NaN	36.54059	-33.62629		Begin recovery of string 3 at 3:52 UTC
Wed 24 Apr 2013 04:19:30	Airgun:Array	recover	NaN	NaN	NaN	36.56102	-33.59832		string 3 on board at 4:17 UTC
Wed 24 Apr 2013 04:20:09	Airgun:Array	recover	NaN	NaN	NaN	36.56154	-33.59763		begin recovery of string 4 at 4:19 UTC
Wed 24 Apr 2013 04:49:52	Airgun:Array	recover	NaN	NaN	NaN	36.58573	-33.56504		String 4 on board at 4:42 UTC
Wed 24 Apr 2013 04:50:24	Airgun:Array	recover	NaN	NaN	NaN	36.58611	-33.56452		begin recovery of string 2 at 4:42 UTC
Wed 24 Apr 2013 04:51:12	Echosounder3.5	endLine	NaN	NaN	NaN	36.58670	-33.56370		Knudsen taken offline for entry into EEZ
Wed 24 Apr 2013 04:52:04	EM122	stop	NaN	NaN	NaN	36.58742	-33.56279		multibeam taken offline for entry into EEZ
Wed 24 Apr 2013 05:03:34	Airgun:Array	recover	NaN	NaN	NaN	36.59676	-33.54974		gun string 2 on board at 5:02 UTC
Wed 24 Apr 2013 05:06:10	Airgun:Array	recover	NaN	NaN	NaN	36.59904	-33.54695		begin recovery of string 1 at 5:02 UTC
Wed 24 Apr 2013 06:04:44	Airgun:Array	recover	NaN	NaN	NaN	36.64656	-33.42933		all guns onboard

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Wed 24 Apr 2013 10:17:11	EM122	other	NaN	NaN	NaN	36.86642	-32.66792	1871	Performed a self test (BIST) on multi-beam at 1006 UTC. Everything past at 1014 UTC
Wed 24 Apr 2013 12:40:11	EM122	other	NaN	NaN	NaN	36.99867	-32.19545	2045	Multibeam system froze at 1014UTC, rebooted and started pinging at 1032 UTC
Fri 26 Apr 2013 07:42:08	EM122	start	NaN	NaN	NaN	36.52952	-33.44750	2522	Started multibeam out of EEZ at 0740 UTC
Fri 26 Apr 2013 07:43:10	Echosounder3.5	startLine	NaN	NaN	NaN	36.52825	-33.44976	2353	Started echosounder out of EEZ at 0740 UTC
Fri 26 Apr 2013 09:34:47	Ship	other	NaN	NaN	NaN	36.38210	-33.65129	2646	Ship tried a test turn to see how ship would respond in seas at 0934. End turn at 0939 UTC
Sat 27 Apr 2013 07:57:26	Airgun:Array	deploy	NaN	NaN	NaN	36.39260	-33.73142	2704	start deployment of airgun array 1
Sat 27 Apr 2013 08:20:09	Airgun:Array	deploy	NaN	NaN	NaN	36.40336	-33.72186	2568	start deployment of airgun array 2
Sat 27 Apr 2013 08:38:54	Airgun:Array	deploy	NaN	NaN	NaN	36.41157	-33.70787	2341	start deployment of airgun array 3
Sat 27 Apr 2013 09:31:28	Airgun:Array	deploy	NaN	NaN	NaN	36.43581	-33.65654		start deployment of airgun array 4
Sat 27 Apr 2013 10:09:08	Airgun:Array	other	NaN	NaN	NaN	36.45056	-33.60709		Ramp up is over. Starting to shoot at full power 6600CI
Sat 27 Apr 2013 11:05:45	Airgun:Array	startLine	MGL1305OBS12	NaN	NaN	36.49491	-33.58287	2173	Start of line MGL1305OBS12 FSP 11496 at 1103 UTC.
Sat 27 Apr 2013 11:52:24	Other	start	NaN	NaN	NaN	36.47972	-33.64401		Maggie and Pam remain inside due to the weather conditions
Sat 27 Apr 2013 12:29:50	Airgun:Array	passingOverStation	MGL1305OBS12	OBS012	NaN	36.44877	-33.68748	2316	Passing OBS012 on Port side (South) at 1228 UTC SP 11519
Sat 27 Apr 2013 13:27:57	Airgun:Array	passingOverStation	MGL1305OBS12	OBS010 OBS013	SP11537	36.40091	-33.75373	2608	Passing OBS010 and OBS013 at 1327 UTC SP 11537
Sat 27 Apr 2013 14:18:48	Airgun:Array	passingOverStation	MGL1305OBS12	OBS009 OBS014	SP 11552	36.35790	-33.81236	2154	Passing OBS009 and OBS014 at 1327 UTC SP 11537
Sat 27 Apr 2013 14:44:37	Airgun:Array	other	MGL1305OBS012	NaN	NaN	36.33650	-33.84186	2020	Power down at 1444 UTC for Turtle, last full shoot 11560
Sat 27 Apr 2013 14:52:21	Airgun:Array	other	MGL1305OBS012	NaN	NaN	36.33029	-33.85051	2197	Airgun full power at 1452UTC SP11563
Sat 27 Apr 2013 15:02:06	Airgun:Array	passingOverStation	MGL1305OBS012	OBS015	SP11566	36.32223	-33.86164	2603	Passing OBS015 at 1502 UTC SP 11566
Sat 27 Apr 2013 15:38:59	Airgun:Array	passingOverStation	MGL1305OBS012	OBS016	SP11577	36.29245	-33.90273	2447	Passing OBS016 at 1538 UTC SP 11577
Sat 27 Apr 2013 16:11:36	Airgun:Array	passingOverStation	MGL1305OBS012	OBS016	SP11586	36.26551	-33.93982	2615	Passing OBS016 at 1608 UTC SP 11586
Sat 27 Apr 2013 16:32:48	Airgun:Array	other	MGL1305OBS012	NaN	SP11591	36.24809	-33.96398		Missed SP11591 due to network hanging up
Sat 27 Apr 2013 16:34:44	Airgun:Array	passingOverStation	MGL1305OBS012	OBS020	SP11594	36.24637	-33.96616	3107	Passing OBS020 at 1634 UTC SP 11594
Sat 27 Apr 2013 17:14:11	Airgun:Array	passingOverStation	MGL1305OBS012	OBS021	SP11606	36.21377	-34.01070	2538	Passing OBS021 at 1713 UTC SP 11606
Sat 27 Apr 2013 17:56:06	Airgun:Array	passingOverStation	MGL1305OBS012	OBS022	SP11619	36.17845	-34.05924	2655	Passing OBS022 at 1755 UTC SP 11619
Sat 27 Apr 2013 18:49:17	Airgun:Array	passingOverStation	MGL1305OBS012	OBS002 and OBS023	SP11635	36.13498	-34.11831	1420	Passing OBS002 and OBS023 at 18:49 UTC SP 11635

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sat 27 Apr 2013 19:50:52	Airgun:Array	passingOverStation	MGL1305OBS12	OBS001 and OBS024	SP11652	36.08366	-34.18901	2143	Passing OBS001 and OBS022 at 19:44 UTC SP11652
Sat 27 Apr 2013 21:07:49	Airgun:Array	endLine	MGL1305OBS12	11677	NaN	36.01926	-34.27235	1696	Last shot SP11677 at 21:07 UTC
Sat 27 Apr 2013 21:16:30	Airgun:Array	startLine	MGL1305OBS12T	12003	NaN	36.00922	-34.27054	1804	First shot SP12003 at 21:15 UTC
Sat 27 Apr 2013 21:33:49	Airgun:Array	endLine	MGL1306OBS12T	12008	NaN	35.99634	-34.25122	1893	End of Line MGL1305OBS12T at SP12008 21:33 UTC
Sat 27 Apr 2013 21:42:28	Airgun:Array	startLine	MGL1305OBS13	12503	NaN	35.99802	-34.23931	1815	First shot of MGL1305OBS13 at SP 12503 21:41 UTC
Sat 27 Apr 2013 23:24:07	Airgun:Array	passingOverStation	MGL1305OBS13	OBS024	NaN	36.08057	-34.12659	2532	Nearest shot to OBS024 SP 12528 at 23:04 UTC
Sun 28 Apr 2013 00:52:50	Airgun:Array	passingOverStation	MGL1305OBS13	OBS 23	NaN	36.15234	-34.02856	2809	Nearest shot to OBS023: SP12505 at 0:02 UTC
Sun 28 Apr 2013 00:58:41	Airgun:Array	passingOverStation	MGL1305OBS13	OBS024	NaN	36.15726	-34.02202	2556	Nearest shot to OBS022: SP12561 at 0:55 UTC
Sun 28 Apr 2013 01:41:45	Airgun:Array	passingOverStation	MGL1305OBS13	OBS 21	NaN	36.19231	-33.97404	3064	Nearest shot to OBS021: SP15574 at 1:39 UTC
Sun 28 Apr 2013 02:19:57	Airgun:Array	passingOverStation	MGL1305OBS13	OBS020	NaN	36.22321	-33.93123	3146	Nearest shot to OBS020: SP12583, 02:15 UTC
Sun 28 Apr 2013 02:47:24	Airgun:Array	passingOverStation	MGL1305OBS13	OBS018	NaN	36.24604	-33.89987	2431	Nearest shot to OBS018: SP12594, 2:44 UTC
Sun 28 Apr 2013 03:15:25	Airgun:Array	passingOverStation	MGL1305OBS13	OBS016	NaN	36.26897	-33.86803	2431	Nearest shot to OBS016: SP12603, 3:14 UTC
Sun 28 Apr 2013 03:55:06	Airgun:Array	passingOverStation	MGL1305OBS13	OBS015	NaN	36.30126	-33.82402	2782	Nearest shot to OBS015: SP12614, 3:51 UTC
Sun 28 Apr 2013 04:34:02	Airgun:Array	passingOverStation	MGL1305OBS13	OBS014	NaN	36.33386	-33.77926	2958	Nearest shot to OBS014: SP12627, 4:33 UTC
Sun 28 Apr 2013 05:02:31	ObserverMammals	other	MGL1305OBS13	NaN	NaN	36.35805	-33.74581	2803	PAM had been deployed at 0452 UTC
Sun 28 Apr 2013 05:25:44	Airgun:Array	passingOverStation	MGL1305OBS13	OBS13	NaN	36.37676	-33.71950	2688	Passing OBS013 on Port side (North) at 0525 UTC SP 12643
Sun 28 Apr 2013 06:25:41	Airgun:Array	passingOverStation	MGL1305OBS13	OBS13	NaN	36.42548	-33.65194	2574	Passing OBS012 on Port side (North) at 0625 UTC SP 12661
Sun 28 Apr 2013 07:26:41	Ship	other	MGL1305OBS13	NaN	NaN	36.47448	-33.58270	2087	Starting startboard turn to new line MG1305OBS13T at 0724 UTC
Sun 28 Apr 2013 07:29:36	Airgun:Array	endLine	MGL1305OBS13	NaN	NaN	36.47539	-33.57848	2025	End of Line MGL1305OBS13 at SP12680 0728 UTC
Sun 28 Apr 2013 07:34:25	Airgun:Array	startLine	MGL1305OBS13T	NaN	NaN	36.47488	-33.57168	1988	Start of line MGL1305OB13T FSP 13002 at 0734 UTC
Sun 28 Apr 2013 07:52:05	Airgun:Array	endLine	MGL1305OBS13T	NaN	NaN	36.46108	-33.55191	1435	End of Line MGL1305OBS13T at SP13007 0750 UTC
Sun 28 Apr 2013 08:00:23	Airgun:Array	startLine	MGL1305OBS14	NaN	NaN	36.45112	-33.55220	1460	Start of line MGL1305OBS14 FSP 13503 at 0800 UTC
Sun 28 Apr 2013 08:07:36	Ship	other	MGL1305OBS14	NaN	NaN	36.44448	-33.55936	1477	End of starboard turn at 0806 UTC
Sun 28 Apr 2013 08:25:19	magnetometer	start	MGL1305OBS14	NaN	NaN	36.42954	-33.57998	1588	magnetometer deployed at 0824 UTC

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sun 28 Apr 2013 09:09:33	Airgun:Array	passingOverStation	MGL1305OBS14	OBS035	NaN	36.39317	-33.62994	2340	Passing OBS035 on Port side (South) at 0905 UTC SP 13503
Sun 28 Apr 2013 10:04:43	Airgun:Array	passingOverStation	MGL1305OBS14	OBS034	NaN	36.34808	-33.69347	2806	Passing OBS034 on Port side (South) at 1004 UTC SP 13541
Sun 28 Apr 2013 10:40:47	Airgun:Array	other	MGL1305OBS14	NaN	NaN	36.31816	-33.73415	2479	Power down at 1040 UTC for MMO
Sun 28 Apr 2013 10:55:46	Airgun:Array	other	MGL1305OBS14	NaN	NaN	36.30742	-33.74923	2213	Back to full power SP 13556 at 1055 UTC
Sun 28 Apr 2013 10:59:28	Airgun:Array	passingOverStation	MGL1305OBS14	OBS033	NaN	36.30456	-33.75305	2164	Passing OBS033 on Port side (South) at 1059 UTC SP 13557
Sun 28 Apr 2013 11:38:12	EM122	stop	MGL1305OBS14	NaN	NaN	36.27291	-33.79636	2782	Logging briefly stopped to perform a BIST at 1137 UTC
Sun 28 Apr 2013 11:43:51	Airgun:Array	passingOverStation	MGL1305OBS14	OBS032	NaN	36.26826	-33.80261	NA center	Passing OBS035 on Port side (South) at beam off 1132 UTC SP 13570 for BIST
Sun 28 Apr 2013 11:58:51	EM122	start	MGL1305OBS14	NaN	NaN	36.25626	-33.81934	2903	EM122 system back on after acoustic test at 1157 UTC
Sun 28 Apr 2013 12:19:43	Airgun:Array	passingOverStation	MGL1305OBS14	OBS031	NaN	36.23918	-33.84302	2512	Passing OBS031 on Port side (South) at 1219 UTC SP 13581
Sun 28 Apr 2013 12:49:33	Airgun:Array	passingOverStation	MGL1305OBS14	OBS030	SP13590	36.21501	-33.87655		Passing OBS030 on Port side (South) at 12:48 UTC SP 13590
Sun 28 Apr 2013 13:05:52	Airgun:Array	passingOverStation	MGL1305OBS14	OBS019	SP13595	36.20179	-33.89452	2244	Passing OBS019 at 1305 UTC SP 13595
Sun 28 Apr 2013 13:57:45	Airgun:Array	passingOverStation	MGL1305OBS14	OBS028	SP13610	36.15832	-33.95355	2925	Passing OBS028 on Port side (South) at 13:54 UTC SP 13610
Sun 28 Apr 2013 14:37:23	Airgun:Array	passingOverStation	MGL1305OBS24	OBS27	SP13623	36.12549	-33.99876	2904	Passing OBS027 on Port side (South) at 14:37 UTC SP 13623
Sun 28 Apr 2013 15:29:48	Airgun:Array	passingOverStation	MGL1305OBS14	OBS026	SP13639	36.08158	-34.05913	2775	Passing OBS026 on Port side (South) at 15:28 UTC SP 13639
Sun 28 Apr 2013 16:29:14	Airgun:Array	passingOverStation	MGL1305OBS14	OBS025	SP13657	36.03345	-34.12486	2427	Passing OBS025 at 1629 UTC SP 13657
Sun 28 Apr 2013 17:43:47	Ship	other	MGL1305OBS14	NaN	NaN	35.97077	-34.20985	1989	Start of turn
Sun 28 Apr 2013 17:47:10	Airgun:Array	endLine	MGL1305OBS14	SP13681	NaN	35.96698	-34.21234	1975	End of Line MGL1305OBS14 at SP13681 1747 UTC
Sun 28 Apr 2013 17:56:02	Airgun:Array	startLine	MGL1305OBS14T	SP14003	NaN	35.95658	-34.21127	2342	Start of line MGL1305OBS14T FSP 14003 at 1755 UTC
Sun 28 Apr 2013 18:07:08	Ship	other	MGL1305OBS14T	NaN	NaN	35.94653	-34.20037	2328	Start of turn
Sun 28 Apr 2013 18:12:57	Airgun:Array	endLine	MGL1305OBS14T	SP14008	NaN	35.94296	-34.19227	2247	End of Line MGL1305OBS14T at SP14008 1812 UTC
Sun 28 Apr 2013 18:19:21	Airgun:Array	other	MGL1305OBS15	NaN	NaN	35.94304	-34.18271		Power down at 1818 UTC for Whale
Sun 28 Apr 2013 18:21:18	Airgun:Array	startLine	MGL1305OBS15	FSP14503	NaN	35.94400	-34.18013	2376	Start of line MGL1305OBS15 FSP 14503 at 1820 UTC
Sun 28 Apr 2013 18:35:44	Ship	other	MGL1305OBS15	NaN	NaN	35.95509	-34.16483		Slowed down to 3 knots untill we can shoot at full power again
Sun 28 Apr 2013 18:48:31	Airgun:Array	other	MGL1305OBS15	NaN	NaN	35.96276	-34.15455	2383	Back to full power first shot SP14510 at 18:48
Sun 28 Apr 2013 19:43:49	Airgun:Array	passingOverStation	MGL1305OBS15	OBS025	SP14527	36.00864	-34.09219	2686	Passing OBS025 at 1943 UTC SP 14527
Sun 28 Apr 2013 20:46:20	Airgun:Array	passingOverStation	NaN	OBS026	SP14545	36.06014	-34.02156	2445	Passing OBS026 at 2042 UTC SP 14545

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sun 28 Apr 2013 21:41:12	Airgun:Array	passingOverStation	MGL1305OBS15	OBS027		36.10612	-33.95894	2303	Nearest shot to OBS027: SP14561, 21:35 UTC
Sun 28 Apr 2013 22:19:12	Airgun:Array	passingOverStation	MGL1305OBS15	OBS028		36.13796	-33.91553	1901	Nearest shot to OBS028: 14574, 22:17 UTC
Sun 28 Apr 2013 23:34:58	Airgun:Array	passingOverStation	MGL1305OBS15	OBS30	NaN	36.19988	-33.83050	2415	Nearest shot to OBS030: SP 14594, 23:23 UTC
Sun 28 Apr 2013 23:59:16	Airgun:Array	passingOverStation	MGL1305OBS15	OBS031	NaN	36.22026	-33.80254		Nearest shot to OBS031: SP14603, 23:52 UTC
Mon 29 Apr 2013 00:33:07	Airgun:Array	passingOverStation	OBS1305OBS15	OBS032	NaN	36.24831	-33.76387	2912	Nearest shot to OBS032: 14614, 00:29 UTC
Mon 29 Apr 2013 01:15:15	Airgun:Array	passingOverStation	MGL1305OBS15	OBS033	NaN	36.28321	-33.71612	2524	Nearest shot to OBS033: SP14628, 1:14 UTC
Mon 29 Apr 2013 02:05:40	Airgun:Array	passingOverStation	MGL1305OBS15	OBS034	NaN	36.32372	-33.65998	2065	Nearest shot to OBS034: SP14643, 2:05 UTC
Mon 29 Apr 2013 03:06:06	Airgun:Array	passingOverStation	MGL1305OBS15	OBS035	NaN	36.37295	-33.59117	1783	Nearest shot to OBS035: SP14661, 3:04 UTC
Mon 29 Apr 2013 04:15:51	Airgun:Array	endLine	MGL1305OBS15	NaN	NaN	36.42500	-33.51324	1730	End of line MGL1305OBS15 at SP14681 at 4:13 UTC
Mon 29 Apr 2013 04:19:07	Airgun:Array	startLine	MGL1305OBS15T	NaN	NaN	36.42445	-33.50849	1418	First shot of MGL1305OBS15T SP15002 at 04:18 UTC
Mon 29 Apr 2013 04:39:59	Airgun:Array	endLine	MGL1305OBS15T	NaN	NaN	36.40509	-33.48911	1569	End of line MGL1305OBS15T at SP15008 at 04:38 UTC
Mon 29 Apr 2013 04:47:11	Airgun:Array	startLine	MGL1305OBS16	NaN	NaN	36.39673	-33.49237	1577	Start of line MGL1305OBS016; SP 15502 at 04:42 UTC
Mon 29 Apr 2013 05:51:58	Airgun:Array	passingOverStation	MGL1305OBS16	OBS036	NaN	36.34297	-33.56637	1911	Passing OBS036 on Port side (South) at 0552 UTC SP 15523
Mon 29 Apr 2013 06:49:44	Airgun:Array	passingOverStation	MGL1305OBS16	OBS037	NaN	36.29418	-33.63410	1966	Passing OBS037 on Port side (South) at 0649 UTC SP 15541
Mon 29 Apr 2013 07:38:46	Airgun:Array	passingOverStation	MGL1305OBS16	OBS038	NaN	36.25327	-33.69012	2317	Passing over OBS038 at 0738 UTC SP 15556
Mon 29 Apr 2013 08:24:30	Airgun:Array	passingOverStation	MGL1305OBS16	OBS039	NaN	36.21555	-33.74222	2563	Passing over OBS039 at 0824 UTC SP 15570
Mon 29 Apr 2013 08:45:22	Airgun:Array	other	MGL1305OBS16	NaN	NaN	36.19855	-33.76572	2268	Power down at 0844 UTC for MMO
Mon 29 Apr 2013 09:11:54	Airgun:Array	other	MGL1305OBS16	NaN	NaN	36.17751	-33.79442		Back to full power first shot SP15583 at 0907
Mon 29 Apr 2013 09:14:06	Airgun:Array	passingOverStation	MGL1305OBS16	OBS040	NaN	36.17577	-33.79685	2073	Passing over OBS040 at 0900 UTC SP 15581
Mon 29 Apr 2013 09:31:36	Airgun:Array	passingOverStation	MGL1305OBS16	OBS041	NaN	36.16172	-33.81594	1925	Passing over OBS041 at 0931 UTC SP 15590
Mon 29 Apr 2013 10:01:08	Airgun:Array	passingOverStation	MGL1305OBS16	OBS042	NaN	36.13761	-33.84985	2219	Passing over OBS042 at 1000 UTC SP 15599
Mon 29 Apr 2013 10:36:42	Airgun:Array	passingOverStation	MGL1305OBS16	OBS043	NaN	36.10730	-33.89080	2175	Passing over OBS043 at 1036 UTC SP 15610

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Mon 29 Apr 2013 11:19:40	Airgun:Array	passingOverStation	MGL1305OBS16	OBS044	NaN	36.07138	-33.94026	2232	Passing over OBS044 at 1118 UTC SP 15623
Mon 29 Apr 2013 11:28:41	Airgun:Array	other	MGL1305OBS016	NaN	NaN	36.06377	-33.95068	2325	Power down at 1124UTC for MMO last FV 15625. Back to full power at 1134 UTC sp15628
Mon 29 Apr 2013 12:10:26	Airgun:Array	passingOverStation	MGL1305OBS16	OBS045	NaN	36.02888	-33.99858	2291	Passing over OBS045 at 1210 UTC SP 15639
Mon 29 Apr 2013 13:06:14	Airgun:Array	passingOverStation	MGL1305OBS16	OBS046	SP15656	35.98306	-34.06151	2426	Passing over OBS046 at 1306 UTC SP 15656
Mon 29 Apr 2013 14:23:27	Ship	other	MGL1305OBS16	NaN	NaN	35.91884	-34.14861	2224	Start of turn
Mon 29 Apr 2013 14:28:32	Airgun:Array	endLine	MGL1305OBS16	SP15681	NaN	35.91362	-34.15270	2254	Last shot SP15681 at 14:28 UTC
Mon 29 Apr 2013 14:37:41	Airgun:Array	startLine	MGL1305OBS16T	FSP16003	NaN	35.90285	-34.15162	2354	Start of line MGL1305OBS16T FSP 16003 at 1437 UTC
Mon 29 Apr 2013 14:54:10	Airgun:Array	endLine	MGL1305OBS16T	SP16007	NaN	35.88931	-34.13322		End of line MGL1305OBS16T at SP16007 at 14:50 UTC
Mon 29 Apr 2013 15:04:10	Airgun:Array	startLine	MGL1305OBS17	FSP16504	NaN	35.89241	-34.11740	1679	Start of line MGL1305OBS17 FSP 16504 at 1504 UTC
Mon 29 Apr 2013 16:28:43	Airgun:Array	passingOverStation	MGL1305OBS17	OBS046	SP16528	35.96280	-34.02230		Passing OBS046 at 1622 UTC SP 16528
Mon 29 Apr 2013 17:22:10	Airgun:Array	passingOverStation	MGL1305OBS17	OBS045	SP16546	36.00670	-33.96231	1965	Passing OBS046 at 1722 UTC SP 16546
Mon 29 Apr 2013 18:23:23	Airgun:Array	other	MGL1305OBS17	NaN		36.05736	-33.89220	1410	Power down at 18.21 UTC for Turtle SP 16567
Mon 29 Apr 2013 18:31:38	Airgun:Array	other	MGL1305OBS17	NaN	NaN	36.06386	-33.88339	1374	Back to full power first shot SP16567 at 18:31
Mon 29 Apr 2013 19:35:23	Airgun:Array	passingOverStation	MGL1305OBS17	OBS042	SP16585	36.11642	-33.81237	1779	Passing OBS043 at 19:30 UTC SP 16585
Mon 29 Apr 2013 20:30:07	Airgun:Array	other	MGL1305OBS17	NaN	NaN	36.16089	-33.75056	1251	power down 19:29 UTC sp16601 for Whale
Mon 29 Apr 2013 21:06:28	Airgun:Array	other	MGL1305OBS17	NaN	NaN	36.19133	-33.70916	2293	Full Power shot at SP16614 at 21:06 UTC
Tue 30 Apr 2013 00:46:15	Airgun:Array	endLine	MGL1305OBS17	NaN	NaN	36.37158	-33.45644	1528	End of line MGL1305OBS17: SP16681 , 00:45 UTC
Tue 30 Apr 2013 02:15:18	Airgun:Array	startLine	MGL1305OBS19	NaN	NaN	36.30674	-33.52052	1890	Start of line MGL1305OBS19: SP17001 ,02:14 UTC
Tue 30 Apr 2013 02:58:31	Airgun:Array	passingOverStation	MGL1305OBS19	OBS036	NaN	36.34409	-33.56567	1891	Nearest shot to OBS036: SP17014, 2:58 UTC
Tue 30 Apr 2013 03:51:46	Airgun:Array	passingOverStation	MGL1305OBS19	OBS035	NaN	36.39255	-33.61975	2299	Nearest shot to OBS035: SP17030, 03:51 UTC
Tue 30 Apr 2013 04:36:47	Airgun:Array	passingOverStation	MGL1305OBS19	OBS012	NaN	36.43262	-33.66479	2432	Nearest shot to OBS012: SP17043, 4:34 UTC
Tue 30 Apr 2013 05:28:45	Airgun:Array	passingOverStation	MGL1305OBS019	OBS011	NaN	36.48133	-33.71942	1937	Passing over OBS011 at 0526 UTC SP 17059
Tue 30 Apr 2013 06:00:20	Ship	other	MGL1305OBS019	NaN	NaN	36.51050	-33.75296	1289	Started port turn at 0550
Tue 30 Apr 2013 06:02:17	Airgun:Array	endLine	MGL1305OBS019	NaN	NaN	36.51136	-33.75580		End of line MGL1305OBS19: SP17070 at 0602 UTC
Tue 30 Apr 2013 06:07:45	Airgun:Array	startLine	MGL1305OBS020	NaN	NaN	36.51144	-33.76414	1331	Start of line MGL1305OBS20: FSP17502 at 0606 UTC

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Tue 30 Apr 2013 06:53:29	Ship	other	MGL1305OBS020	NaN	NaN	36.47445	-33.81673		Start of port turn at 0651 UTC
Tue 30 Apr 2013 06:57:58	Airgun:Array	endLine	MGL1305OBS020	NaN	NaN	36.46919	-33.81876	1069	End of line MGL1305OBS20: SP17517 at 0656 UTC
Tue 30 Apr 2013 07:02:07	Airgun:Array	startLine	MGL1305OBS021	NaN	NaN	36.46411	-33.81825	1010.1	Start of line MGL1305OBS21: FSP18001 at 0700 UTC
Tue 30 Apr 2013 07:09:09	Ship	other	MGL1305OBS21	NaN	NaN	36.45695	-33.81246	1176	End of port turn at 0706 UTC
Tue 30 Apr 2013 07:41:28	Airgun:Array	passingOverStation	MGL1305OBS021	OBS010	NaN	36.42716	-33.77901	1673	Passing over OBS010 at 0740 UTC SP 18014
Tue 30 Apr 2013 08:32:32	Airgun:Array	passingOverStation	MGL1305OBS021	OBS013	NaN	36.37990	-33.72615	2715	Passing over OBS013 at 0832 UTC SP 18030
Tue 30 Apr 2013 09:16:05	Airgun:Array	passingOverStation	MGL1305OBS21	OBS034	NaN	36.33970	-33.68089	2778	Passing over OBS034 at 0914 UTC SP 18043
Tue 30 Apr 2013 10:06:40	Airgun:Array	passingOverStation	MGL1305OBS21	OBS037	NaN	36.29273	-33.62907	2008	Passing over OBS037 at 1006 UTC SP 18059
Tue 30 Apr 2013 10:38:28	Ship	other	MGL1305OBS021	NaN	NaN	36.26379	-33.59695		Start of starboard turn at 1035 UTC
Tue 30 Apr 2013 10:40:02	Airgun:Array	endLine	MGL1305OBS21	NaN	NaN	36.26209	-33.59568	2045	End of line MGL1305OBS21: SP18068 at 1036 UTC Shut down for MMO and EOL
Tue 30 Apr 2013 10:47:21	Airgun:Array	startLine	MGL1305OBS22	NaN	NaN	36.25309	-33.59452	2119	Start of line MGL1305OBS22: FSP18502 at 1047 UTC
Tue 30 Apr 2013 11:31:22	Airgun:Array	endLine	MGL1305OBS022	NaN	NaN	36.21840	-33.64575	2161	End of line MGL1305OBS22: SP18515 at 1130 UTC
Tue 30 Apr 2013 11:36:42	Airgun:Array	startLine	MGL1305OBS023	NaN	NaN	36.22072	-33.65353	2380	Start of line MGL1305OBS23: FSP19003 at 1136 UTC
Tue 30 Apr 2013 11:45:16	Ship	other	MGL1305OBS23	NaN	NaN	36.22838	-33.66219	2252	End of starboard turn at 1142 UTC
Tue 30 Apr 2013 11:58:59	Airgun:Array	other	MGL1305OBS023	NaN	NaN	36.24094	-33.67608	2245	Shut down at 1156 UTC for MMO last FVS 19009. Back to Full power at 1209 UTC
Tue 30 Apr 2013 12:13:07	Airgun:Array	passingOverStation	MGL1305OBS023	OBS038	NaN	36.25377	-33.69030	2320	Passing over OBS038 at 1213 UTC SP 19014
Tue 30 Apr 2013 12:50:47	Airgun:Array	other	MGL1305OBS023	NaN	NaN	36.28896	-33.72948	2688	Shut down at 1250 UTC for turtle LSP:19025, mitigation gun from SP19027, full volume SP19029
Tue 30 Apr 2013 13:01:37	Airgun:Array	other	MGL1305OBS23	NaN	NaN	36.29901	-33.74077	2600	Back to full volume SP19029 at 13:01
Tue 30 Apr 2013 13:05:35	Airgun:Array	passingOverStation	MGL1305OBS23	OBS033	SP19030	36.30276	-33.74489	2332	Passing over OBS033 at 1304 UTC SP 19030
Tue 30 Apr 2013 13:47:29	Airgun:Array	passingOverStation	MGL1305OBS023	OBS014	SP19043	36.34085	-33.78761	2800	Passing over OBS014 at 1347 UTC SP 19030
Tue 30 Apr 2013 14:47:35	Airgun:Array	passingOverStation	MGL1305OBS23	OBS009	SP19059	36.39666	-33.84985		Passing over OBS009 at 1439 UTC SP 19059
Tue 30 Apr 2013 15:09:37	Ship	other	MGL1305OBS23	NaN	NaN	36.41727	-33.87238	440	Start of turn
Tue 30 Apr 2013 15:15:32	Airgun:Array	endLine	MGL1305OBS23	LSP 19070	NaN	36.42101	-33.88010	606	End of line MGL1305OBS23: SP19070 at 1515 UTC
Tue 30 Apr 2013 15:24:07	Airgun:Array	startLine	MGL1305OBS24	FSP19503	NaN	36.42009	-33.89283	1193	Start of line MGL1305OBS24 FSP 19503 at 1523 UTC

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Tue 30 Apr 2013 15:50:38	Ship	other	MGL1305OBS24	NaN	NaN	36.39915	-33.92203		Start of turn
Tue 30 Apr 2013 15:54:36	Airgun:Array	endLine	MGL1305OBS24	LSP 19512	NaN	36.39501	-33.92530	1704	End of line MGL1305OBS24: SP19512 at 1554 UTC
Tue 30 Apr 2013 16:04:20	Airgun:Array	startLine	MGL1305OBS25	FSP20003	NaN	36.38343	-33.92467	1821	Start of line MGL1305OBS25 FSP 20003 at 1604 UTC
Tue 30 Apr 2013 16:41:46	Airgun:Array	passingOverStation	MGL1305OBS25	OBS008	SP20014	36.34929	-33.88717	2147	Passing over OBS008 at 1640 UTC SP 20014
Tue 30 Apr 2013 19:08:09	Airgun:Array	passingOverStation	MGL1305OBS25	OBS039	SP20059	36.21449	-33.73661	2454	Passing over OBS039 at 1908 UTC SP 20059
Tue 30 Apr 2013 19:41:16	Airgun:Array	endLine	MGL1305OBS25	NaN	SP20070	36.18305	-33.70328	2404	End of line turn MGL1305OBS25 SP20070 UTC19:42
Tue 30 Apr 2013 19:52:41	Airgun:Array	startLine	MGL1305OBS26	NaN	SP20503	36.16912	-33.70598	2060	Start of Line MGL1305OBS26 SP20503 UTC19:52
Tue 30 Apr 2013 19:58:27	Airgun:Array	other	NaN	OBS026	NaN	36.16427	-33.71281	1809	Power Down for turtle at SP 20505 mitigation shot UTC 19:58 OBS26
Tue 30 Apr 2013 20:08:54	Airgun:Array	other	NaN	NaN	NaN	36.15551	-33.72476	1524	Back to Full Power at SP20508 UTC 20:08
Tue 30 Apr 2013 20:43:23	Airgun:Array	endLine	MGL1305OBS26	NaN	NaN	36.12830	-33.76526	1294	End Of Line Last Shot SP 20518 UTC 20:43
Tue 30 Apr 2013 20:46:50	Airgun:Array	other	NaN	NaN	NaN	36.12826	-33.77033	1186	Power Down for Whales Last shot 20519 UTC 20:46
Tue 30 Apr 2013 20:57:52	Airgun:Array	startLine	MGL1305OBS29	NaN	NaN	36.13604	-33.78405	1614	Start of line UTC20:57 SP21004
Tue 30 Apr 2013 21:04:19	Airgun:Array	other	MGL1305OBS29	NaN	NaN	36.14223	-33.79085	1455	Back to full power last shot 21007 UTC 21:04
Tue 30 Apr 2013 21:26:31	Airgun:Array	passingOverStation	MGL1305OBS29	OBS41	NaN	36.16323	-33.81383	1935	Passing OBS041 at 21:26 UTC SP 21014
Tue 30 Apr 2013 22:18:59	Airgun:Array	passingOverStation	MGL1305OBS29	OBS30	NaN	36.21128	-33.86754	2058	Passing OBS030 at 22:17 UTC SP 21031
Tue 30 Apr 2013 22:59:36	Airgun:Array	passingOverStation	MGL1305OBS29	OBS018	NaN	36.24960	-33.91048	2719	Passing OBS018 at 22:59 UTC SP 21043
Tue 30 Apr 2013 23:52:01	Airgun:Array	passingOverStation	MGL1305OBS29	OBS006	NaN	36.29623	-33.96265	1923	Passing OBS006 at 23:52 UTC SP 21058
Wed 01 May 2013 00:33:04	Airgun:Array	endLine	MGL1305OBS29	NaN	NaN	36.33113	-34.00627	2100	end of line MGL1305OBS29 at 00:33 UTC
Wed 01 May 2013 00:35:26	Airgun:Array	startLine	MGL1305OBS30	NaN	NaN	36.33128	-34.00992	2073	start of line MGL1305OBS30 at 00:34 UTC SP21503
Wed 01 May 2013 01:27:59	Airgun:Array	endLine	MGL1305OBS30	NaN	NaN	36.29061	-34.07136	2387	end of line MGL1305OBS30 at 01:27 UTC SP21518
Wed 01 May 2013 01:35:44	Airgun:Array	startLine	MGL1305OBS33	NaN	NaN	36.28119	-34.07560	2380	start of line MGL1305OBS33 at 01:34 UTC SP22002
Wed 01 May 2013 02:16:40	Airgun:Array	passingOverStation	MGL1305OBS33	OBS04	NaN	36.24295	-34.03799	2521	Passing OBS004 at 02:16 UTC SP22014
Wed 01 May 2013 03:09:13	Airgun:Array	passingOverStation	MGL1305OBS33	OBS021	NaN	36.19499	-33.98437	3051	Passing OBS021 at 03:10 UTC SP22030
Wed 01 May 2013 03:53:44	Airgun:Array	passingOverStation	MGL1305OBS33	OBS28	NaN	36.15459	-33.93903	2647	Passing OBS028 at 03:53 UTC SP 22042
Wed 01 May 2013 04:44:58	Airgun:Array	passingOverStation	MGL1305OBS33	OBS43	NaN	36.10728	-33.88685	2188	Passing OBS043 at 04:45 UTC SP 22059
Wed 01 May 2013 05:20:26	Ship	other	MGL1305OBS033	NaN	NaN	36.07356	-33.85152	1487	Start of starboard turn at 0518 UTC
Wed 01 May 2013 05:22:29	Airgun:Array	endLine	MGL1305OBS033	NaN	NaN	36.07117	-33.85086	1643	end of line MGL1305OBS33 at 0531 UTC LSP22070
Wed 01 May 2013 05:26:57	Airgun:Array	startLine	MGL1305OBS034	NaN	NaN	36.06585	-33.85135	1676	start of line MGL1305OBS34 at 0527 UTC FSP 22502

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Wed 01 May 2013 06:02:29	Airgun:Array	endLine	MGL1305OBS034	NaN	NaN	36.03794	-33.89032	1653	End of line MGL1305OBS34 LSP22512 0600 UTC
Wed 01 May 2013 06:06:29	Airgun:Array	startLine	MGL1305OBS035	NaN	NaN	36.03842	-33.89623	1826	start of line MGL1305OBS35 at 0606 UTC FSP 23002
Wed 01 May 2013 06:46:29	Airgun:Array	passingOverStation	MGL1305OBS35	OBS44	NaN	36.07421	-33.93974	2249	Passing over OBS44 at 0645 UTC SP 23014
Wed 01 May 2013 07:37:51	Airgun:Array	passingOverStation	MGL1305OBS35	OBS027	NaN	36.12119	-33.99218	2796	Passing over OBS027 at 0737 UTC SP 23030
Wed 01 May 2013 08:19:14	Airgun:Array	passingOverStation	MGL1305OBS35	OBS022	NaN	36.16030	-34.03573	2191	Passing over OBS022 at 0819 UTC SP 23043
Wed 01 May 2013 09:08:34	Airgun:Array	other	MGL1305OBS035	NaN	NaN			1995	Power down at 0924 UTC for MMO last FVS 23063 at 0923.
Wed 01 May 2013 09:10:40	Airgun:Array	passingOverStation	MGL1305OBS35	OBS003	NaN	36.20856	-34.08887	1709	Passing over OBS003 at 0910 UTC SP 23059
Wed 01 May 2013 09:17:37	Airgun:Array	other	MGL1305OBS035	NaN	NaN	36.21510	-34.09615	2032	Full power at 0916 UTC FSP 23061
Wed 01 May 2013 09:31:23	Airgun:Array	other	MGL1305OBS035	NaN	NaN	36.22821	-34.11093	2175	Full power at 0932 UTC FSP 23066
Wed 01 May 2013 09:32:35	Airgun:Array	other	MGL1305OBS035	NaN	NaN	36.22935	-34.11222	2196	Power down at 0904 UTC for MMO LFVSP 23057
Wed 01 May 2013 09:44:21	Airgun:Array	other	MGL1305OBS035	NaN	NaN	36.23969	-34.12504		Power down at 0939 UTC for MMO sp 23068
Wed 01 May 2013 09:45:47	Ship	other	MGL1305OBS35	NaN	NaN	36.24042	-34.12703	1868	Start of port turn at 0941 UTC
Wed 01 May 2013 09:47:26	Airgun:Array	endLine	MGL1305OBS35	NaN	NaN	36.24099	-34.12945	1643	Shut down at 0946 UTC for MMO last FVS 23070 and End of Line MG1305OBS035
Wed 01 May 2013 09:51:54	Airgun:Array	startLine	MGL1305OBS036	NaN	NaN	36.24120	-34.13615	1605	start of line MGL1305OBS36 at 0951 UTC FSP 230502. Still on mitigation gun
Wed 01 May 2013 10:29:55	Ship	other	MGL1305OBS36	NaN	NaN	36.21023	-34.18057	1764	Start of port turn at 1028 UTC
Wed 01 May 2013 10:33:04	Airgun:Array	endLine	MGL1305OBS36	NaN	NaN	36.20676	-34.18226	1757	End of line MGL1305OBS36 SP23514 1030 UTC
Wed 01 May 2013 10:38:34	Airgun:Array	startLine	MGL1305OBS037	NaN	NaN	36.20012	-34.18227	1562	start of line MGL1305OBS37 at 1037 UTC FSP 24002.
Wed 01 May 2013 11:20:00	Airgun:Array	passingOverStation	MGL1305OBS37	OBS002	NaN	36.16127	-34.14109	1410	Passing over OBS002 at 1117 UTC SP 24014
Wed 01 May 2013 12:17:23	Airgun:Array	passingOverStation	MGL1305OBS37	OBS023	NaN	36.10884	-34.08284	2407	Passing over OBS023 at 1209 UTC SP 24030
Wed 01 May 2013 14:17:35	Airgun:Array	other	MGL1305OBS37	NaN	NaN	35.99989	-33.96156	1771	Start of turn
Wed 01 May 2013 14:23:29	Airgun:Array	endLine	MGL1305OBS37	NaN	NaN	35.99377	-33.95828	1798	Last Shot SP 24070 UTC 14:23
Wed 01 May 2013 14:25:10	Airgun:Array	other	NaN	NaN	NaN	35.99193	-33.95811		Internal shooting at 17 s intervals 14:25
Wed 01 May 2013 14:32:49	Airgun:Array	startLine	MGL1305OBS38	NaN	NaN	35.98393	-33.96097	1609	First shot SP24503 at 14:32 UTC
Wed 01 May 2013 14:36:44	Airgun:Array	other	MGL1305OBS38	NaN	NaN	35.98044	-33.96502	1424	End of turn
Wed 01 May 2013 15:14:34	Airgun:Array	other	MGL1305OBS38	NaN	NaN	35.95063	-34.00620	1143	Start of turn
Wed 01 May 2013 15:21:19	Airgun:Array	endLine	MGL1305OBS38	NaN	NaN	35.94780	-34.01605	1183	Last shot SP24517 at UTC 15:20
Wed 01 May 2013 15:21:59	Airgun:Array	other	NaN	NaN	NaN	35.94790	-34.01712	1151	Shooting guns at 17 s intervals
Wed 01 May 2013 15:28:18	Airgun:Array	startLine	MGL1305OBS39	NaN	NaN	35.95032	-34.02619	1380	First shot SP25003 at 15:27 UTC

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Wed 01 May 2013 17:03:21	Airgun:Array	passingOverStation	MGL1305OBS039	OBS025	NaN	36.03737	-34.12266	23838	Passing OBS025 SP25031
Wed 01 May 2013 17:39:17	Airgun:Array	passingOverStation	MGL1305OBS39	OBS024	NaN	36.07039	-34.15951	2274	Passing OBS024 at SP 25043 UTC 17:38
Wed 01 May 2013 18:28:01	Airgun:Array	passingOverStation	MGL1305OBS39	OBS001	SO25059	36.11567	-34.20941	1531	Passing over OBS001 at 1830 UTC SP 25059
Wed 01 May 2013 19:14:27	Airgun:Array	endLine	MGL1305OBS39	LSP 25072	NaN	36.15732	-34.25676	1825	End of line MGL1305OBS39 SP25072 1914 UTC
Wed 01 May 2013 19:54:23	Airgun:Array	recover	NaN	NaN	NaN	36.18395	-34.28525	2118	Recover string 2 onboard at UTC 19:52
Wed 01 May 2013 20:05:14	Airgun:Array	recover	NaN	NaN	NaN	36.18995	-34.29150	2133	Recover string 1 onboard at UTC 20:06
Wed 01 May 2013 20:06:12	Other	end	NaN	NaN	NaN	36.19045	-34.29206	2103	Magnetometer back onboard
Wed 01 May 2013 20:27:29	Airgun:Array	recover	NaN	NaN	NaN	36.20452	-34.30295	1911	Recover string 3 onboard at UTC 20:26
Wed 01 May 2013 20:53:18	Airgun:Array	recover	NaN	NaN	NaN	36.22265	-34.31754	1745	Recover string 4 onboard at UTC 20:53
Wed 01 May 2013 22:44:30	OBS	release	NaN	OBS001	NaN	36.12184	-34.21060	1628	Release OBS01 at 22:44 UTC
Wed 01 May 2013 23:00:35	OBS	onSurface	NaN	OBS001	NaN	36.12114	-34.20817	1628	OBS001 on surface at 23:00 UTC
Wed 01 May 2013 23:10:18	OBS	recover	NaN	OBS001	NaN	36.11896	-34.21081	1628	OBS001 recovered onboard at 23:10 UTC
Thu 02 May 2013 00:12:51	OBS	release	NaN	OBS002	NaN	36.16846	-34.14351	1037	Release OBS002 at 00:12 UTC
Thu 02 May 2013 00:34:51	OBS	onSurface	NaN	OBS002	NaN	36.16753	-34.14196	NA	OBS002 on surface at 00:34 UTC
Thu 02 May 2013 01:03:09	OBS	recover	NaN	OBS002	NaN	36.16386	-34.14468	NA	OBS002 recovered onboard at 01:03 UTC
Thu 02 May 2013 01:45:42	OBS	release	NaN	OBS003	NaN	36.20153	-34.09388	NA	Release OBS003 at 01:45 UTC
Thu 02 May 2013 02:21:58	OBS	onSurface	NaN	OBS003	NaN	36.20717	-34.08426	NA	OBS003 on surface at 02:21 UTC
Thu 02 May 2013 02:33:48	OBS	recover	NaN	OBS003	NaN	36.20273	-34.08875	NA	OBS003 recovered onboard at 02:33 UTC
Thu 02 May 2013 03:11:39	OBS	release	NaN	OBS004	NaN	36.23904	-34.04232		Release OBS004
Thu 02 May 2013 03:52:47	OBS	onSurface	NaN	OBS 004	NaN	36.23972	-34.02930		OBS 004 on surface at 03:52UTC
Thu 02 May 2013 04:22:11	OBS	recover	NaN	OBS004	NaN	36.24096	-34.03378		OBS004 recovered
Thu 02 May 2013 05:06:19	OBS	release	NaN	OBS005	NaN	36.27113	-33.99784		Released at 0507 UTC
Thu 02 May 2013 05:42:16	OBS	onSurface	NaN	OBS 005	NaN	36.27127	-33.99142		OBS005 on the surface at 0541 UTC
Thu 02 May 2013 05:51:06	OBS	recover	NaN	OBS005	NaN	36.27183	-33.99563	2363	OBS005 on deck at 0551 UTC
Thu 02 May 2013 06:02:27	XBT	release	NaN	OBS005	NaN	36.27377	-33.99352	2341	XBT successful launch to 2227m at 0554UTC salinaty 36.28
Thu 02 May 2013 06:25:25	OBS	release	NaN	OBS006	NaN	36.29540	-33.96472		Releasing OBS006 at 0624 UTC
Thu 02 May 2013 07:05:58	OBS	onSurface	NaN	OBS 006	NaN	36.29606	-33.95828		OBS 006 on surface at 0705 UTC
Thu 02 May 2013 07:15:00	OBS	recover	NaN	OBS006	NaN	36.29468	-33.96384		OBS006 on deck at 0714 UTC
Thu 02 May 2013 07:41:18	OBS	release	NaN	OBS007	NaN	36.31748	-33.93214		Releasing OBS007 at 0741 UTC
Thu 02 May 2013 08:16:01	OBS	onSurface	NaN	OBS 007	NaN	36.31932	-33.92676		OBS007 on the surface at 0815 UTC
Thu 02 May 2013 08:26:17	OBS	onSurface	NaN	OBS 007	NaN	36.31830	-33.93280		OBS007 on deck at 0826 UTC
Thu 02 May 2013 09:00:42	OBS	release	NaN	OBS008	NaN	36.34922	-33.89159		Releasing OBS008 at 0900 UTC
Thu 02 May 2013 09:50:12	OBS	release	NaN	OBS008	NaN	36.35336	-33.88318		OBS008 on the surface at 0949 UTC
Thu 02 May 2013 10:02:39	OBS	release	NaN	OBS008	NaN	36.34983	-33.89092		OBS008 on deck at 1002 UTC
Thu 02 May 2013 10:44:57	OBS	release	NaN	OBS009	NaN	36.38340	-33.84595		Releasing OBS009 at 1044 UTC
Thu 02 May 2013 11:25:35	OBS	onSurface	OBS009	NaN	NaN	36.38906	-33.83474		OBS009 on the surface at 1125 UTC
Thu 02 May 2013 11:37:22	OBS	recover	OBS009	NaN	NaN	36.38632	-33.84304		OBS009 on deck at 1137 UTC
Thu 02 May 2013 11:47:19	XBT	release	OBS009	NaN	NaN	36.38769	-33.84635	2000	XBT Terminated early to 347m at 1139UTC
Thu 02 May 2013 12:28:47	OBS	release	NaN	OBS010	NaN	36.42868	-33.78357		Releasing OBS010 at 1228 UTC
Thu 02 May 2013 13:07:30	OBS	onSurface	NaN	OBS010	NaN	36.42955	-33.78204		OBS010 on the surface at UTC 13:03

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Thu 02 May 2013 13:10:53	OBS	recover	NaN	OBS010	NaN	36.42982	-33.78417		OBS010 on deck at UTC 13:20
Thu 02 May 2013 14:12:17	OBS	release	NaN	OBS011	NaN	36.48103	-33.71211		Burn command fail OBS011 at 14:12 UTC
Thu 02 May 2013 14:19:03	OBS	release	NaN	OBS011	NaN	36.48093	-33.71200		Releasing OBS011 at 1418 UTC
Thu 02 May 2013 14:52:23	OBS	onSurface	NaN	OBS011	NaN	36.48087	-33.71147		OBS011 on the surface at 14:52 UTC
Thu 02 May 2013 15:20:41	OBS	recover	NaN	OBS011	NaN	36.48127	-33.71846		OBS011 on deck at UTC 15:20 (failed to retreive on first attempt)
Thu 02 May 2013 16:20:56	OBS	release	NaN	OBS012	NaN	36.43161	-33.65507		Releasing OBS012 at 16:20 UTC
Thu 02 May 2013 16:47:46	OBS	onSurface	NaN	OBS012	NaN	36.43150	-33.65710		OBS012 on the surface at 16:47 UTC
Thu 02 May 2013 16:57:05	OBS	recover	NaN	OBS012	NaN	36.43336	-33.66314		OBS012 on deck at UTC 16:56
Thu 02 May 2013 17:38:50	OBS	release	NaN	OBS035	NaN	36.39281	-33.61924		Releasing OBS035 at 17:37 UTC
Thu 02 May 2013 18:13:19	OBS	onSurface	NaN	OBS035	NaN	36.39117	-33.61308		OBS035 on the surface at 18:13 UTC
Thu 02 May 2013 18:26:44	OBS	recover	NaN	OBS035	NaN	36.39407	-33.61794		OBS035 on deck at UTC 18:26
Thu 02 May 2013 19:26:08	OBS	release	NaN	OBS036	NaN	36.34441	-33.56183		Releasing OBS036 at UTC 19:25
Thu 02 May 2013 20:02:51	OBS	onSurface	NaN	OBS036	NaN	36.34320	-33.56098		OBS036 on the surface at UTC 20:02
Thu 02 May 2013 20:13:04	OBS	recover	NaN	OBS036	NaN	36.34418	-33.56447		OBS036 on deck at UTC 20:12
Thu 02 May 2013 21:14:15	OBS	release	NaN	OBS037	NaN	36.29643	-33.62874		OBS037 release at 21:13 UTC, eta 30 mins
Thu 02 May 2013 21:40:11	OBS	onSurface	NaN	OBS037	NaN	36.29721	-33.62602		OBS 037 on surface at 21:39 UTC
Thu 02 May 2013 21:55:30	OBS	recover	NaN	OBS037	NaN	36.29567	-33.63141		OBS037 recovered
Thu 02 May 2013 22:59:39	OBS	release	NaN	OBS038	NaN	36.25243	-33.68311		OBS 038 released at 22:59
Thu 02 May 2013 23:18:57	OBS	onSurface	NaN	OBS038	NaN	36.25595	-33.68276		OBS038 on surface
Thu 02 May 2013 23:35:58	OBS	recover	NaN	OBS038	NaN	36.25153	-33.68911		OBS 038 recovered at 23:34 UTC
Fri 03 May 2013 00:26:53	OBS	release	NaN	OBS039	NaN	36.21637	-33.73650		OBS039 released at 00:25 UTC eta 20mins
Fri 03 May 2013 00:51:05	OBS	onSurface	NaN	OBS0039	NaN	36.21782	-33.73368		OBS039 on surface at 00:50 UTC
Fri 03 May 2013 01:04:33	OBS	recover	NaN	OBS039	NaN	36.21744	-33.74145		OBS039 recovered at 01:04 UTC
Fri 03 May 2013 01:47:51	OBS	release	NaN	OBS040	NaN	36.18654	-33.78505		Not receiving communication from OBS040
Fri 03 May 2013 02:51:39	OBS	release	NaN	OBS040	NaN	36.18521	-33.77912		Back on OBS040 site until 03:45 estimated time of the OBS arrival on surface
Fri 03 May 2013 03:49:42	OBS	recover	NaN	OBS040	NaN	36.18775	-33.78092		Unsuccessfull recovery of OBS040, heading to OBS041 site
Fri 03 May 2013 04:23:08	OBS	release	NaN	OBS041	NaN	36.16263	-33.81084		OBS041 released at 04:22
Fri 03 May 2013 04:47:47	OBS	onSurface	NaN	OBS041	NaN	36.16263	-33.81047		OBS041 on surface at 04:47 UTC
Fri 03 May 2013 04:59:22	OBS	recover	NaN	OBS041	NaN	36.16247	-33.81340		OBS041 recovered
Fri 03 May 2013 05:16:50	OBS	release	NaN	OBS042	NaN	36.14666	-33.83607		OBS042 released at 05:47
Fri 03 May 2013 06:18:32	OBS	onSurface	NaN	OBS042	NaN	36.13639	-33.84329		OBS 042 on surface at 06:17
Fri 03 May 2013 06:26:18	OBS	recover	NaN	OBS042	NaN	36.13717	-33.84471		BS 042 recovered at 06:28 UTC

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Fri 03 May 2013 06:40:45	OBS	other	NaN	OBS42	NaN	36.13821	-33.84256		Instrument came back with lithium battery reacted (probably soon after deployment). It was not reacting when retrieved, so it was brought onboard and the battery and data logger packages thrown over the board.
Fri 03 May 2013 07:21:29	OBS	release	NaN	OBS043	NaN	36.10701	-33.88371		OBS043 released at 07:35
Fri 03 May 2013 07:44:02	OBS	onSurface	NaN	OBS043	NaN	36.10637	-33.88437		OBS 043 on surface at 07:43 UTC
Fri 03 May 2013 07:52:41	OBS	recover	NaN	OBS043	NaN	36.10862	-33.88666		recovered at 07:51
Fri 03 May 2013 08:50:02	OBS	release	NaN	OBS044	NaN	36.06919	-33.93369		Releasing OBS044 at 08:49 UTC
Fri 03 May 2013 09:16:33	OBS	onSurface	NaN	OBS044	NaN	36.06988	-33.93282		OBS 044 on surface at 09:15 UTC
Fri 03 May 2013 09:24:14	OBS	recover	NaN	OBS044	NaN	36.07034	-33.93481		OBS 044 recovered at 09:23 UTC
Fri 03 May 2013 10:31:37	OBS	release	NaN	OBS045	NaN	36.03100	-33.99893		Release OBS045 at 10:30 UTC
Fri 03 May 2013 10:51:06	OBS	onSurface	NaN	OBS045	NaN	36.02948	-33.99153		OBS045 on the surface at 10:50 UTC
Fri 03 May 2013 11:02:18	OBS	recover	NaN	OBS045	NaN	36.02718	-33.99580		recovered at 11:01
Fri 03 May 2013 11:17:09	XBT	release	NaN	XBT-T5 Seq 17	NaN	36.02185	-34.00689		XBT launched at 11:10 measured to 2210 m
Fri 03 May 2013 11:55:43	OBS	release	NaN	OBS046	NaN	35.98237	-34.06116		Release OBS046 at 21:54 UTC
Fri 03 May 2013 12:35:02	OBS	onSurface	NaN	OBS046	NaN	35.98088	-34.05536		OBS046 on the surface at 12:33 UTC
Fri 03 May 2013 12:47:43	OBS	recover	NaN	obs046	NaN	35.98072	-34.06097		recovered at 12:45
Fri 03 May 2013 13:36:24	OBS	release	NaN	OBS025	NaN	36.02455	-34.11591		Release OBS025 at 13:36 UTC
Fri 03 May 2013 14:00:23	OBS	onSurface	NaN	OBS025	NaN	36.02803	-34.11518		OBS025 on the surface at 13:59 UTC
Fri 03 May 2013 14:17:30	OBS	recover	NaN	obs025	NaN	36.02681	-34.11439		Recovered at 14:17
Fri 03 May 2013 14:53:00	OBS	release	NaN	OBS024	NaN	36.06850	-34.15865		Release OBS024 at 14:52 UTC
Fri 03 May 2013 15:27:51	OBS	onSurface	NaN	OBS024	NaN	36.06549	-34.15458	2301	On the surface at 15:27 UTC
Fri 03 May 2013 15:36:44	OBS	recover	NaN	obs024	NaN	36.06790	-34.15912		Recovered at 15:37
Fri 03 May 2013 17:08:48	EM122	stop	NaN	NaN	NaN	36.19628	-34.00926		Mutli-beam system crashed had to restart at 17:08. Out of memory, New survey: MGL1305B
Fri 03 May 2013 17:14:05	EM122	start	NaN	NaN	NaN	36.20721	-33.99635		System back online
Fri 03 May 2013 17:42:05	OBS	deploy	NaN	OBS055	SN13008	36.25246	-33.94291	3016	
Fri 03 May 2013 18:28:51	OBS	deploy	NaN	OBS054	SN13005	36.24219	-33.88942	2282	
Fri 03 May 2013 18:55:23	OBS	deploy	NaN	OBS053	SN13001	36.23723	-33.86738	2120	
Fri 03 May 2013 19:44:32	OBS	deploy	NaN	OBS050	SN13004	36.22184	-33.86032	2169	
Fri 03 May 2013 20:03:14	OBS	deploy	NaN	OBS049	SN13003	36.20828	-33.87671	2021	
Fri 03 May 2013 20:30:07	OBS	deploy	NaN	OBS048	SN13014	36.21333	-33.89823	2227	
Fri 03 May 2013 20:46:30	OBS	deploy	NaN	OBS057	SN13015	36.23008	-33.90319	2377	
Fri 03 May 2013 22:18:12	Hydrophone:Streamer	deploy	NaN	NaN	NaN	36.21321	-33.92338	NA	Deploy hydrophone streamer at 21:52 UTC
Sat 04 May 2013 01:30:53	Hydrophone:Streamer	other	NaN	NaN	NaN	36.12916	-34.07321	2306	Bird17 OK
Sat 04 May 2013 01:40:25	Hydrophone:Streamer	other	NaN	NaN	NaN	36.12511	-34.08155	2324	Bird16 OK

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sat 04 May 2013 02:12:51	Hydrophone:Streamer	other	NaN	NaN	NaN	36.11099	-34.10979	2604	Bird15 OK
Sat 04 May 2013 02:18:45	Hydrophone:Streamer	other	NaN	NaN	NaN	36.10837	-34.11528	2541	Bird14 OK
Sat 04 May 2013 02:28:47	Hydrophone:Streamer	other	NaN	NaN	NaN	36.10420	-34.12369	2496	Bird13 OK
Sat 04 May 2013 02:31:55	Hydrophone:Streamer	other	NaN	NaN	NaN	36.10291	-34.12646	2474	Bird12 OK
Sat 04 May 2013 02:42:13	Hydrophone:Streamer	other	NaN	NaN	NaN	36.09866	-34.13580	2488	Bird11 OK
Sat 04 May 2013 02:53:15	Hydrophone:Streamer	other	NaN	NaN	NaN	36.09444	-34.14546	2374	Bird10 OK
Sat 04 May 2013 03:01:30	Hydrophone:Streamer	other	NaN	NaN	NaN	36.09134	-34.15290	2295	Bird09 OK
Sat 04 May 2013 03:10:06	Hydrophone:Streamer	other	NaN	NaN	NaN	36.08762	-34.16094	2156	Bird08 OK
Sat 04 May 2013 03:14:15	Hydrophone:Streamer	other	NaN	NaN	NaN	36.08600	-34.16470	1958	Bird07 OK
Sat 04 May 2013 03:22:53	Hydrophone:Streamer	other	NaN	NaN	NaN	36.08262	-34.17268	1980	Bird06 OK
Sat 04 May 2013 03:31:42	Hydrophone:Streamer	other	NaN	NaN	NaN	36.07887	-34.18051	1921	Bird05 OK
Sat 04 May 2013 03:57:08	Hydrophone:Streamer	other	NaN	NaN	NaN	36.06921	-34.20098	2126	Bird04 OK
Sat 04 May 2013 04:07:22	Hydrophone:Streamer	other	NaN	NaN	NaN	36.06455	-34.21023	2010	Bird03 OK
Sat 04 May 2013 04:30:23	Hydrophone:Streamer	other	NaN	NaN	NaN	36.05456	-34.22878	1889	Bird02 OK
Sat 04 May 2013 04:37:43	Hydrophone:Streamer	other	NaN	NaN	NaN	36.05130	-34.23593	2001	Bird01 OK
Sat 04 May 2013 04:48:51	Hydrophone:Streamer	other	NaN	NaN	NaN	36.04632	-34.24623	2116	Streamer power down
Sat 04 May 2013 08:29:38	Hydrophone:Streamer	deploy	NaN	NaN	NaN	35.90604	-34.46812	1329	Streamer deployed at 08.28
Sat 04 May 2013 09:58:56	Airgun:Array	deploy	NaN	NaN	NaN	35.83126	-34.50073	1559	start deployment of airgun array 1
Sat 04 May 2013 10:13:44	Airgun:Array	deploy	NaN	NaN	NaN	35.82359	-34.48089	1340	airgun array 1 in position
Sat 04 May 2013 10:19:47	Airgun:Array	deploy	NaN	NaN	NaN	35.82388	-34.47194	1132	start deployment of airgun array 2
Sat 04 May 2013 10:42:38	Airgun:Array	deploy	NaN	NaN	NaN	35.83553	-34.44299		airgun array 2 in position at 10:37
Sat 04 May 2013 10:43:49	Airgun:Array	deploy	NaN	NaN	NaN	35.83648	-34.44182		start deployment of airgun array 4 at 10:42
Sat 04 May 2013 11:09:46	Airgun:Array	other	NaN	NaN	NaN	35.85563	-34.41664		start shoting mit at 11:07
Sat 04 May 2013 11:10:54	Airgun:Array	deploy	NaN	NaN	NaN	35.85647	-34.41553		airgun array 4 in position
Sat 04 May 2013 11:13:51	Airgun:Array	deploy	NaN	NaN	NaN	35.85852	-34.41264	1231	start deployment of airgun array 3
Sat 04 May 2013 11:33:30	Airgun:Array	deploy	NaN	NaN	NaN	35.87395	-34.39161	1140	airgun array 3 in position

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sat 04 May 2013 11:39:22	Airgun:Array	other	NaN	NaN	NaN	35.87850	-34.38531		start ramping
Sat 04 May 2013 11:59:12	magnetometer	start	NaN	NaN	NaN	35.89513	-34.36281	1495	start deployment
Sat 04 May 2013 12:11:03	magnetometer	start	NaN	NaN	NaN	35.90577	-34.34780	1474	deployed
Sat 04 May 2013 12:12:40	Airgun:Array	other	NaN	NaN	NaN	35.90725	-34.34576	1477	Ramp up completed
Sat 04 May 2013 12:14:31	Airgun:Array	startLine	MGL1305MCS101	NaN	NaN	35.90892	-34.34342		SOL MGL1305MCS101 at shot# 25556
Sat 04 May 2013 14:16:51	Airgun:Array	startLine	MGL1305MC101	NaN	NaN	36.00907	-34.12352	2073	First Shot Point #26001 MGL1305MC101 at UTC 14:04
Sat 04 May 2013 17:21:49	Airgun:Array	other	MGL1305MC101	SP26779	NaN	36.18408	-33.96685	3189	Power down at 1721 UTC for MMO last Full Volume 26779
Sat 04 May 2013 17:24:41	Airgun:Array	other	MGL1305MC101	SP26780 SP26781 SP26797	NaN	36.18651	-33.96353		SP 26780, 26781 and 26797 no fire
Sat 04 May 2013 17:27:10	Airgun:Array	other	MGL1305MC101	SP26797	NaN	36.18866	-33.96064	3198	Shut down at 1726 UTC for MMO last shot 26796
Sat 04 May 2013 17:33:17	Airgun:Array	other	MGL1305MC101	FSP26819	NaN	36.19409	-33.95324	3253	Back to one mitigation gun at SP26819 at 1732
Sat 04 May 2013 17:39:39	Airgun:Array	service	MGL1305MC101	SP 26846	NaN	36.19955	-33.94572	3100	Back to full power at SP26846 UTC 1739
Sat 04 May 2013 23:23:15	Airgun:Array	other	MGL1305MC101	NaN	NaN	36.47775	-33.56376	1806	start of turn at 23:12 UTC SP28045
Sat 04 May 2013 23:28:34	Airgun:Array	endLine	MGL1305MC101	NaN	NaN	36.48322	-33.56173	1812	end of line MGL1305MC101 at 23:27 UTC LSP 28090
Sun 05 May 2013 00:15:30	Airgun:Array	startLine	MGL1305MC102	NaN	NaN	36.50212	-33.62119	2684	start of MGL1305MC102 at 00:14 UTC FSP30052
Sun 05 May 2013 08:59:22	Airgun:Array	endLine	MGL1305MC102	NaN	NaN	36.00746	-34.31081	1912	End of line MGL1305MC102 SP32263 0859 UTC
Sun 05 May 2013 09:12:54	Hydrophone:Streamer	other	MGL1305MC102	NaN	NaN	35.99534	-34.32811	1663	Changed tow point to streamer deck from paravane deck at 0906 UTC
Sun 05 May 2013 10:25:16	Ship	other	NaN	NaN	NaN	35.93512	-34.41136	1481	Start of turn to line MGL1305MC103 at 1022 UTC
Sun 05 May 2013 10:28:41	Other	start	NaN	NaN	NaN	35.93181	-34.41433		Went straight after line MGL1305MC102 to work on compressors
Sun 05 May 2013 10:52:16	Airgun:Array	other	MGL1305MC102	NaN	NaN	35.90565	-34.41043	1114	Starting ramp up at 1051 UTC
Sun 05 May 2013 11:03:00	Ship	other	NaN	NaN	NaN	35.89601	-34.39999	1274	End of first turn at 1052 UTC
Sun 05 May 2013 11:13:08	EM122	other	NaN	NaN	NaN	35.88668	-34.38985		Started a BIST at 1112 UTC
Sun 05 May 2013 11:24:11	EM122	start	NaN	NaN	NaN	35.87673	-34.37807	1278	BIST passed started logging at 1123 UTC
Sun 05 May 2013 11:26:56	Airgun:Array	other	MGL1305MC103	NaN	NaN	35.87488	-34.37430	1200	End of ramp up at 1123 UTC
Sun 05 May 2013 11:29:08	Ship	other	MGL1305MC103	NaN	NaN	35.87370	-34.37099	1294	Start of second port turn at 1126 UTC
Sun 05 May 2013 11:45:37	Airgun:Array	startLine	MGL1305MC103	NaN	NaN	35.87741	-34.34443	1392	Start line MGL1305MC103 at 1145 UTC sp 33672
Sun 05 May 2013 11:51:52	Ship	other	MGL1305MC103	NaN	NaN	35.88353	-34.33659	1707	End of turn at 1151 UTC
Sun 05 May 2013 13:05:44	Airgun:Array	startLine	MGL1305MC103	FSP34001	NaN	35.95226	-34.24354	1559	First Shot Point 34001 MGL1305MC103 at UTC 13:05
Sun 05 May 2013 23:14:55	Ship	other	MGL1305MC103	NaN	NaN	36.46159	-33.55234	1497	start of turn at 23:14 UTC line MGL1305MC103

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sun 05 May 2013 23:23:52	Airgun:Array	endLine	MGL1305MC103	NaN	NaN	36.47116	-33.54492	1702	end of line MGL1305MC103 at 23:23 UTC LSP 36271
Mon 06 May 2013 00:05:28	Airgun:Array	startLine	MGL1305MC104	NaN	NaN	36.49758	-33.59382	2429	start of line MGL1305MC104 at 00: 04 FSP37030
Mon 06 May 2013 00:13:00	Ship	other	MGL1305MC104	NaN	NaN	36.49084	-33.60390	2412	end of turn at 00:12 UTC
Mon 06 May 2013 04:42:53	Airgun:Array	passingOverStation	MGL1305MC104	NaN	NaN	36.24832	-33.94344	3161	passing 350m southeast of OBS55 at 04:42 SP38144
Mon 06 May 2013 07:32:08	Airgun:Array	other	MGL1305MC104	NaN	NaN	36.10555	-34.14141	2136	Power down at 0727 for MMO LFV sp38766
Mon 06 May 2013 07:51:52	Airgun:Array	other	MGL1305MC104	NaN	NaN	36.09202	-34.16011	2193	Back to full power at 0750 fsp38839
Mon 06 May 2013 09:10:56	Airgun:Array	other	MGL1305MC104	NaN	NaN	36.02867	-34.24762	1996	Power down at 0909 UTC for MMO last FVS 39122. Full power at 0917 sp39149
Mon 06 May 2013 09:19:20	Ship	other	MGL1305MC104	NaN	NaN	36.02221	-34.25765	1979	Start of port turn at 0935 UTC
Mon 06 May 2013 09:40:12	Airgun:Array	other	MGL1305MC104	NaN	NaN	36.00429	-34.27971	1745	Shut down at 0939 UTC for MMO last shot 39226
Mon 06 May 2013 09:41:41	Airgun:Array	endLine	MGL1305MC104	NaN	NaN	36.00259	-34.28072	1732	End of line MGL1305MC104 at 0939 UTC lsp 39226
Mon 06 May 2013 10:53:35	Airgun:Array	startLine	MGL1305MC105	NaN	NaN	35.95313	-34.20846	2320	Start of line MGL1305MC105 at 1052UTC fsp 40059
Mon 06 May 2013 11:18:42	Airgun:Array	other	MGL1305MC105	NaN	NaN	35.97676	-34.17712	2367	Power down at 1117 UTC for MMO lsp40163. full power at 1129 fsp 40208
Mon 06 May 2013 12:39:06	Airgun:Array	other	MGL1305MC105	NaN	NaN	36.04457	-34.08623	2883	Power down at 1237 UTC for MMO last FVS 40459.
Mon 06 May 2013 12:57:58	Airgun:Array	other	MGL1305MC105	SP40516	NaN	36.05637	-34.06979	2789	Back to full power at 1257 FSP40516
Mon 06 May 2013 13:25:23	Airgun:Array	service	MGL1305MC105	OBS026	SP40606	36.07668	-34.04246	2463	passing 350m southeast of OBS026 at 1325 SP40606
Mon 06 May 2013 15:48:21	Airgun:Array	other	MGL1305MC105	SP41073	NaN	36.18376	-33.89785	2214	Power down at 1547 UTC for MMO lsp41073. full power at 1555 fsp 41098
Mon 06 May 2013 17:37:13	Airgun:Array	other	NaN	NaN	NaN	36.26184	-33.79162	2909	Guns turned off due to lost air pressure SP41407 UTC 17:33
Mon 06 May 2013 17:38:20	Airgun:Array	other	NaN	NaN	NaN	36.26266	-33.79046	2852	Guns at full volume at SP41413 at UTC 17:35
Mon 06 May 2013 21:37:14	Ship	other	MGL1305MC105	NaN	NaN	36.45109	-33.53446	1668	start of turn at 21:36 UTC SP42248
Mon 06 May 2013 21:44:25	Airgun:Array	endLine	MGL1305MC105	NaN	NaN	36.45857	-33.52904	1463	end of line MGL1305MC105 at 21:43 UTC LSP42273
Mon 06 May 2013 22:26:07	Airgun:Array	startLine	MGL1305MC106	NaN	NaN	36.48596	-33.57640	2154	start of line MGL1305MC106 at 22:25 UTC FSP43039
Mon 06 May 2013 22:28:14	Ship	other	MGL1305MC106	NaN	NaN	36.48428	-33.57929	2231	end of turn at 22:35 UTC
Tue 07 May 2013 00:33:49	Airgun:Array	passingOverStation	MGL1305MC106	NaN	NaN	36.38026	-33.72554	2716	Passing 150m southeast of OBS013 at 00:33 UTC SP43514
Tue 07 May 2013 01:26:30	Airgun:Array	passingOverStation	MGL1305MC106	NaN	NaN	36.33733	-33.78562	2842	Passing over OBS014 at 01:26 UTC SP43709
Tue 07 May 2013 02:11:18	Airgun:Array	passingOverStation	MGL1305MC106	NaN	NaN	36.30092	-33.83597	2990	Passing OBS015 at 02:11 SP43869
Tue 07 May 2013 02:46:20	Airgun:Array	passingOverStation	MGL1305MC106	NaN	NaN	36.27226	-33.87647	2447	Passing OBS016 at 02:46 UTC SP44002

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Tue 07 May 2013 03:16:09	Airgun:Array	passingOverStation	MGL1305MC106	NaN	NaN	36.24727	-33.91137	2672	Passing OBS018 at 03:16 UTC SP 44109
Tue 07 May 2013 03:45:14	Airgun:Array	passingOverStation	MGL1305MC106	OBS20	NaN	36.22241	-33.94573	3234	Nearest shot to OBS020: SP44215, 03:43 UTC
Tue 07 May 2013 04:23:08	Airgun:Array	passingOverStation	MGL1305MC106	OBS21	NaN	36.18968	-33.99153		Nearest shot to OBS021: SP44449, 04:18 UTC
Tue 07 May 2013 05:01:31	Airgun:Array	passingOverStation	MGL1305MC106	OBS22	NaN	36.15713	-34.03647	2209	Nearest shot to OBS022: SP444509 0501 UTC
Tue 07 May 2013 05:51:50	Airgun:Array	passingOverStation	MGL1305MC106	OBS23	NaN	36.11493	-34.09478	2454	Nearest shot to OBS023: SP44696, 05:51 UTC
Tue 07 May 2013 08:24:48	Ship	other	MGL1305MC106	NaN	NaN	35.99393	-34.26186	1948	Start of turn to line MGL1305MC107 at 0823 UTC
Tue 07 May 2013 08:31:26	Airgun:Array	endLine	MGL1305MC106	NaN	NaN	35.98671	-34.26611		End of line MGL1305MC106 at 0830 UTC LSP45256
Tue 07 May 2013 08:52:32	Ship	other	NaN	NaN	NaN	35.96196	-34.25687	1682	End of first port turn at 0852 UTC
Tue 07 May 2013 09:18:20	Ship	other		NaN	NaN	35.93739	-34.22797	2119	Start of second turn to port at 0917 UTC
Tue 07 May 2013 09:33:54	Airgun:Array	startLine	MGL1305MC107	NaN	NaN	35.93550	-34.20223	2320	Start of line MGL1305MC107 at 0933 UTC fsp 46039
Tue 07 May 2013 09:45:15	Ship	other	MGL1305MC107	NaN	NaN	35.94483	-34.18760	2286	End of port turn at 0945 UTC
Tue 07 May 2013 20:13:57	Airgun:Array	other	MGL1305MC107	NaN	NaN	36.41276	-33.55250	1605	Power down for blue wale SP48140 UTC 20:13
Tue 07 May 2013 20:16:43	Ship	other	MGL1305MC107	NaN	NaN	36.41484	-33.54967	1602	Slow down to 3 knots at UTC 20:16
Tue 07 May 2013 20:37:31	Airgun:Array	other	MGL1305MC107	NaN	NaN	36.42631	-33.53440	1703	Full power back on at SP48201 UTC 20:36
Tue 07 May 2013 20:41:33	Other	start	MGL1305MC107	NaN	NaN	36.42891	-33.53075	1622	Missed SP48141, 48199, 48200 due to changing to mitigation gun UTC 20:12
Tue 07 May 2013 20:55:13	Ship	other	MGL1305MC107	NaN	NaN	36.43920	-33.51638	1757	start of turn at 20:53 UTC SP48255
Tue 07 May 2013 21:04:18	Airgun:Array	endLine	MGL1305MC107	NaN	NaN	36.44280	-33.50501	1492	end of line MGL1305MC107 at 21:03 UTC LSP48286
Tue 07 May 2013 22:02:14	Airgun:Array	startLine	MGL1305MC107T	NaN	NaN	36.40165	-33.45960	1458	start of line MGL1305MC107T at 22:01 UTC FSP48971
Tue 07 May 2013 22:09:15	Ship	other	NaN	NaN	NaN	36.39394	-33.46461	1542	end of turn at 22:08 UTC SP49000
Tue 07 May 2013 22:12:14	Ship	other	MGL1305MC107T	NaN	NaN	36.39075	-33.46714	1489	Slow down to 4 knots at UTC 22:10
Tue 07 May 2013 23:02:31	Airgun:Array	other	MGL1305MC107T	NaN	NaN	36.34751	-33.50296	1540	Gun 4 back on board at 22:59 UTC
Wed 08 May 2013 00:26:03	Airgun:Array	other	MGL1305MC107T	NaN	NaN	36.27990	-33.55849	2210	Gun 3 recovered on board for repair
Wed 08 May 2013 00:54:56	Airgun:Array	other	MGL1305MC107T	NaN	NaN	36.25609	-33.57817	2208	SP49475 missed 00:47 UTC
Wed 08 May 2013 01:09:29	Airgun:Array	other	MGL1305MC107T	NaN	NaN	36.24369	-33.58806	2136	Gun 3 redeployed at 01:01 UTC
Wed 08 May 2013 02:27:04	Ship	other	MGL1305MC107T	NaN	NaN	36.16873	-33.65039	1868	start of turn at 02:21 UTC
Wed 08 May 2013 02:32:02	Airgun:Array	endLine	MGL1305MC107T	NaN	NaN	36.16531	-33.65665	1959	end of line MGL1305MC107T at 02:31 UTC LSP49817
Wed 08 May 2013 02:38:35	Airgun:Array	startLine	MGL1305MC108	NaN	NaN	36.16346	-33.66623	1803	start of line MGL1305MC108 02:38 UTC FSP52021
Wed 08 May 2013 02:44:40	Ship	other	MGL1305MC108	NaN	NaN	36.16436	-33.67581	2082	end of turn at 02:44 UTC SP52043
Wed 08 May 2013 04:47:32	Airgun:Array	passingOverStation	MGL1305MC108	OBS030	NaN	36.20340	-33.87025	2106	Passing OBS30 at 04:47 UTC SP 52525
Wed 08 May 2013 04:53:27	Airgun:Array	passingOverStation	MGL1305MC108	OBS049	NaN	36.20550	-33.88038	2044	Passing OBS049 at 04:53 UTC SP52550

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Wed 08 May 2013 05:07:44	Airgun:Array	passingOverStation	MGL1305MC108	OBS048	NaN	36.21043	-33.90427	2403	Passing OBS048 on Starboard side at 0506 UTC SP 52604
Wed 08 May 2013 05:13:11	Airgun:Array	passingOverStation	MGL1305MC108	OBS019	NaN	36.21242	-33.91316	2562	Passing OBS019 on Starboard at 0512 UTC SP 52629
Wed 08 May 2013 05:35:19	Airgun:Array	passingOverStation	MGL1305MC108	OBS020	NaN	36.21946	-33.94921	3170	Passing OBS020 on Starboard at 0534 UTC SP 52718
Wed 08 May 2013 07:27:24	Ship	other	MGL1305MC108	NaN	NaN	36.25508	-34.12504	1814	Start of starboard turn at 0726 UTC
Wed 08 May 2013 07:36:37	Airgun:Array	endLine	MGL1305MC108	NaN	NaN	36.26248	-34.13481	1888	End of line MGL1305MC108 SP53169 at 0731 UTC
Wed 08 May 2013 09:00:09	Ship	other	NaN	NaN	NaN	36.33624	-34.07805	2200	Start of second turn to starboard at 0859
Wed 08 May 2013 09:14:22	Airgun:Array	startLine	MGL1305MC109	NaN	NaN	36.33973	-34.05915	1997	Start of to line MGL1305MC109 sp 55024 at 0913 UTC
Wed 08 May 2013 09:29:40	Ship	other	MGL1305MC109	NaN	NaN	36.32967	-34.03943	2082	End of starboard turn at 0929 UTC
Wed 08 May 2013 11:01:31	Airgun:Array	passingOverStation	MGL1305MC109	OBS055	NaN	36.24590	-33.94585	3221	Passing OBS055 on Port side at 1100 UTC SP 55409
Wed 08 May 2013 11:11:52	EM122	other	MGL1305MC109	NaN	NaN	36.23707	-33.93569	3227	Performed a self test (BIST) on multi-beam at 1111 UTC. Everything past at 1119 UTC
Wed 08 May 2013 11:39:35	Airgun:Array	passingOverStation	MGL1305OBS0109	OBS019	NaN	36.21215	-33.90803	2418	Passing OBS19 on Port side at 1139 UTC SP 55546
Wed 08 May 2013 11:44:17	Airgun:Array	passingOverStation	MGL1305OBS0109	OBS048	NaN	36.20789	-33.90328		Passing OBS048 on Port side at 1144 UTC SP 55566
Wed 08 May 2013 14:23:00	Ship	other	MGL1305MC109	NaN	NaN	36.06864	-33.74794	1313	Start of turn to line MGL1305MC110 at 1422 UTC
Wed 08 May 2013 14:35:02	Airgun:Array	endLine	MGL1305MC109	LSP 56153	NaN	36.06221	-33.73292	910	End of line MGL1305MC209 SP56153 1432 UTC
Wed 08 May 2013 15:00:15	Ship	other	MGL1305MC110	NaN	NaN	36.07641	-33.70229	1650	End of turn
Wed 08 May 2013 16:03:42	Ship	other	MGL1305MC110	NaN	NaN	36.14518	-33.66625	1966	Start of turn
Wed 08 May 2013 16:25:29	Airgun:Array	startLine	MGL1305MC110	FSP 58042	NaN	36.17053	-33.67374	2422	Start of line MGL1305MC110 FSP 58042 at 1625 UTC
Wed 08 May 2013 16:33:19	Ship	other	MGL1305MC110	NaN	NaN	36.17585	-33.68598	2539	End of turn
Wed 08 May 2013 18:29:41	Airgun:Array	passingOverStation	MGL1305MC110	OBS030	NaN	36.21342	-33.87447	2000	Passing OBS030 on Port side at UTC 1824 SP 58525
Wed 08 May 2013 18:38:41	Airgun:Array	passingOverStation	MGL1305MC110	OBS049	NaN	36.21649	-33.88997	1956	Passing OBS049 on Port side (South) at 18:30 UTC SP 58549
Wed 08 May 2013 19:07:33	Airgun:Array	other	MGL1305MC110	NaN	NaN	36.22635	-33.93810	3237	Shut down for turtle at UTC 19:06 last SP58697
Wed 08 May 2013 19:09:50	Airgun:Array	other	MGL1305MC110	NaN	NaN	36.22708	-33.94180		Power down mitigation gun UTC 19:08; missed SP: 58697, 58698, 58699, 58700, 58701
Wed 08 May 2013 19:16:59	Airgun:Array	other	MGL1305MC110	NaN	NaN	36.22947	-33.95357	3176	Back to full volume at SP58732 UTC 19:16
Wed 08 May 2013 20:47:57	OBS	other	NaN	NaN	NaN	36.13410	-33.56450	3187	Passing OBS020 SP58720 UTC 19:12

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Wed 08 May 2013 20:58:17	Ship	other	NaN	NaN	NaN	36.26349	-34.11871	2378	Start of turn to MGL1305MC111 UTC 20:58
Wed 08 May 2013 21:04:19	Airgun:Array	endLine	MGL1305MC110	NaN	NaN	36.26804	-34.12614	2081	end of line MGL1305MC110 at 21:03 UTC LSP59166
Wed 08 May 2013 22:42:51	Airgun:Array	startLine	MGL1305MC111	NaN	NaN	36.34743	-34.03895	1684	start of line MGL1305MC111 at 22:42 UTC FSP61040
Wed 08 May 2013 22:51:23	Ship	other	MGL1305MC111	NaN	NaN	36.34054	-34.02907	1961	end of turn at 22:51 UTC
Thu 09 May 2013 00:54:49	Airgun:Array	passingOverStation	MGL1305MC111	NaN	NaN	36.22857	-33.90353	2265	Passing OBS057 at 23:54 UTC SP61520
Thu 09 May 2013 01:18:51	Airgun:Array	passingOverStation	MGL1305MC111	NaN	NaN	36.20567	-33.87805	2048	Passing OBS049 at 00:18 UTC SP 61611
Thu 09 May 2013 03:38:08	Ship	other	MGL1305MC111	NaN	NaN	36.07955	-33.73709	1186	start of turn at 02:37 UTC SP62111
Thu 09 May 2013 03:50:11	Airgun:Array	endLine	MGL1305MC111	NaN	NaN	36.07262	-33.72158	1203	end of line MGL1305MC111 at 02:49 UTC LSP62152
Thu 09 May 2013 04:16:51	Ship	other	NaN	NaN	NaN	36.08877	-33.69056	1900	end of first turn heading to MGL1305MC112
Thu 09 May 2013 05:37:26	Airgun:Array	startLine	MGL1305MC112	NaN	NaN	36.17789	-33.66796	2171	Start of line MGL1305MC112 at 0537 UTC fsp64036
Thu 09 May 2013 05:48:48	Ship	other	MGL1305MC112	NaN	NaN	36.18427	-33.68434	2532	End of turn at 0548 UTC
Thu 09 May 2013 07:44:12	Airgun:Array	passingOverStation	MGL1305MC112	OBS050	NaN	36.22121	-33.86730	2044	Passing OBS050 on Starboard side at 07 UTC SP0741 64521
Thu 09 May 2013 08:09:09	Airgun:Array	passingOverStation	MGL1305MC112	OBS057	NaN	36.22955	-33.90795	2499	Passing OBS057 on Starboard side at 0808 UTC SP 64628
Thu 09 May 2013 09:48:23	Airgun:Array	other	MGL1305MC112	NaN	NaN	36.26241	-34.07337	2280	Power down at 0939 UTC for MMO lsp 65004. full power at 0947 fsp 65038
Thu 09 May 2013 11:53:13	Ship	other	MGL1305MC112	NaN	NaN	36.30266	-34.27418	1377	Start of starboard turn at 1152 UTC
Thu 09 May 2013 12:02:38	Airgun:Array	endLine	MGL1305MC112	NaN	NaN	36.30987	-34.28624	1377	end of line MGL1305MC112 at 1158 UTC LSP65554
Thu 09 May 2013 12:37:16	Airgun:Array	startLine	MGL1305M112T	NaN	NaN	36.35072	-34.28002	1931	Start of line MGL1305M112T FSP 67021 at 1135 UTC
Thu 09 May 2013 12:51:50	Airgun:Array	other	MGL1305MC112T	NaN	NaN	36.35730	-34.25965	1791	End of turn
Thu 09 May 2013 15:18:21	Airgun:Array	other	MGL1305MC112T	NaN	NaN	36.36520	-34.05404	1612	Start of turn
Thu 09 May 2013 15:28:15	Airgun:Array	endLine	MGL1305MC112T	NaN	NaN	36.36237	-34.04084	1523	EOL SP 67592 at 15:26 UTC
Thu 09 May 2013 15:31:55	Airgun:Array	startLine	MGL1305MC113	NaN	NaN	36.36005	-34.03668	1559	Start of line SP 70015 at 15:31 UTC
Thu 09 May 2013 16:26:30	Airgun:Array	other	MGL1305MC113	NaN	NaN	36.31542	-33.98641	1974	Power down LGSP 70190 at 16:24 UTC
Thu 09 May 2013 16:29:09	Airgun:Array	other	MGL1305MC113	NaN	NaN	36.31320	-33.98393	1951	Shutdown Last SP 70196 at 16:26 turtle
Thu 09 May 2013 16:33:59	Airgun:Array	other	MGL1305MC113	NaN	NaN	36.30901	-33.97936	1974	Full volume SP 70217 at 16:33 UTC
Thu 09 May 2013 18:18:52	Airgun:Array	passingOverStation	MGL1305MC113	OBS057	NaN	36.22229	-33.88140	2125	Passing OBS057 on Starboard side (South) at 1805 UTC SP 70720
Thu 09 May 2013 18:19:38	Airgun:Array	other	MGL1305MC113	NaN	NaN	36.22160	-33.88060		Power down dolphins last good SP 70566
Thu 09 May 2013 18:35:46	Airgun:Array	other	MGL1305MC113	SP70619	NaN	36.20907	-33.86713	2070	Back to full volume at SP70619 UTC 18:35
Thu 09 May 2013 21:13:07	Ship	other	MGL1305MC113	NaN	NaN	36.08098	-33.71810		start of turn at 21:03 UTC SP71109
Thu 09 May 2013 21:13:57	Airgun:Array	endLine	MGL1305MC113	NaN	NaN	36.08073	-33.71697	1424	end of line MGL1305MC113 at 21:11 UTC LSP71137

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Thu 09 May 2013 21:43:18	Ship	other	NaN	NaN	NaN	36.09866	-33.68284	1937	end of first turn at 21:42 UTC heading to MGL1305MC114
Thu 09 May 2013 22:52:24	Ship	other	NaN	NaN	NaN	36.18366	-33.66116		start of second turn to MGL1305MC114 at 22:38 UTC
Thu 09 May 2013 22:58:08	Airgun:Array	startLine	MGL1305MC114	NaN	NaN	36.18901	-33.66779	2502	start of line MGL1305MC114 at 22:57 UTC FSP73041
Fri 10 May 2013 00:51:32	Airgun:Array	passingOverStation	MGL1305MC114	NaN	NaN	36.22492	-33.83842	2563	Passing OBS031 at 00:51 UTC SP73466
Fri 10 May 2013 01:07:20	Airgun:Array	passingOverStation	MGL1305MC114	NaN	NaN	36.22974	-33.86182	2165	Passing OBS50 at 01:07UTC SP73523
Fri 10 May 2013 01:14:51	Airgun:Array	passingOverStation	MGL1305MC114	NaN	NaN	36.23220	-33.87313	2023	Passing OBS053 at 01:14 UTC SP73550
Fri 10 May 2013 01:29:32	Airgun:Array	passingOverStation	MGL1305MC114	NaN	NaN	36.23610	-33.89513	2287	Passing OBS054 at 01:29 UTC SP73606
Fri 10 May 2013 01:35:40	Airgun:Array	passingOverStation	MGL1305MC114	NaN	NaN	36.23819	-33.90428	2400	Passing OBS057 at 01:35 UTC SP73629
Fri 10 May 2013 01:43:31	Airgun:Array	passingOverStation	MGL1305MC114	NaN	NaN	36.24058	-33.91638	2617	Passing OBS018 at 01:43 UTC SP73658
Fri 10 May 2013 02:03:14	Airgun:Array	passingOverStation	MGL1305MC114	NaN	NaN	36.24697	-33.94705	3202	Passing OBS055 at 02:03 UTC SP73735
Fri 10 May 2013 03:43:14	Ship	other	MGL1305MC114	NaN	NaN	36.27924	-34.10609	2297	start of turn at 03:42 UTC SP74124
Fri 10 May 2013 03:51:18	Airgun:Array	endLine	MGL1305MC114	NaN	NaN	36.28462	-34.11684	2204	end of line MGL1305MC114 at 03:51 UTC LSP74156
Fri 10 May 2013 04:22:11	Ship	other	NaN	NaN	NaN	36.31783	-34.11331	2389	end of turn at 04:21 UTC
Fri 10 May 2013 05:44:02	Airgun:Array	startLine	MGL1305MC115	NaN	NaN	36.36500	-34.02504	1861	Start of line MGL1305MC115 at 0543 UTC fsp76023
Fri 10 May 2013 08:20:14	Airgun:Array	passingOverStation	MGL1305MC115	OBS054	NaN	36.24457	-33.88312		Passing OBS054 starboard side at 0819 UTC SP 76515
Fri 10 May 2013 08:31:00	Airgun:Array	passingOverStation	MGL1305MC115	OBS017	NaN	36.23660	-33.87436	2022	Passing OBS035 on starboard side at 0830 UTC SP 76547
Fri 10 May 2013 08:36:19	Airgun:Array	passingOverStation	MGL1305MC115	OBS053	NaN	36.23270	-33.86976	2094	Passing OBS053 on starboard side at 0835 UTC SP 76562
Fri 10 May 2013 08:54:19	Airgun:Array	passingOverStation	MGL1305MC115	OBS050	NaN	36.21951	-33.85539	2273	Passing OBS050 on startboard side at 0852 UTC SP 75609
Fri 10 May 2013 09:14:40	Airgun:Array	other	MGL1305MC115	NaN	NaN	36.20402	-33.83799	2441	Shut down at 0912 UTC for MMO lfvsp 76672. mitgation gun at 0915. Full power at 0921 sp76700
Fri 10 May 2013 11:24:06	Ship	other	MGL1305MC115	NaN	NaN	36.09426	-33.71478	1813	Start of turn port turn at 1119 UTC
Fri 10 May 2013 11:30:11	Airgun:Array	endLine	MGL1305MC115	NaN	NaN	36.09171	-33.70722	1772	end of line MGL1305MC115 at 1127 UTC LSP77127
Fri 10 May 2013 12:00:30	Ship	other	NaN	NaN	NaN	36.11046	-33.67305	1823	End of first port turn at 1200
Fri 10 May 2013 12:37:01	Ship	other	NaN	NaN	NaN	36.15630	-33.65822	1965	Start of second port turn at 1250 UTC
Fri 10 May 2013 13:06:30	Airgun:Array	startLine	MGL1305MC116	FSP79018	NaN	36.19288	-33.65758		Start of line MGL1305MC116 FSP 79018 at 1305 UTC
Fri 10 May 2013 14:39:21	EM122	stop	MGL1305MC116	NaN	NaN	36.22799	-33.80725		Stop for restart
Fri 10 May 2013 14:41:29	EM122	start	MGL1305MC116	NaN	NaN	36.22877	-33.81083		System restarted
Fri 10 May 2013 15:18:46	Airgun:Array	passingOverStation	MGL1305MC116	NaN	NaN	36.24113	-33.87238	2083	Passing OBS031 at UTC 15:17 SP79467
Fri 10 May 2013 17:40:01	Airgun:Array	other	MGL1305MC116	NaN	NaN	36.28720	-34.10011	2375	Start of turn
Fri 10 May 2013 17:49:47	Airgun:Array	endLine	MGL1305MC116	NaN	NaN	36.29308	-34.11110	2323	Last SP 80149 at 1749
Fri 10 May 2013 19:12:50	Airgun:Array	other	Transect	NaN	NaN	36.35663	-34.05974	1777	Lost several guns - deciding if recovery is necessary

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Fri 10 May 2013 19:49:22	Airgun:Array	startLine	MGL1305MC117	NaN	NaN	36.37198	-34.01965		Start of line first SP 82016 at 19:48 - 32 guns 6250 cu.in.
Fri 10 May 2013 23:12:22	Airgun:Array	other	MGL1305MC117	NaN	NaN	36.20903	-33.82941		Shot locations of SP82550-82638 may not be proper probably due to GPS problem by strong wind
Sat 11 May 2013 01:25:36	Airgun:Array	endLine	MGL1305MC117	NaN	NaN	36.08894	-33.69620	1801	End of line MGL1305MC117 LSP83154 at 01:24 UTC
Sat 11 May 2013 01:27:08	Airgun:Array	other	NaN	NaN	NaN	36.08753	-33.69484	1800	Gun 3 and 4 power down at 01:26 UTC
Sat 11 May 2013 01:41:34	Ship	other	NaN	NaN	NaN	36.07606	-33.68619		Go straight along MGL1305MC117 for a while to fix guns 3 and 4
Sat 11 May 2013 01:48:08	Airgun:Array	recover	NaN	NaN	NaN	36.07140	-33.68321	2025	gun 3 recovered on board for repair at 01:48 UTC
Sat 11 May 2013 02:03:56	Airgun:Array	recover	NaN	NaN	NaN	36.05875	-33.67572	1919	gun 4 recovered on board for repair at 02:04 UTC
Sat 11 May 2013 02:40:40	Ship	other	NaN	NaN	NaN	36.03743	-33.64887	1678	start of turn to head to MGL1305MC118 at 02:40 UTC
Sat 11 May 2013 03:10:53	Airgun:Array	deploy	NaN	NaN	NaN	36.05858	-33.61842	1811	started to deploy gun 4 at 03:10 UTC
Sat 11 May 2013 03:25:57	Airgun:Array	deploy	NaN	NaN	NaN	36.07403	-33.61227	1815	Gun 4 deployed at 03:24 UTC
Sat 11 May 2013 03:30:09	Airgun:Array	deploy	NaN	NaN	NaN	36.07800	-33.61114	1787	started to deploy gun 3 at 03:29 UTC
Sat 11 May 2013 03:46:24	Airgun:Array	deploy	NaN	NaN	NaN	36.09378	-33.60588	1759	Gun 3 deployed at 03:46 UTC
Sat 11 May 2013 03:59:13	Airgun:Array	other	NaN	NaN	NaN	36.11025	-33.61026	1654	turned off string 3 at 03:58 UTC
Sat 11 May 2013 04:02:33	Airgun:Array	recover	NaN	NaN	NaN	36.11344	-33.61205	1684	started to pick up string 3 at 04:01 UTC
Sat 11 May 2013 04:16:12	Airgun:Array	recover	NaN	NaN	NaN	36.12700	-33.61939	1785	String 3 recovered on board at 04:15 UTC
Sat 11 May 2013 04:18:50	magnetometer	stop	NaN	NaN	NaN	36.12967	-33.62075	1821	magnetometer turned off at 04:18 UTC
Sat 11 May 2013 04:22:10	magnetometer	other	NaN	NaN	NaN	36.13327	-33.62251	1857	magnetometer recovered on board at 04:21 UTC
Sat 11 May 2013 05:30:09	Airgun:Array	deploy	NaN	NaN	NaN	36.20549	-33.65335	2318	start deployment of airgun string 3
Sat 11 May 2013 05:37:29	Airgun:Array	startLine	MGL1305MC118	MGL103-118		36.20843	-33.66410	2387	Start of line MGL1305-118 at 05:28 UTC
Sat 11 May 2013 05:48:54	Airgun:Array	deploy	NaN	NaN	NaN	36.21217	-33.68164	2464	airgun array 3 in position at 05:40 UTC
Sat 11 May 2013 05:54:38	Airgun:Array	other	NaN	NaN	NaN	36.21365	-33.69079		total volum in airguns is 6480 cui
Sat 11 May 2013 06:06:52	Airgun:Array	passingOverStation	NaN	OBS081	NaN	36.21755	-33.70989		Passing over OBS081 at SP85465
Sat 11 May 2013 06:07:41	Airgun:Array	passingOverStation	NaN	OBS017	NaN	36.21780	-33.71118		Passing OBS017 at SP 85554
Sat 11 May 2013 06:08:31	Airgun:Array	passingOverStation	NaN	OBS018	NaN	36.21802	-33.71249		Passing OBS018 at SP 85658
Sat 11 May 2013 07:24:02	Airgun:Array	passingOverStation	MGL1305MC118	OBS031	NaN	36.24252	-33.83370	2742	Passing OBS031 on Port side at 0723 UTC SP 85465
Sat 11 May 2013 07:48:01	Airgun:Array	passingOverStation	MGL1305MC118	OBS017	NaN	36.25069	-33.87355	2164	Passing OBS017 at 0745 UTC SP 85554
Sat 11 May 2013 08:11:00	Airgun:Array	passingOverStation	MGL1305MC118	OBS018	NaN	36.25871	-33.91166	2739	Passing OBS018 on Port side at 0810 UTC SP 85658
Sat 11 May 2013 10:01:03	Ship	other	MGL1305MC118	NaN	NaN	36.29578	-34.09729	2424	Start of starboard ten at 1000 UTC
Sat 11 May 2013 10:10:03	Airgun:Array	endLine	MGL1305MC118	NaN	NaN	36.30374	-34.10918	2368	End of line MGL1305MC118 at 1008 UTC LSP86146
Sat 11 May 2013 10:42:28	Ship	other		NaN	NaN	36.33885	-34.09539	2369	End of first turn

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sat 11 May 2013 11:45:40	Ship	other	NaN	NaN	NaN	36.38195	-34.01762	1649	start of second turn to MGL1305MC119 at 1140 UTC
Sat 11 May 2013 11:55:21	Airgun:Array	startLine	MGL1305MC119	NaN	NaN	36.38137	-34.00499	1664	Start of line MGL1305MC119 at 11154 UTC fsp 88018
Sat 11 May 2013 12:07:21	Ship	other	MGL1305MC119	NaN	NaN	36.37359	-33.99122	1802	End of final turn to line MGL1305MC119 at 1205 UTC
Sat 11 May 2013 17:30:54	Airgun:Array	other	NaN	NaN	NaN	36.09624	-33.68005	1957	Start of turn
Sat 11 May 2013 17:42:33	Airgun:Array	endLine	MGL1305MC119	NaN	NaN	36.09192	-33.66570	1984	Last SP 89183 at 17:35
Sat 11 May 2013 18:01:40	EM122	other	NaN	NaN	NaN	36.10075	-33.64036		Multibeam lost depth
Sat 11 May 2013 18:06:11	Airgun:Array	startLine	MGL1305MS199T	NaN	NaN	36.10455	-33.63495		Start of line first SP 91011 at 1805 vol 6560
Sat 11 May 2013 18:52:44	Airgun:Array	endLine	MGL1305M119T	NaN	NaN	36.14540	-33.58804		End of Line MGL1305M199T UTC 18:51
Sat 11 May 2013 19:09:17	Airgun:Array	startLine	MGL1305MC119T2	NaN	NaN	36.16677	-33.58968	1837	Start of line first SP 94018 at 1908
Sat 11 May 2013 20:46:58	Airgun:Array	other	NaN	NaN	NaN	36.29227	-33.61029		Start of turn
Sat 11 May 2013 20:58:02	Airgun:Array	endLine	MGL1305MC119T2	NaN	NaN	36.30474	-33.62006	2031	End of line MGL1305MC119T2 SP 94423
Sat 11 May 2013 21:10:03	Airgun:Array	startLine	MGL1305MC122	NaN	NaN	36.30632	-33.64083	2063	SOL MGL1305MCS122 SP94437
Sat 11 May 2013 21:58:55	Airgun:Array	other	NaN	NaN	NaN	36.26441	-33.69957		End of turn at 21:27
Sun 12 May 2013 03:20:41	Airgun:Array	endLine	MGL1305MSC122	NaN	NaN	36.00303	-34.01912	2348	EOL SEQ072 MGL1305MCS122 SP98138
Sun 12 May 2013 04:19:27	Airgun:Array	startLine	MGL1305MC123	NaN	NaN	36.00174	-33.93820		
Sun 12 May 2013 06:52:29	Airgun:Array	passingOverStation	MGL1305MC123	OBS029	NaN	36.18674	-33.88648	1980	Passing OBS029 on Port side at 0651 UTC SP 100331
Sun 12 May 2013 07:11:38	Airgun:Array	passingOverStation	MGL1305MC123	OBS049	NaN	36.21121	-33.87960	1997	Passing OBS049 on Port side at 0711 UTC SP 100408
Sun 12 May 2013 07:34:35	Airgun:Array	passingOverStation	MGL1305MC123	OBS053	NaN	36.24034	-33.87158	2046	Passing OBS053 on Starboard side at 0734 UTC SP 100497
Sun 12 May 2013 07:40:12	Airgun:Array	passingOverStation	MGL1305MC123	OBS017	NaN	36.24738	-33.86965	2045	Passing OBS017 on Startboard side at 0739 UTC SP 100518
Sun 12 May 2013 09:37:52	Ship	other	MGL1305MC123	NaN	NaN	36.39567	-33.82865	1675	Start of turn to line MGL1305M115R at 0937 UTC
Sun 12 May 2013 09:46:33	Airgun:Array	endLine	MGL1305MC123	NaN	NaN	36.40685	-33.83251	1557	End of line MGL1305MC123 SP100992 0944 UTC
Sun 12 May 2013 10:06:46	Ship	other	NaN	NaN	NaN	36.41426	-33.86521		End of first turn at 1006 UTC to line MGL1305M115R
Sun 12 May 2013 10:21:40	Ship	other	NaN	NaN	NaN	36.41231	-33.89188	1061	start of second turn to MGL1305M115R at 1020 UTC
Sun 12 May 2013 10:46:31	Ship	other	NaN	NaN	NaN	36.38813	-33.91547	1432	End of second turn at 1046 UTC
Sun 12 May 2013 11:12:37	Airgun:Array	startLine	MGL1305M123T Seq 74	NaN	NaN	36.35613	-33.92116	1447	Start of line MGL1305M123T at 1116 UTC FSP:103065
Sun 12 May 2013 12:13:46	Ship	other	MGL1305M123T	NaN	NaN	36.28870	-33.93019		Start of third turn to line MGL1305M115R at 1210 UTC
Sun 12 May 2013 12:21:16	Airgun:Array	endLine	MGL1305M123T Seq 74	NaN	NaN	36.28147	-33.92551	2135	End of line MGL1305M123T SP103271 1220 UTC
Sun 12 May 2013 12:24:51	Airgun:Array	startLine	MGL1305M115R SEQ75	NaN	NaN	36.27847	-33.92204		Start of line MGL1305M115R at 1224 UTC FSP:76379

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Sun 12 May 2013 12:26:12	Ship	other	MGL1305M115R	NaN	NaN	36.27721	-33.92071		End of turn of final turn at 1223 UTC
Sun 12 May 2013 14:06:46	Airgun:Array	other	MGL1305MC115R	NaN	NaN	36.18933	-33.82268		Crash of Spectra - SP76710 to 76717 no navigation info will need interpolation
Sun 12 May 2013 14:10:00	Airgun:Array	other	MGL1305MC115R	NaN	NaN	36.18630	-33.81929		Start of turn
Sun 12 May 2013 14:18:37	Airgun:Array	endLine	MGL1305MC115R	NaN	NaN	36.17672	-33.81342	2107	EOL Last SP76773 at 14:17 UTC
Sun 12 May 2013 17:59:21	Airgun:Array	endLine	MGL1305M110R	NaN	NaN	36.24826	-34.03056	2405	END of line MGL1305M110R UTC 17:59 SP58927
Sun 12 May 2013 18:07:04	Airgun:Array	passingOverStation	NaN	NaN	NaN			2072	Passing OBS30 at UTC 16:21 SP 58526
Sun 12 May 2013 18:09:29	Airgun:Array	passingOverStation	NaN	NaN	NaN			1951	Passing OBS049 at UTC 16:29 SP58561
Sun 12 May 2013 18:15:18	Airgun:Array	passingOverStation	NaN	NaN	NaN			2395	Passing OBS048 at 16:39 UTC SP58605
Sun 12 May 2013 18:19:29	Airgun:Array	passingOverStation	NaN	NaN	NaN			2432	Passing OBS019 at UTC16:45 SP 58630
Sun 12 May 2013 18:21:31	Airgun:Array	passingOverStation	NaN	NaN	NaN			3199	Passing OBS020 at UTC 17:01 SP58719
Sun 12 May 2013 19:26:44	Airgun:Array	other	MGL1305MC113R	NaN	NaN	36.31399	-33.98870	2065	Start of line first SP70186 at 19:23 UTM
Mon 13 May 2013 00:44:38	Airgun:Array	endLine	MGL1305MCS113R	NaN	NaN	36.07814	-33.72088	1399	End of line MGL1305MCS113R 0042 UTC SP 71137
Mon 13 May 2013 00:53:24	Airgun:Array	passingOverStation	MGL1305MCS113R	OBS018	NaN	36.07097	-33.71364	2680	Passing OBS018 SP70466 2054UTC Lat:36 14'57.256'' N Long: 33 54'39.997''W
Mon 13 May 2013 00:56:05	Airgun:Array	passingOverStation	MGL1305MCS113R	OBS054	NaN	36.06879	-33.71183	2268	Passing OBS054 SP 70515 2112UTC Lat:36 1412.959'' N Long: 33 53'50.559''W
Mon 13 May 2013 00:59:21	Airgun:Array	passingOverStation	MGL1305MCS113R	OBS059	NaN	36.06621	-33.71057	2157	Passing OBS059 SP70527 Sun May 2116UTC Lat:36 14'02.267'' N Long: 33 53'38.047''W
Mon 13 May 2013 01:01:57	Airgun:Array	passingOverStation	MGL1305MCS113R	OBS050	NaN	36.06417	-33.70947	2010	Passing OBS050 SP70610 Sun May 2146UTC Lat:36 12'47.766'' N Long: 33 52'14.187''W
Mon 13 May 2013 01:04:05	Airgun:Array	passingOverStation	MGL1305MCS113R	OBS049	NaN	36.06240	-33.70838	2014	Passing OBS049 SP70612 Sun May 2147UTC Lat:36 12'45.890'' N Long: 33 52'12.216''W
Mon 13 May 2013 01:06:05	Airgun:Array	passingOverStation	MGL1305MCS113R	OBS030	NaN	36.06083	-33.70741	2073	Passing OBS030 SP70626 Sun May 2152UTC Lat:36 12'33.323'' N Long: 33 51'58.680''W
Mon 13 May 2013 01:33:57	Airgun:Array	recover	NaN	NaN	NaN	36.03784	-33.69591		String 3 recovered on board at 01:19 UTC
Mon 13 May 2013 01:40:01	Airgun:Array	recover	NaN	NaN	NaN	36.03360	-33.69197		String 4 recovered onboard at 01:35 UTC
Mon 13 May 2013 01:54:25	Airgun:Array	recover	NaN	NaN	NaN	36.03189	-33.67838		String 2 recovered at 01:54 UTC
Mon 13 May 2013 02:19:40	Airgun:Array	recover	NaN	NaN	NaN	36.04490	-33.65669		String 1 recovered at 02:49 UTC
Mon 13 May 2013 02:27:49	Hydrophone:Streamer	recover	NaN	NaN	NaN	36.04846	-33.65106	1520	started to revover hydrophone streamer at 02:27UTC
Mon 13 May 2013 02:30:46	Ship	other	NaN	NaN	NaN	36.04955	-33.64941	1532	slow down to 2 knots at 02:29 UTC
Mon 13 May 2013 02:52:46	Hydrophone:Streamer	recover	NaN	NaN	NaN	36.05252	-33.63574	1721	Head float on board at 02:52 UTC
Mon 13 May 2013 03:06:35	Hydrophone:Streamer	other	NaN	NaN	NaN	36.05318	-33.62816	1768	Hydrophone streamer power down at 03:02 UTC
Mon 13 May 2013 03:27:06	Ship	other	NaN	NaN	NaN	36.05479	-33.61458	1886	slow down to 1.0 knots at 03:26 UTC

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Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Mon 13 May 2013 05:38:53	Hydrophone:Streamer	other	NaN	NaN	NaN	36.05572	-33.55992		streamer powered on then turned off to remouve the stretching
Mon 13 May 2013 06:50:20	Hydrophone:Streamer	recover	NaN	NaN	NaN	36.05456	-33.52324	2034	streamer recovered onboard at 6:37 UTC
Mon 13 May 2013 06:58:15	Echosounder3.5	startLine	NaN	NaN	NaN	36.06126	-33.53822	2040	Knudsen turned back on at 0656 UTC
Mon 13 May 2013 08:42:49	EM122	stop	NaN	NaN	NaN	36.20890	-33.86441		turned off to comunicste with OBS at 08:37 UTC
Mon 13 May 2013 08:59:17	OBS	release	NaN	NaN	NaN	36.21088	-33.87265		OBS030 released at 09:00
Mon 13 May 2013 09:28:51	OBS	onSurface	NaN	NaN	NaN	36.21184	-33.87236		OBS030 on surface at 9:28UTC
Mon 13 May 2013 09:40:09	OBS	recover	NaN	NaN	NaN	36.20925	-33.87332		OBS030 recovered at 09:39 UTC
Mon 13 May 2013 10:26:14	OBS	release	NaN	NaN	NaN	36.23327	-33.83729		OBS031 released on 10:25 UTC
Mon 13 May 2013 11:03:33	OBS	onSurface	NaN	NaN	NaN	36.23639	-33.83837		OBS031 on surface at 11:03 UTC
Mon 13 May 2013 11:12:07	OBS	recover	NaN	NaN	NaN	36.23368	-33.83850		OBS31 recovered at 11:11 UTC
Mon 13 May 2013 11:51:17	XBT	release	NaN	NaN	NaN	36.26399	-33.79753		XBT lunched at 11:42 and mesured to 2228
Mon 13 May 2013 12:13:26	OBS	release	NaN	NaN	NaN	36.26394	-33.79272		OBS032 released at 12:12 UTC
Mon 13 May 2013 12:44:14	OBS	onSurface	NaN	OBS032	NaN	36.26484	-33.79814		OBS32 on surface at 12:43 UTC
Mon 13 May 2013 12:53:49	OBS	recover	NaN	OBS032	NaN	36.26417	-33.79639	3105	Recovered at 12:54
Mon 13 May 2013 12:57:44	Ship	other	NaN	NaN	NaN	36.26258	-33.79722		Leaving station
Mon 13 May 2013 13:41:44	OBS	release	NaN	OBS033	NaN	36.30040	-33.74664	2298	Realease at 13:43 ETA on the surface 14:28
Mon 13 May 2013 13:43:04	XBT	release	NaN	OBS033	NaN	36.30012	-33.74677	2298	X5 probe successful to >2200 m
Mon 13 May 2013 14:23:16	OBS	onSurface	NaN	OBS033	NaN	36.30288	-33.75216	2298	On surface at 14:22
Mon 13 May 2013 14:36:31	OBS	recover	NaN	OBS033	NaN	36.30091	-33.74808	2247	Recovered at 14:36
Mon 13 May 2013 16:00:06	OBS	release	NaN	OBS034	NaN	36.34381	-33.68999	2786	OBS off the bottom, after some difficulty
Mon 13 May 2013 16:36:28	OBS	onSurface	NaN	OBS034	NaN	36.34099	-33.68820		On the surface at 16:27
Mon 13 May 2013 16:38:43	OBS	recover	NaN	OBS034	NaN	36.34059	-33.68830		On deck at 16:38
Mon 13 May 2013 17:30:15	OBS	release	NaN	OBS013	NaN	36.38181	-33.73202	2703	Off the bottom
Mon 13 May 2013 18:16:10	OBS	onSurface	NaN	OBS013	NaN	36.38210	-33.73320		On the surface
Mon 13 May 2013 18:22:27	OBS	recover	NaN	OBS013	NaN	36.38072	-33.73188	2705	OBS on deck
Mon 13 May 2013 19:16:32	OBS	release	NaN	OBS014	NaN	36.33945	-33.79121	2874	Off the bottom, ETA on surface 19:05
Mon 13 May 2013 20:04:22	OBS	onSurface	NaN	OBS014	NaN	36.34272	-33.79108		On the surface
Mon 13 May 2013 20:11:11	OBS	recover	NaN	OBS014	NaN	36.34148	-33.79322	2661	On deck at 20:11
Mon 13 May 2013 20:59:39	OBS	release	NaN	OBS015	NaN	36.30477	-33.84365	2871	OBS015 released: estimated time 15mins
Mon 13 May 2013 20:59:43	OBS	release	NaN	OBS015	NaN	36.30475	-33.84367	2871	OBS015 released: estimated time 15mins
Mon 13 May 2013 21:44:09	OBS	onSurface	NaN	OBS015	NaN	36.30756	-33.84362		OBS015 on surface
Mon 13 May 2013 21:55:45	OBS	recover	NaN	)BS015	NaN	36.30478	-33.84771	2871	OBS015 recovered
Mon 13 May 2013 22:49:51	OBS	release	NaN	OBS016	NaN	36.27678	-33.87789	2475	OBS016 released at 22:44 eta 40mins
Mon 13 May 2013 23:31:17	OBS	onSurface	NaN	OBS016	NaN	36.27643	-33.88553	2475	OBS016 on surface at 23:29 UTC
Mon 13 May 2013 23:55:06	OBS	recover	NaN	OBS016	NaN	36.27655	-33.88800	2475	OBS016 recovered
Tue 14 May 2013 00:47:15	OBS	release	NaN	OBS017	NaN	36.24772	-33.86864	2141	OBS017 released at 00:42 UTC eta 25mins
Tue 14 May 2013 01:11:43	OBS	onSurface	NaN	OBS017	NaN	36.24797	-33.87109	2141	OBS017 on surface at 01:11 UTC
Tue 14 May 2013 01:29:12	OBS	recover	NaN	OBS017	NaN	36.24647	-33.87367	2141	OBS017 recovered

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Tue 14 May 2013 01:59:29	OBS	release	NaN	OBS018	NaN	36.25189	-33.92051	2721	OBS018 released at 01:58 UTC eta 50mins
Tue 14 May 2013 02:44:07	OBS	onSurface	NaN	OBS18	NaN	36.25142	-33.91592	NA	OBS018 on surface at 02:43 UTC
Tue 14 May 2013 02:53:19	OBS	recover	NaN	OBS018	NaN	36.25139	-33.91527	2283	OBS018 recovered on board at 02:53 UTC
Tue 14 May 2013 03:50:03	OBS	release	NaN	OBS019	NaN	36.21615	-33.91739	NA	OBS019 released at 03:48 UTC eta 25mins
Tue 14 May 2013 04:13:48	OBS	onSurface	NaN	OBS019	NaN	36.21514	-33.91521	2613	OBS019 on surface at 04:12 UTC
Tue 14 May 2013 04:21:28	OBS	recover	NaN	OBS019	NaN	36.21493	-33.91406	NA	OBS019 recovered on board at 04:21 UTC
Tue 14 May 2013 05:53:31	OBS	onSurface	NaN	OBS020	NaN	36.22757	-33.95004	2623	OBS020 on surface at 05h53
Tue 14 May 2013 06:05:06	OBS	recover	NaN	OBS020	NaN	36.22469	-33.95127		OBS 20 recovered onboard at 06.04 UTC
Tue 14 May 2013 06:28:54	OBS	release	NaN	OBS021	NaN	36.19677	-33.98254		OBS021 released at 06.41 UTC
Tue 14 May 2013 07:29:28	OBS	onSurface	NaN	OBS021	NaN	36.19765	-33.99132		OBS021 on surface at 07.29 UTC
Tue 14 May 2013 07:43:03	OBS	recover	NaN	OBS021	NaN	36.19352	-33.99124		OBS021 recovered at 07.42
Tue 14 May 2013 08:18:40	OBS	release	NaN	OBS022	NaN	36.15940	-34.03703		OBS022 released at 08.18UTC
Tue 14 May 2013 08:56:43	OBS	onSurface	NaN	OBS022	NaN	36.16151	-34.04249		OBS022 on surface at 08.56UTC
Tue 14 May 2013 09:08:06	OBS	recover	NaN	OBS022	NaN	36.15664	-34.03896		OBS022 recovered onboard at 09.07 UTC
Tue 14 May 2013 10:00:04	OBS	release	NaN	OBS023	NaN	36.11654	-34.09717		OBS023 released at 10.01 UTC
Tue 14 May 2013 10:32:21	OBS	onSurface	NaN	OBS023	NaN	36.11801	-34.10033		OBS023 on surface
Tue 14 May 2013 10:41:29	OBS	recover	NaN	OBS023	NaN	36.11473	-34.09560		OBS023 recivered at 10.41 UTC
Tue 14 May 2013 11:18:53	OBS	release	NaN	OBS026	NaN	36.07733	-34.05099		OBS026 released at 11.30 UTC
Tue 14 May 2013 12:26:33	OBS	onSurface	NaN	OBS026	NaN	36.07607	-34.05078		OBS026 on surface at 12.26 UTC
Tue 14 May 2013 12:34:00	OBS	recover	NaN	OBS026	NaN	36.07630	-34.04930		OBS026 recovered 12.30
Tue 14 May 2013 14:01:27	OBS	onSurface	NaN	OBS027	NaN	36.12067	-33.99752		OBS027 on surface 13:00 UTC
Tue 14 May 2013 14:14:47	OBS	recover	NaN	OBS027	NaN	36.12181	-33.99412		OBS027 recovered at 14:14 UTC
Tue 14 May 2013 15:12:15	OBS	release	NaN	OBS028	NaN	36.15541	-33.94037		OBS028 released at 15:12 UTC
Tue 14 May 2013 15:34:22	XBT	release	NaN	NaN	NaN	36.15241	-33.94326		XBT launched at 15:25 to 2300m
Tue 14 May 2013 15:53:54	OBS	onSurface	NaN	OBS028	NaN	36.15696	-33.94789		OBS028 on surface 15:53 UTC
Tue 14 May 2013 16:06:40	OBS	recover	NaN	OBS028	NaN	36.15558	-33.94617		OBS028 on surface at 16:04 UTC
Tue 14 May 2013 17:00:15	OBS	release	NaN	OBS029	NaN	36.18412	-33.90371		Released, ETA surface 16:35
Tue 14 May 2013 17:41:08	OBS	recover	NaN	OBS029	NaN	36.18555	-33.90562	2376	On deck
Tue 14 May 2013 19:09:26	OBS	deploy	NaN	OBS047	SN 13023	36.18460	-33.93153	3158	
Tue 14 May 2013 22:17:58	Ship	other	NaN	NaN	NaN	36.18807	-33.91229		leaving OBS047 going to site of OBS051
Tue 14 May 2013 22:57:54	OBS	deploy	NaN	OBS051	SN 13036	36.20251	-33.82370	2531	OBS051 deployed at 22:57 UTC. Depth obtained from bathy grid.
Wed 15 May 2013 01:28:57	Ship	other	NaN	NaN	NaN	36.19375	-33.81360	NA	started to acoustic survey around OBS051 at 00:08 UTC
Wed 15 May 2013 01:50:57	Ship	other	NaN	NaN	NaN	36.20166	-33.82526	NA	Leaving OBS051 heading to site of OBS52 at 01:49
Wed 15 May 2013 02:30:18	OBS	deploy	NaN	OBS052	Sn 13021	36.26930	-33.84217	2588	OBS052 deployed at 02:30 UTC
Wed 15 May 2013 02:31:27	EM122	other	NaN	NaN	NaN	36.26959	-33.84206		turned off multibeam system at 02:29 UTC
Wed 15 May 2013 02:40:14	XBT	release	NaN	NaN	NaN	36.26967	-33.84003	NA	XBT launched at 02:39 UTC successful to 2200 m depth

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Wed 15 May 2013 03:32:56	OBS	other	NaN	OBS052	13021	36.26450	-33.82681	NA	started to acoustic survey around OBS052 at 03:33 UTC
Wed 15 May 2013 04:55:14	OBS	other	NaN	OBS052	Sn 13021	36.27658	-33.84075	NA	end of acoustic survey at OBS52 heading to OBS058 at 4:54 UTC
Wed 15 May 2013 04:57:52	EM122	other	NaN	NaN	NaN	36.27478	-33.84465	2720	turned on multibeam system at 04:56 UTC
Wed 15 May 2013 05:40:33	OBS	deploy	NaN	OBS058	SN 13033	36.23039	-33.90227	2297	Deploy OBS058 at 05.41UTC
Wed 15 May 2013 05:58:44	OBS	deploy	NaN	OBS059	SN13002	36.22939	-33.90087	2260	Deploy OBS059 at 05.58 UTC
Wed 15 May 2013 06:13:10	OBS	deploy	NaN	OBS060	SN 13010	36.22809	-33.90138	2240	Deploy OBS060 at 06.13 UTC
Wed 15 May 2013 06:21:03	OBS	deploy	NaN	OBS061	SN 13011	36.22762	-33.90347	2329	Deploy OBS061 at 06.21 UTC
Wed 15 May 2013 06:36:29	OBS	deploy	NaN	OBS056	SN 13012	36.22865	-33.90509	2384	Deploy OBS056 at 06.35 UTC
Wed 15 May 2013 06:39:08	OBS	other	NaN	OBS058	SN 13033	36.22901	-33.90491		Start acoustic survey of OBS 58
Wed 15 May 2013 08:20:21	OBS	other	NaN	OBS058	SN 13033	36.23398	-33.89144	NA	OBS058 disabled survey compete moving on to OBS059
Wed 15 May 2013 08:21:34	OBS	other	NaN	OBS059	SN 13002	36.23544	-33.89226	NA	Starting survey of OBS059 at 0821 UTC
Wed 15 May 2013 08:54:18	OBS	other	NaN	OBS059	SN 13002	36.22203	-33.89909	NA	Survey of OBS059 complete and trying to disable at 0854
Wed 15 May 2013 09:15:48	OBS	other	NaN	OBS059	SN 13002	36.23847	-33.89680	NA	OBS059 Disabled. Beginning enable command for OBS060 at 0915
Wed 15 May 2013 09:20:49	OBS	other	NaN	OBS060	SN 13010	36.23851	-33.90391	NA	Starting survey of OBS060 at 0918 UTC
Wed 15 May 2013 10:08:56	OBS	other	NaN	OBS060	SN 13010	36.23725	-33.89526	NA	Survey of OBS060 is complete. Beginning disable proccess.
Wed 15 May 2013 10:16:58	OBS	other	NaN	OBS061	SN 13011	36.23703	-33.90687	NA	Survey started on OBS061 at 1016 UTC
Wed 15 May 2013 11:26:36	OBS	other	NaN	OBS61	SN 13011	36.22120	-33.91082	NA	Survey of OBS060 is complete and disabled at 1125 UTC
Wed 15 May 2013 11:27:17	OBS	other	NaN	OBS56	SN 13012	36.22079	-33.91025	NA	Starting survey of OBS056 at 1126 UTC
Wed 15 May 2013 12:08:23	OBS	other	NAN	OBS056	SN 13012	36.21992	-33.90274		Survey of OBS056 is complete and disabled at 1207 UTC
Wed 15 May 2013 12:09:47	OBS	other	NaN	OBS057	NaN	36.22110	-33.90024	NA	Sending enable code to OBS057 at 1208 UTC
Wed 15 May 2013 12:20:36	OBS	other	NaN	OBS057	NaN	36.23597	-33.89513	NA	Survey of OBS057 started at 1218 UTC
Wed 15 May 2013 13:40:13	OBS	other	NaN	OBS055	NaN	36.25439	-33.94292		Surveying OBS055
Wed 15 May 2013 16:01:38	OBS	other	NaN	OBS055	NaN	36.24847	-33.94603		Finished surveying
Wed 15 May 2013 17:21:44	OBS	other	NaN	OBS040	NaN	36.18821	-33.77962		Started trying to recover OBS 16:30
Wed 15 May 2013 19:41:26	OBS	other	NaN	OBS040	NaN	36.18757	-33.78688		Abandoning rescue effort
Wed 15 May 2013 20:53:47	magnetometer	start	NaN	NaN	NaN	36.02882	-33.79962	1572	Deploying maggy for final survey
Thu 16 May 2013 08:59:55	Ship	other	NaN	NaN	NaN	36.59917	-33.76675	2005	Turn to new survey line 1305MB07 at 0859 UTC
Thu 16 May 2013 14:03:40	EM122	other	NaN	NaN	NaN	36.19666	-34.43737		Increased angle to port to 65 degrees to fill gap
Thu 16 May 2013 14:33:06	Ship	other	NaN	NaN	NaN	36.15749	-34.50209		Turn
Thu 16 May 2013 14:34:02	EM122	other	NaN	NaN	NaN	36.15785	-34.50385		Port angle decreased to 62
Thu 16 May 2013 15:01:53	Ship	other	NaN	NaN	NaN	36.21729	-34.50331		Turn
Thu 16 May 2013 16:48:08	XBT	release	NaN	NaN	NaN	36.35733	-34.27018	1826	XBT launch to 880m UTC 16:39

R2R ELOG Cruise MGL1305

Date	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Comment
Fri 17 May 2013 06:54:49	Ship	other	1305MB13	NaN	NaN			2192	Turn to new survey line 1305MB14 at 0654 UTC
Fri 17 May 2013 07:23:06	Ship	other	1305MB14	NaN	NaN	35.67044	-34.03160	2331	Turn to new survey line 1305MB15 at 0722 UTC
Fri 17 May 2013 08:44:38	Ship	other	1305MB15	NaN	NaN	35.83458	-33.93250	1545	Turn to new survey line 1305MB16 at 0843 UTC
Fri 17 May 2013 16:35:09	magnetometer	stop	NaN	NaN	NaN	36.55852	-33.56365	2613	Maggue turned off for final recovery
Fri 17 May 2013 16:53:25	EM122	stop	NaN	NaN	NaN	36.57472	-33.54025	2341	Stopped data collection EEZ
Sun 19 May 2013 07:28:43	Ship	endCruise	NaN	NaN	NaN	37.73882	-25.66082		Docking at pier in Ponta Delgada.

A.17. Incidental Harassment Authorization (IHA)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

Meagan J. Cummings / Jeff Rupert
Marine Environmental & Safety Coordinator
Department of Marine Operations
Lamont-Doherty Earth Observatory
P.O. Box 1000
Palisades, New York 10964-8000

APR 0 8 2013

Dear Ms. Cummings:

Enclosed is an Incidental Harassment Authorization (IHA) issued to the Lamont-Doherty Earth Observatory, under the authority of Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*), to harass small numbers of marine mammals, by Level B harassment, incidental to the R/V *Marcus G. Langseth*'s marine seismic survey in the Atlantic Ocean during April through June, 2013.

You are required to comply with the conditions contained in the IHA. The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, National Marine Fisheries Service (NMFS), at 301-427-8401.

In addition, you must submit a report to the NMFS' Office of Protected Resources within 90 days of the completion of the cruise. The IHA requires monitoring of marine mammals by qualified individuals before, during, and after seismic activities and reporting of marine mammal observations, including species, numbers, and behavioral modifications potentially resulting from this activity.

If you have any questions concerning the IHA or its requirements, please contact Jeannine Cody, Office of Protected Resources, NMFS, at 301-427-8401.

Sincerely,

Helen M. Golde
Acting Director
Office of Protected Resources

Enclosures

Printed on Recycled Paper

DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE

INCIDENTAL HARASSMENT AUTHORIZATION

We hereby authorize the Lamont-Doherty Earth Observatory (Observatory), Columbia University, P.O. Box 1000, 61 Route 9W, Palisades, New York 10964-8000, under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107, to incidentally harass small numbers of marine mammals incidental to a marine geophysical survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) marine geophysical survey on the Mid-Atlantic Ridge in the Atlantic Ocean, April through June, 2013.

1. This Authorization is valid from April 8 through June 24, 2013.

2. This Authorization is valid only for specified activities associated with the R/V *Marcus G. Langseth*'s (*Langseth*) seismic operations as specified in the Observatory's Incidental Harassment Authorization (IHA) application and environmental analysis in the following specified geographic area:

   (a) In the Atlantic Ocean on the Mid-Atlantic Ridge bounded by the following coordinates: approximately 35.5 to 36.5° North by 33.5 to 34.5° West as specified in the Observatory's application and the National Science Foundation's environmental analysis.

3. SPECIES AUTHORIZED AND LEVEL OF TAKES

(a) This authorization limits the incidental taking of marine mammals, by Level B harassment only, to the following species in the area described in Condition 2(a):

(i) Mysticetes – see Table 1 (attached) for authorized species and take numbers.

(ii) Odontocetes – see Table 1 (attached) for authorized species and take numbers.

(iii) During the seismic activities, if the Holder of this Authorization encounters any marine mammal species that are not listed in Table 1 (attached) for authorized taking and are likely to be exposed to sound pressure levels greater than or equal to 160 decibels (dB) re: 1 μPa, then the Holder must alter speed or course or shut-down the airguns to avoid take.

(b) This Authorization prohibits the taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 3(a) or the taking of any kind of any other species of marine mammal. Thus, it may result in the modification, suspension or revocation of this Authorization.

(c) This Authorization limits the methods authorized for taking by Level B harassment to the following acoustic sources without an amendment to this Authorization:

(i) a 36 Bolt airgun array with a total capacity of 6,600 in^3 (or smaller);

(ii) an acoustic release transponder used to communicate with ocean bottom seismometers (OBS).

(iii) a multi-beam echosounder; and

(iv) a sub-bottom profiler.

4. The Holder of this Authorization must report the taking of any marine mammal in a manner prohibited under this Authorization immediately to the Office of Protected Resources, National Marine Fisheries Service, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

5. We require the Holder of this Authorization to cooperate with the Office of Protected Resources, National Marine Fisheries Service and any other Federal, state or local agency monitoring the impacts of the activity on marine mammals.

6. MITIGATION AND MONITORING REQUIREMENTS

We require the Holder of this Authorization to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable adverse impact on affected marine mammal species or stocks:

6. VISUAL OBSERVERS

(a) Utilize two, National Marine Fisheries Service-qualified, vessel-based Protected Species Visual Observers (visual observers) to watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from civil twilight-dawn to civil twilight-dusk) and before and during start-ups of airguns day or night.

(i) At least one visual observer will be on watch during meal times and restroom breaks.

(ii) Observer shifts will last no longer than four hours at a time.

(iii) Visual observers will also conduct monitoring while the Langseth crew deploy and recover the airgun array and streamers from the water.

(iv) When feasible, visual observers will conduct observations during daytime periods when the seismic system is not operating for comparison of sighting rates and behavioral reactions during, between, and after airgun operations.

(v) The *Langseth*'s vessel crew will also assist in detecting marine mammals, when practicable. Visual observers will have access to reticle binoculars (7x50 Fujinon), and big-eye binoculars (25x150).

6. EXCLUSION ZONES

(b) Establish a 180-decibel (dB) exclusion zone (zone) for cetaceans before starting the 4-string airgun array (6,600 in^3); and a 180-dB exclusion zone for the single airgun (40 in^3). See Table 2 (attached) for distances of the exclusion zones. Observers will use the predicted radius distance for the 180-dB exclusion zone for cetaceans.

6. VISUAL MONITORING AT THE START OF AIRGUN OPERATIONS

(c) Monitor the entire extent of the zones listed in Table 2 (attached) for at least 30 minutes (day or night) prior to the ramp-up of airgun operations after a shutdown.

(d) Delay airgun operations if the visual observer sees a cetacean within the 180-dB zone for cetaceans until the marine mammal(s) has left the area.

(i) If the visual observer sees a marine mammal that surfaces, then dives below the surface, the observer shall wait 30 minutes. If the observer sees no marine mammals during that time, he/she should assume that the animal has moved beyond the 180-dB zone for cetaceans.

(ii) If for any reason the visual observer cannot see the full 180-dB zone for cetaceans for the entire 30 minutes (*i.e*., rough seas, fog, darkness), or if marine mammals are near, approaching, or within zone, the *Langseth* may not resume airgun operations.

(iii) If one airgun is already running at a source level of at least 180 dB re: 1 µPa, the *Langseth* may start the second gun–and subsequent airguns–without observing relevant exclusion zones for 30 minutes, provided that the observers have not seen any marine mammals near the relevant exclusion zones (in accordance with Condition 6(b)).

6. PASSIVE ACOUSTIC MONITORING

(e) Utilize the passive acoustic monitoring (PAM) system, to the maximum extent practicable, to detect and allow some localization of marine mammals around the *Langseth* during all airgun operations and during most periods when airguns are not operating. One visual observer and/or bioacoustician will monitor the PAM at all times in shifts no longer than 6 hours. A bioacoustician shall design and set up the PAM system and be present to operate or oversee PAM, and available when technical issues occur during the survey.

(f) Do and record the following when an animal is detected by the PAM:

(i) notify the visual observer immediately of a vocalizing marine mammal so a power-down or shut-down can be initiated, if required;

(ii) enter the information regarding the vocalization into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position, and water depth when first detected, bearing if determinable, species or species group (e.g., unidentified dolphin, sperm whale), types and nature of sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information.

6. RAMP-UP PROCEDURES

(g) Implement a "ramp-up" procedure when starting the airguns at the beginning of seismic operations or anytime after the entire array has been shutdown, which means start the smallest gun first and add airguns in a sequence such that the source level of the array will increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-up, the observers will monitor the exclusion zone, and if marine mammals are sighted, a course/speed alteration, power-down, or shutdown will be implemented as though the full array were operational.

6. RECORDING VISUAL DETECTIONS

(h) Visual observers must record the following information when they have sighted a marine mammal:

(i) Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (*e.g.*, none, avoidance, approach, paralleling, etc., and including responses to ramp-up), and behavioral pace; and

(ii) Time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or shut-down), Beaufort sea state and wind force, visibility, and sun glare; and

(iii) The data listed under 6(f)(ii) at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

6. SPEED OR COURSE ALTERATION

(i) Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant exclusion zone. If speed or course alteration is not safe or practicable, or if after alteration the marine mammal still appears likely to enter the exclusion zone, the Holder of this Authorization will implement further mitigation measures, such as a shutdown.

6. POWER-DOWN PROCEDURES

(j) Power down the airguns if a visual observer detects a marine mammal within, approaching, or entering the relevant exclusion zones (as defined in Table 2, attached). A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun. This would reduce the exclusion zone to the degree that the animal(s) is outside of it.

6. RESUMING AIRGUN OPERATIONS AFTER A POWER-DOWN

(k) Following a power-down, if the marine mammal approaches the smaller designated exclusion zone, the airguns must then be completely shut-down. Airgun activity will not resume until the observer has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or has not been seen within the exclusion zone for 15 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales).

(l) Following a power-down and subsequent animal departure, the *Langseth* may resume airgun operations at full power. Initiation requires that the observers can effectively monitor the full exclusion zones described in Condition 6(b). If the observer sees a marine mammal within or about to enter the relevant zones, then the *Langseth* will implement a course/speed alteration, power-down, or shutdown.

6. SHUTDOWN PROCEDURES

(m) Shutdown the airgun(s) if a visual observer detects a marine mammal within, approaching, or entering the relevant exclusion zone (as defined in Table 2, attached). A shutdown means that the *Langseth* turns off all operating airguns.

(n) If a North Atlantic right whale (*Eubalaena glacialis*) is visually sighted, the airgun array will be shut-down regardless of the distance of the animal(s) to the sound source. The array will not resume firing until 30 minutes after the last documented whale visual sighting.

6. RESUMING AIRGUN OPERATIONS AFTER A SHUTDOWN

(o) Following a shutdown, if the observer has visually confirmed that the animal has departed the 180-dB exclusion zone within a period of less than or equal to 8 minutes after the shutdown, then the *Langseth* may resume airgun operations at full power.

(p) Else, if the observer has not seen the animal depart the 180-dB exclusion zone, the *Langseth* shall not resume airgun activity until 15 minutes has passed for species with shorter dive times (*i.e.,* small odontocetes and pinnipeds) or 30 minutes has passed for species with longer dive durations (*i.e.,* mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales). The Langseth will follow the ramp-up procedures described in Conditions 6(g).

6. SURVEY OPERATIONS AT NIGHT

(q) The *Langseth* may continue marine geophysical surveys into night and low-light hours if the Holder of the Authorization initiates these segment(s) of the survey when the observers can view and effectively monitor the full relevant exclusion zones.

(r) This Authorization does not permit the Holder of this Authorization to initiate airgun array operations from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the visual observers cannot view and effectively monitor the full relevant exclusion zones.

(s) To the maximum extent practicable, the Holder of this Authorization should schedule seismic operations (*i.e.*, shooting the airguns) during daylight hours.

6. MITIGATION AIRGUN

(t) The *Langseth* may operate a small-volume airgun (*i.e.*, mitigation airgun) during turns and maintenance at approximately one shot per minute. The *Langseth* would not be operate the small-volume airgun for longer than three hours in duration during turns. During turns or brief transits between seismic tracklines, one airgun will continue operating. The Langseth's crew will still follow the ramp-up procedure (described in Condition 6(g) when increasing the source levels from one airgun to the full airgun array. Through use of this approach, seismic operations may resume without the 30-minute observation period of the full exclusion zone required for a "cold

start," and without ramp-up if operating with the mitigation airgun for less than 8 minutes, or with ramp-up if operating with the mitigation airgun over 8 minutes. Observers will be on duty whenever the airguns are firing during daylight, and at night during the 30 minute period prior to ramp-ups as well as during ramp-ups or when the acoustician detects the present of marine mammals with the exclusion zone.

7. REPORTING REQUIREMENTS

This Authorization requires the Holder of this Authorization to:

(a) Submit a draft report on all activities and monitoring results to the Office of Protected Resources, National Marine Fisheries Service, within 90 days of the completion of the *Langseth's* central Pacific Ocean cruise. This report must contain and summarize the following information:

(i) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings;

(ii) Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (number of shutdowns), observed throughout all monitoring activities.

(iii) An estimate of the number (by species) of marine mammals with known exposures to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re: 1 µPa and/or 180 dB re 1 µPa for cetaceans and a discussion of any specific behaviors those individuals exhibited.

(iv) An estimate of the number (by species) of marine mammals with estimated exposures (based on modeling results) to the seismic activity at received levels greater than or equal to 160 dB re: 1 µPa and/or 180 dB re 1 µPa for cetaceans with a discussion of the nature of the probable consequences of that exposure on the individuals.

(v) A description of the implementation and effectiveness of the: (A) terms and conditions of the Biological Opinion's Incidental Take Statement (attached); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report will confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on Endangered Species Act listed marine mammals.

(b) Submit a final report to the Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, within 30 days after receiving comments from us on the draft report. If we decide that the draft report needs no comments, we will consider the draft report to be the final report.

8. REPORTING PROHIBITED TAKE

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (*e.g.*, ship-strike, gear interaction, and/or entanglement), the Observatory shall immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

The report must include the following information:

- Time, date, and location (latitude/longitude) of the incident;
- Name and type of vessel involved;
- Vessel's speed during and leading up to the incident;
- Description of the incident;
- Status of all sound source use in the 24 hours preceding the incident;
- Water depth;
- Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

The Observatory will not resume their activities until we are able to review the circumstances of the prohibited take. We will work with the Observatory to determine what is necessary to minimize the likelihood of further prohibited take and ensure Marine Mammal Protection Act compliance. The Observatory may not resume their activities until we notify them by letter, email, or telephone.

9. REPORTING AN INJURED OR DEAD MARINE MAMMAL WITH AN UNKNOWN CAUSE OF DEATH

In the event that the Observatory discovers an injured or dead marine mammal, and the lead visual observer determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.*, in less than a moderate state of decomposition as described in the next paragraph), the Observatory will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

The report must include the same information identified in the Condition 8. Activities may continue while we review the circumstances of the incident. We will work with the Observatory to determine whether modifications in the activities are appropriate.

10. Reporting an Injured or Dead Marine Mammal not Related to the Activities

In the event that the Observatory discovers an injured or dead marine mammal, and the lead visual observer determines that the injury or death is not associated with or related to the activities authorized in the Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the Observatory will report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov within 24 hours of the discovery. The Observatory will provide photographs or video footage (if available) or other documentation of the stranded animal sighting to us.

11. Endangered Species Act Biological Opinion and Incidental Take Statement

The Observatory is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to the Endangered Species Act Biological Opinion issued to both the National Science Foundation and the National Marine Fisheries Service's Office of Protected Resources, Permits and Conservation Division (attached).

A copy of this Authorization and the Incidental Take Statement must be in the possession of all contractors and protected species observers operating under the authority of this Incidental Harassment Authorization.

APR 0 8 2013

Helen M. Golde
Acting Director,
Office of Protected Resources
National Marine Fisheries Service

Date

Attachments

Attachment

Table 1. Authorized Level B take for the Observatory's seismic survey on the Mid-Atlantic Ridge in the Atlantic Ocean, April through June, 2013.

Species	Requested Take Authorization
Humpback whale	50
Bryde's whale	1
Sei whale	9
Fin whale	198
Blue whale	66
Minke whale	3
Sperm whale	164
Northern bottlenose whale	4
Cuvier's beaked whale	7
Mesoplodon spp. [1]	39
Bottlenose dolphin	47
Atlantic spotted dolphin	112
Striped dolphin	1,034
Short-beaked common dolphin	2,115
Risso's dolphin	21
False killer whale	7
Killer whale	5
Short-finned pilot whale	674

Table 2. Modeled distances to which sound levels greater than or equal to 160 and 180 dB re: 1 µPa could be received during the proposed survey over the Mid-Atlantic Ridge in the north Atlantic Ocean, during April through June, 2013.

Source and Volume (in^3)	Tow Depth (m)	Water Depth (m)	Predicted RMS Distances[1] (m)	
			160 dB	180 dB
Single Bolt airgun (40 in^3)	12	> 1,000 100 to 1,000	388 582	100 100
36-Airgun Array (6,600 in^3)	12	> 1,000 100 to 1,000	6,908 10,362	1,116 1,674

Incidental Take Statement

Section 9 of the ESA and federal regulation pursuant to Section 4(d) of the ESA prohibit the "take" of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the NMFS as an act which actually kills or injures wildlife, which may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Sections 7(b)(4) and 7(o)(2), taking that is incidental and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken by the NSF and the Permits Division so that they become binding conditions for L-DEO for the exemption in Section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with Section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of listed species, the NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures and term and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of Section 9(a), pursuant to Section 7(o) of the ESA.

Section 7(b)(4)(C) of the ESA specifies that in order to provide an incidental take statement for an endangered or threatened species of marine mammal, the taking must be authorized under Section 101(a)(5) of the MMPA. One of the federal actions considered in this Opinion is the Permits and Conservation Division's proposed authorization of the incidental taking of fin, blue, sei, humpback, and sperm whales pursuant to Section 101(a)(5)(D) of the MMPA. The final authorization will be issued and its mitigation and monitoring measures incorporated in this Incidental take Statement as Terms and Conditions. With this authorization, the incidental take of listed whales is exempt from the taking prohibition of Section 9(a), pursuant to Section 7(o) of the ESA as long as such take occurs consistent with this statement.

Amount or Extent of Take

The NMFS anticipates the proposed seismic survey over the mid-Atlantic Ridge is likely to result in the incidental take of listed species by harassment. The proposed action is expected to take by harassment 66 blue, 198 fin, 9 sei, 50 humpback, and 164 sperm whales by exposing individuals to received seismic sound levels greater than 160 dB re 1 μPa by harassment. These estimates are based on the best available information of whale densities in the area to be ensonified above 160 dB re 1 μPa during the proposed activities. This incidental take would result primarily from exposure to acoustic energy during seismic operations and would be in the form of harassment, and is not expected to result in the death or injury of any individuals that are exposed.

We expect the proposed action will also take individual sea turtles as a result of exposure to acoustic energy during seismic studies, and we expect this take would also be in the form of

harassment, with no death or injury expected for individuals exposed. NMFS anticipates that the take of listed sea turtles will be difficult to detect**.** Therefore, NMFS cannot specify the numbers of individuals anticipated to be taken. Take, however, is limited to harassment only. Harassment of sea turtles is expected to occur at received levels above 166 dB re 1 µPa. As we cannot determine the number of individuals to which harassment will occur, we expect the extent of exposure will occur within the 166 dB isopleth of the *Langseth's* airgun array.

Harassment of blue, fin, humpback, sei, and sperm whales exposed to seismic studies at levels less than 160 dB re 1 µPa, or of leatherback, loggerhead, green, and Kemp's ridley sea turtles at levels less than 166 dB re 1 µPa, is not expected. If overt adverse reactions (for example, startle responses, dive reactions, or rapid departures from the area) by listed whales or sea turtles are observed outside of the 160 dB or 166 dB re 1 µPa isopleths, respectively, while airguns are operating, incidental take may be exceeded. If such reactions by listed species are observed while airguns are in operation, this may constitute take that is not covered in this Incidental Take Statement. The NSF and NMFS' Permits and Conservation Division must contact the Endangered Species Act Interagency Cooperation Division to determine whether reinitiation of consultation is required because of such operations.

Any incidental take of blue, fin, humpback, sei, and sperm whales or leatherback, loggerhead, green, and Kemp's ridley sea turtles is restricted to the permitted action as proposed. If the actual incidental take meets or exceeds the predicted level or type, the NSF and NMFS' Permits and Conservation Division must reinitiate consultation. All anticipated takes would be "takes by harassment", as described previously, involving temporary changes in behavior.

Effect of the Take

In the accompanying Opinion, NMFS has determined that the level of incidental take is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat**.**

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

APR 3 2013

In Reply Refer To:
2013-I-0002

Ms. Holly Smith
National Science Foundation
Division of Ocean Sciences
4201 Wilson Blvd., Suite 25
Arlington, Virginia 22230

Subject: Informal Consultation on the Marine Geophysical Survey in the Atlantic Ocean on the Mid-Atlantic Ridge

Dear Ms. Smith:

This letter is in response to your February 4, 2013, email requesting the U.S. Fish and Wildlife Service's (Service) concurrence that the proposed Marine Geophysical Survey in the Atlantic Ocean on the Mid Atlantic Ridge (Principal Investigator Canales) is not likely to adversely affect the Bermuda Petrel (*Pterodroma cahow)* or the roseate tern (*Sterna dougallii*) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 -1544), as amended (ESA). This consultation is based upon the Environmental Analysis of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* on the mid-Atlantic Ridge, April through May 2013.

Lamont-Doherty Earth Observatory, with funding from the National Science Foundation (NSF) plans to conduct a high-energy, 2-D seismic survey on the Mid-Atlantic Ridge for approximately 16 to 20 days in April through May 2013. The seismic survey will take place in International Waters (approximately 36°N and 34°W) in water depths approximately 900–3000 meters. The procedures to be used for the survey will be similar to those used during previous seismic surveys by Lamont-Doherty Earth Observatory and will use conventional seismic methodology. The survey will involve one source vessel, the R/V Marcus G. Langseth and will use a towed array of 36 airguns with a total discharge volume of approximately 6600 inches^3. The receiving system will consist of a hydrophone streamer and/or 46 ocean bottom seismometers. As the airgun array is towed along the survey lines, the hydrophone streamer will receive the returning acoustic signals and transfer the data to the on-board processing system. The ocean bottom seismometers record the returning acoustic signals internally for later analysis.

At the survey area, 46 ocean bottom seismometers will be deployed and a total of approximately 1680 km of survey lines will be shot in a grid pattern. The ocean bottom seismometers will then be retrieved, and approximately 900 kilometers of 2-D survey lines will be shot in multichannel seismic mode using an 8-kilometer streamer as the receiver. All but approximately 17 km would be in water depths greater than 1000 meters. After the multichannel seismic survey, 15 ocean

TAKE PRIDE IN AMERICA

bottom seismometers will be deployed and left in place for 6 months. The total seismic survey effort will consist of approximately 2580 kilometers of transect lines. There would be additional seismic operations in the survey area associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard.

The operation of the airgun array, multibeam echosounder and sub-bottom profiler will increase underwater noise which may result in avoidance behavior by many species including marine mammals, sea turtles, seabirds, and fish. However, an integral part of the planned survey is a monitoring and mitigation program designed to minimize potential impacts of the proposed activities to listed seabirds, marine mammals and sea turtles present during the proposed research and to document as much as possible the nature and extent of any effects. Injurious impacts to marine mammals, sea turtles, and seabirds have not been proven to occur near airgun arrays, and also are not likely to be caused by the other types of sound sources to be used. However, given the high levels of sound emitted by a large array of airguns, a precautionary approach is warranted. The planned monitoring and mitigation measures would reduce the possibility of injurious effects. Protection measures designed to mitigate the potential environmental impacts to marine animals, including the listed seabirds, includes the following: (1) during ramp ups, typically two, but a minimum of one dedicated observer maintaining a visual watch during all daytime airgun operations; (2) two observers 30 min before and during ramp ups during the day and at night; (3) no start ups during poor visibility or at night unless at least one airgun has been operating; (4) passive acoustic monitoring via towed hydrophones during both day and night to complement visual monitoring (unless the system and back-up systems are damaged during operations); and (5) power downs (or if necessary shut downs) when marine mammals, sea turtles or listed seabirds are detected in, or about to enter, designated exclusion zones.

The endangered Bermuda petrel and threatened roseate tern have been identified as species that could occur in the survey area. The effects of sounds from airguns could include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment, or non-auditory physical or physiological effects.

The roseate tern is very unlikely to be in the action area at the time of the action. The population listed under the ESA, arrives on the Eastern Coast of the United States around late April for breeding season and remains until early August. Foraging occurs in shallow waters off the coast. Juveniles are likely to remain in South America for their first summer. Thus, we do not anticipate any adverse effects to the species to occur given roseate terns will not be in open ocean waters during June and July. In the rare event a roseate tern is observed during the survey, the survey activities will power down to avoid impacts to the tern.

The Bermuda petrel is pelagic most of its life, and comes ashore to breed exclusively in Bermuda from January to June. However, even during the breeding season Bermuda petrel have been known to travel thousands of miles to feed their chicks and have been known to forage in the action area. Despite this, Bermuda petrels are incredibly rare and are not frequently spotted. Thus, due to the size of the action area and the rarity of the Bermuda petrel it is unlikely any will

be in the action area at the time of the action. In the rare event a Bermuda petrel is observed during the survey, the survey activities will power down to avoid impacts to the petrel.

Based upon our review of the proposed seismic survey, we concur that the activities covered under the NSF's proposed Marine Geophysical Survey may affect but are not likely to adversely affect the Bermuda petrel and roseate tern. It is our understanding that coordination with National Marine Fisheries Service on listed species has been concluded.

We appreciate and thank NSF, Lamont-Doherty Earth Observatory and their contractors for applying proactive protective measures in order to minimize project impacts to listed seabirds. If you have any question please contact Patrice Ashfield of my office at (703) 358-2478.

Sincerely,

Richard E. Sayers, Jr., Ph.D.
Chief, Division of Environmental Review