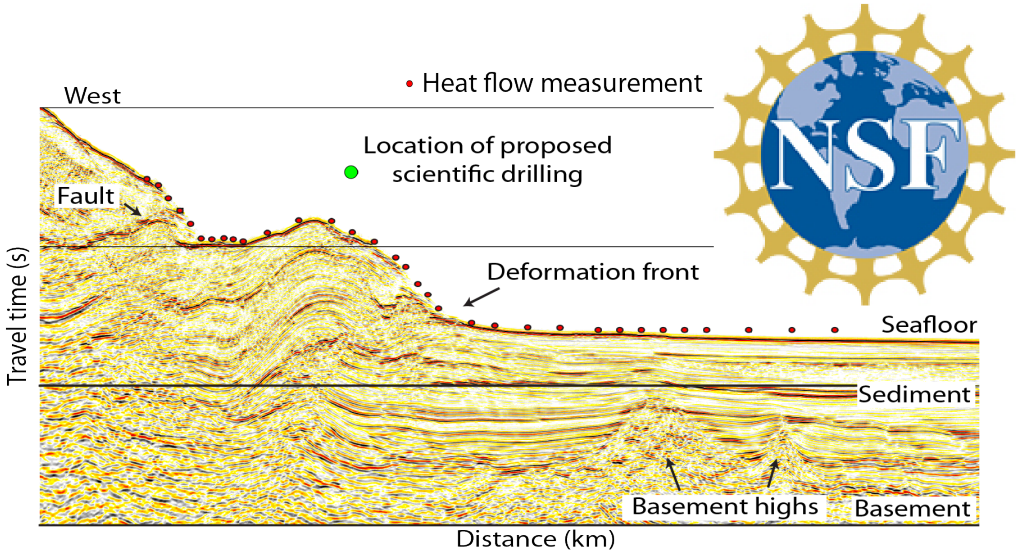
Cruise Report, STINGS Expedition R/V *Roger Revelle*, RR1508, 16 May – 18 June, 2015

The Thermal Regime of the Hikurangi Subduction Zone and Shallow Slow Slip Events, New Zealand



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I. Introduction

This report provides an operational and scientific overview of the Subduction Thrust Investigation of New Zealand using Geothermics and Seismics (STINGS) expedition (*R/V Roger Revelle* cruise RR1508). This report was prepared during and at the end of scientific operations, so all analysis is preliminary.

In general this cruise was very successful in meeting its stated objectives. This success is directly attributable to the skill and dedication of the ship's crew and technical support staff and the outstanding facilities available on the *R/V Roger Revelle*. Shipboard staff and crew were extremely collegial and helpful in sometimes-adverse conditions. We thank them for their support. Three issues that affected us included weather with a loss of approximately 7 science days, a large population of fur seals in the southern field area that led to large gaps in seismic data acquisition and an intermittent problem with the heat flow probe pressure sensor that controls the firing of a calibrated heat pulse for thermal conductivity measurements.

A. Mission/outcomes

161 new heat flow measurements
881 km of seismic reflection profiles
New bathymetric data acquired
21 XBTs acquired
Underway data including ADCP, meteorological data, gravity data

B. Scientific Objectives

The STINGS expedition was the first part of a field and modeling program to investigate the thermal regime and structure of the Hikurangi margin and its influence on slow slip earthquakes.

This project is designed to address the following questions:
1) What is the thermal structure of the incoming Pacific plate and does it vary along strike?
2) What is the fluid flow regime through the outer forearc, and incoming oceanic basement? Do these fluid flow regimes vary between the erosive northern margin and accretionary southern margin.
3) What role does temperature play in influencing the position of the updip boundary of the seismogenic zone and regions of interseismic plate coupling?

The STINGS Expedition included both regional and local goals. Regional heat flow goals included assessing along-strike variations in the thermal state of the incoming Hikurangi Plateau and fluid flow through the basement and margin. Locally we wanted to determine the thermal state in areas of proposed IODP drilling, Proposal 781-Full, *Unlocking the secrets of slow slip by drilling at the northern Hikurangi subduction margin, New Zealand: Riserless drilling to sample and monitor the forearc and subducting plate*.

The objectives of the seismic surveys conducted during RR1508 were threefold:
1) Characterize the site conditions beneath ocean bottom seismometers (OBS) deployed in 2014 (TAN 1405 *R/V Tangaroa*, 10 May 2014 – 20 May 2014) for the

HOBBITS project and retrieved on RR1509. The shots will also be used to relocate and orient the components of the seismometers.
2) Obtain additional seismic reflection transects across the deformation front of the Hikurangi subduction zone to decrease line spacing and better define along-strike structural changes.
3) Acquire high-resolution grids of seismic reflection data over targets indicating complex gas hydrate dynamics. These targets were identified on existing seismic reflection data and had previously been imaged only on single profiles. Consequently their three-dimensional geometrical configurations were unknown prior to RR1508.

C. Regional Setting

The Hikurangi Trough lies at the southern end of the Tonga-Kermadec subduction zone and extends from offshore the Raukumara Peninsula (northern North Island) to the southern Wairarapa coast and Cook Strait (Figure I-1). The Hikurangi margin formed 20 - 25 Myr ago [*Ballance*, 1976; *Walcott*, 1987] in response to westward subduction of the thick and bathymetrically elevated Hikurangi Plateau, an early Cretaceous (120 Myr) large igneous province [*Davy & Wood*, 1994; *Wood & Davy*, 1994; *Taylor*, 2006; *Davy et al*., 2008]. Subduction of the buoyant Hikurangi Plateau is a primary influence on shaping the Hikurangi subduction zone including the shallowness of the trench, the taper angle, and seismogenesis.

The Hikurangi margin is characterized by strong along strike variations in a number of important properties that likely affect deformation and seismogenesis (Figure I-1). The crystalline crust of the subducting plate thickens from 16 km at its northern edge to 23 km adjacent to Chatham Rise in the south [*Davy et al*., 2008] as convergence velocities decrease from orthogonal at > 60 mm/yr in the north to oblique at <30 mm/yr in the south [*Wallace et al.*, 2004]. Basement relief on the incoming plate also decreases to the south. North of Hawke Bay, seamounts stud the incoming plate and basement relief commonly exceeds several kilometers [*Wood & Davy*, 1994; *Davy & Wood*, 1994; *Lewis et al*., 1998; *Davy et al*., 2008].

The Hikurangi Plateau has uplifted the trough and forearc such that offshore New Zealand, the trench is sediment-filled with a water depth of 3 km (much shallower than the > 9 km deep trench characterizing the Tonga/Kermadec system). Sediments thickens to the south, reflecting their source area in the South Island [*Lewis et al.*, 1998; *Lewis & Barnes*, 1999; *Mountjoy et al.*, 2009; *Plaza et al.*, 2012]. Offshore the Raukumara Peninsula, north of where the Hikurangi channel turns east, sediment thickness is < 1 km, increases to ~1 km offshore Hawke Bay and is > 6 km near Cook Strait [e.g., *Lewis et al.*, 1998]. In general sediment thickness is much less east of the Hikurangi Channel. In the north, the ~1 km thick trench turbidites are locally accreting between large seamount-impact reentrants associated with localized tectonic erosion [e.g., *Collot et al*., 2001; *Barker et al*., 2009; *Bell et al*., 2010; *Pedley et al.*, 2010; *Barnes et al*., 2010] whereas the southern area has a well-developed imbricated upper plate and outer accretionary wedge [*Lewis & Pettinga*, 1993; *Nicol & Beavan*, 2003; *Barnes et al*., 2010].

The taper angle of the accretionary wedge decreases from about 10° offshore the

Raukumara peninsula to 4-5° in the south [*Barker et al.*, 2009]. The low taper angle along the southern margin wedge is consistent with largely uncompacted and overpressured sediments having high water content [*Barnes & Mercier de Lepinay*, 1997; *Barnes et al*., 2010; *Fagereng*, 2011]. In general the plate is subducted at a low angle of a few degrees before rolling over to a circular arc having a radius of a few hundred km and then becoming planar below 120 km depth [*Ansell & Bannister*, 1996; *Reyners et al.*, 2006]. The position of the subducting slab is well defined by seismicity, and seismic tomography reveals a high P-wave velocity (Vp) slab extending > 300 km depth [*Reyners et al*., 2006; *Eberhart-Phillips et al.*, 2008].

The northern field study area (Figure I-2) is underlain by an aseismic creep-dominated subduction interface and is the site of repeated shallow (< 15 km depth) SSEs [*Wallace & Beavan*, 2010], and historic tsunami earthquakes that nucleated near the trench (Ms 7.0-7.2 in March and May, 1947 [*Downes et al.*, 2000; *Doser & Webb*, 2003]). Additionally this area is the focus of a proposed IODP drilling transect with the ultimate objective of intersecting the source area of SSEs, and is also within the HOBITTS array that consists of ocean bottom seismometers (OBS), absolute pressure gauges (APGs) and ocean bottom electromagnetic instruments. Temperature recorders were placed on some of these instruments to monitor bottom water temperature variations. These temperature loggers are scheduled to be recovered on the cruise after this one.

The southern field study area is in the location of the SAHKE and PEG09 seismic surveys (Figure I-3) and contrasts strongly with the northern field area. Here SSEs are deep (> 30 km) and geodetic studies indicate updip interseismic coupling on the plate interface, similar to in Cascadia. Heat flow transects will be collected along the passive and controlled source onshore-offshore Seismic Array HiKurangi Experiment (SAHKE) [*Henrys et al.,* 2010, 2013], designed to image the forearc structure and understand physical processes controlling locking along this portion of the Australian-Pacific plate boundary, and along wide-angle multi-channel Pegasus seismic lines [*Geotrace*, 2010], designed to detect hydrocarbons.

II. Cruise narrative

Times in this informal cruise narrative are given in local time (L) to give a flavor to life on board. Selected times are also given in GMT as Julian Day followed by hour and minute (JDxxx@yyyy). Local time is advanced by 12 hours relative to GMT. All times in tables and other scientific data are in GMT. Track charts are shown in Figure II-1 and II-2 for the northern and southern field areas, respectively. A more complete record of the cruise is available in the e-log, which is available through the R2R web site for RR1508.

We left Auckland on schedule at 1600L on May 19 (JD139@0400) after an uneventful mobilization. Weather was fair and seas were calm as we headed out on the ocean, and we were treated to beautiful views of Auckland at dusk. Underway sensors (EM122, 3.5 kHz, gravity, ADCP, MET) were on and operating.

We arrived at the first heat flow station at 1857L on May 20 (JD140@0657), and the probe was on the seafloor and taking the first measurement at 2114L at site HK01-01. The EM122 was turned off for this operation and the 3.5 kHz echo

sounder was turned to pinger mode to track the heat flow probe, which sends back data at 12 kHz. Sixteen measurements were taken along transect HK01, with the final measurement taken at 1740L on May 21 (JD141@0540). The heat flow probe was on deck at 1923L.

The transit to heat flow transect HK02 began at 1948L on May 21 (JD141@0748). Underway EM122 and 3.5 kHz data were turned on for the transit, although the EM122 was turned off temporarily to edit the sound velocity function because the water velocity used for correction was inaccurate. The seafloor velocity extrapolated from the XBT measurements was adjusted to fix this problem.

We arrived at the waypoint for HK02 at 2301L on May 21 (JD141@1101) and deployed the heat flow probe at 2348L using the backup data logger. The first measurement on transect HK02 was begun at 0104L on May 22 (JD 141@1304). The probe was recovered after station HK02-05 because of questions about whether the heat pulse to measure thermal conductivity was being properly activated and was back on deck at 0958L on May 22 (JD141@2158). The batteries for the data logger used for transect HK01 had been recharged and the data loggers were swapped.

The heat flow probe was redeployed at the site of HK02-05 at 1128L (JD141@2328), and transect HK03 was started, with HK03-01 coincident with HK02-05. Measurement HK03-05 was completed at 1835L on May 22 (JD142@0635). The probe was on deck at 2058L, and we were underway to the next transect at 2058L.

Transect HK04 was located on a sedimented part of Gisborne Knoll. The heat flow probe was over the side at 2359L on May 22 (JD142@1159) and measurement station HK04-01 started on May 23 at 0105L. Transect HK04 was completed with station HK04-07 at 0843L on May 23, and the probe was on deck at 0954L (JD142@2154).

We then transited to the start of the first planned seismic survey, HKS01. The primary purpose of survey HKS01 was to record high-resolution seismic lines and airgun records across Ocean Bottom Seismographs (OBSs) deployed in May 2014, and due to be recover in the next R/V Roger Revelle voyage (RR1509). A secondary objective was to acquire seismic reflection transects of the deformation front and to fill in gaps in the existing coverage.

The streamer and airguns were deployed in worsening weather several km from the planned start of line at 1253L on May 23 (JD143@0053). GI guns were started up following mitigation procedures. However no signal was detected from the streamer. After an unsuccessful trouble-shooting effort, the streamer was recovered and was back on deck at ~2100L on May 23 (JD143@0900). Weather continued to worsen rapidly. We were in the middle of a major storm that extended from Fiji to Antarctica and dumped snow on much of New Zealand (see cruise blog: stingscruise.wordpress.com).

The following afternoon (May 24, JD 144), during a relative lull in the weather, we spooled the streamer out on the deck. The problem was tracked down to the deck cable and the cable was replaced. Extensive testing indicated that the streamer was ready to go. However, the weather continued to be uncooperative, with swells as high as 6.5 m and swell wavelengths of over 400 m (Figure II-3).

At 2004L on May 26 (JD 146@0804), in anticipation of predicted improvement in the weather, we started a slow transit to the start of seismic line HKS01-L03. L03 was chosen to start the seismic survey because that line was the most favorably oriented for working in these high seas.

At 1230L on May 27 (JD147@0030), in seas that were considered marginal for seismic work, the streamer and airguns were redeployed, and the first gun was started at 1346L (JD147@0146). After some "practice" shots, we were on line for HKS01-L03 and started the line at 1701L on May 27 (JD147@0501). It was a relief to be back in data acquisition mode after ~4 days of waiting for the weather to improve. Unfortunately, the last section (8 channels) of the streamer was not communicating with the recording system. The decision was made to acquire with 40 channels and then trouble-shoot when the streamer was next brought back on board.

We continued acquiring seismic data with only a few stops for marine mammals or compressor issues for 3 days (until 1422L on May 29; JD150@0222). Weather and sea state improved rapidly, with swells decreasing to ~ 2m. The guns and streamer were on board and secured, and 420 km of seismic data had been acquired (and much of it already processed). See section IV for a discussion of the impact on data coverage of source shut-downs that occurred during HKS01 due to either the presence of marine mammals or problems with the compressor.

Heat flow operations resumed at 1737L on May 29 (JD150@0537) with 5 measurements along transect HK05, 21 measurements along transect HK06, and 14 measurements along transect HK07. The heat flow probe was recovered between each station and the data loggers were swapped between sites HK006-14 and HK07-01. This super-transect of 35 measurements across the deformation front was completed at 1103L on June 2 (JD152@2303).

A short transit brought us to HK08, where 3 measurements were made before the probe was recovered to trouble-shoot an apparent problem with the pressure sensor that controlled triggering of the heat pulse for measuring thermal conductivity. The instrument was on deck at 1746 on June 2 (JD153@0546) in strong winds and high seas. Because of the worsening sea state, we decided not to conduct any EM122 survey operations while trouble-shooting. Transect HK08 was resumed at 0723 on June 3 (JD153@1923) with measurements HK09-01 through HK09-14.

The heat flow probe was recovered at 1031 on June 4 (JD154@2231) and the CTD was deployed to obtain a full-depth profile of ocean temperature and sound velocity and provide data for verifying the XBT measurements and calibrating the heat flow probe.

The heat flow probe was deployed for HK10 at 1522 on June 4 (JD155@0322) and the final measurement on that transect, HK10-12, was completed at 1000 on June 5 (JD155@2200), with the probe on deck at 1204 (JD156@0004). This completed operations in the northern work area.

We then began a 22-hour transit to the southern work area, where the first operation was a heat flow transect, HK11, comprising 11 measurements on the flank of the Chatham Rise. The day began with calm seas, although a long period swell of 3-4 m developed in the evening.

At 0339 on June 7(JD157@1539) HK11-11 was completed, the heat flow probe was recovered at 0505, and we began a 5 hour transit to the beginning of the second seismic survey, HKS02.

Seismic survey HKS02 began smoothly at 1058 on June 7 (JD157@2258). During the period between seismic survey HKS01 and HKS02, trouble-shooting of the streamer had identified a bad connector between the penultimate and last sections. This was remedied and the streamer was deployed with a full 48 channel configuration.

The primary purpose of survey HKS02 was to acquire 3 high-resolution grids over anomalous gas-hydrate-related features identified on seismic profiles from the 2009 Pegasus regional survey. A secondary objective was to make 5 crossings of the deformation front to fill in gaps in the existing coverage.

Many fur seals were in the area, and we had to stop and restart the seismic lines repeatedly. With so many stops, it was not possible to redo all the gaps, and the data acquired that afternoon, as we approached the first high-resolution grid, are of limited value. As the sun got lower in the sky, the observers were not able to see in the direction we were traveling, so we decided to loop around and acquire a line parallel to planned HKS01-L01 in a southeast direction (L30).

Fortunately, we were able to restart acquisition prior to nightfall, so we ended line HKS02-L30 and turned back onto HKS02-L01_A to continue the first high-resolution grid. Data acquisition proceeded uninterrupted until mid-morning, when New Zealand fur seals and other marine mammals decided to investigate. We had numerous source shut-downs throughout the day because of marine mammal sightings and one compressor changeover.

In order to take advantage of the night of June 8, we decided to cut short the lines that extended over the deformation front and focus on obtaining the 2nd high-resolution grid before seal activity re-started the next day around 10 am (JD159@2156GMT).

After seal activity resumed, we attempted to acquire seismic data, but with many gaps. We followed the same strategy as the previous day, cutting the deformation front crossings to insure that we would be in place for the third high-resolution grid at nightfall on June 9. However, the wind picked up to >40 kts and the ship was having difficulty holding its course because of wind, swell and a strong current. Playing it safe, we recovered the seismic gear, and had it on board at 9:35 pm (JD160@0936GMT).

Meanwhile, the wind had died down. Because we could not restart seismic acquisition at night and the days were impacted by seal activity, we decided to acquire some heat flow data for the next 10 hours and then restart seismic acquisition the following evening (JD161@0348GMT). Ten heat flow measurements were obtained on a transect across the feature that was the target of the second high-resolution grid.

We returned to complete the third grid. Seismic data acquisition continued through the night and until 2:33 pm the following day (JD162@0233GMT), when HKS02-L22 was completed.

We then transited to the first point of a planned 30-station heat flow transect across the deformation front collocated with the SAHKE seismic reflection line.

HK13 started June 11 at 16:44 and ended June 12 at 13:03 and consists of 19 measurements. The probe was recovered due to weather and we waited approximately 20 hours for the weather to settle.

HK14 continued the transect across the deformation front starting June 13 at 10:01. The probe was recovered June 14 at 18:14 after making 6 measurements.

We then transited back to the region of HK12 to continue the heat flow transect and started heat flow station HK15. HK15 started June 14 at 20:17 and lasted until June 15 at 13:28. HK15 consists of 15 measurements.

We then transited to a forearc basin near the deformation along seismic line PEG09-25 and made 16 measurements. Heat flow station HK16 started June 15 at 14:47 and lasted until June 16 at 16:34.

We transited back to the BSR site for heat flow station HK17 and made 13 additional measurements. HK17 started June 16 at 18:38 and lasted until June 17 at 12:46.

We started the transit to Napier June 17 at 13:05 and arrived in port the next morning.

III. Heat flow

All heat flow measurements were collected with using a multipenetration heat flow (MPHF) probe (Figure III-1). The MPHF probe consists of a 3.5-m, 11-thermistor, violin-bow heat flow system maintained at Oregon State University. The MPHF probe operations were run from the aft A-frame using the trawl wire. The probe weighs 0.52 tons in water. The design of the MPHF probe provides both the mechanical robustness to withstand repeated insertions and withdrawals from the sediment, and sensitivity needed to make highly accurate measurements. Repeated insertions of the probe allow multiple heat flow measurements to be made with a single transit through the water column increasing measurement efficiency. Temperature time series used for both the determination of the thermal gradient and thermal conductivity are logged into solid-state memory in a data logger located in the probe weight stand. Other parameters logged by the system include time, pressure (depth), water temperature, tilt, and a stable reference resistance. Acoustic telemetry during surveys relays temperature data and tilt to the surface so that instrument performance can be monitored in real time. Internal power allows stations to run 20-30 measurements when fully charged.

Heat flow measurements were started by lowering the MPHF probe into the sediment at 60 m/min. Following the insertion of the probe, temperatures were interrogated every 10 seconds for 7 minutes. During this period thermistors approach thermal equilibrium with the surrounding sediment and this temperature-time series is used to compute the thermal gradient. Following this initial 7-minute period a calibrated heat pulse is generated along a heating wire within the thermistor tube. The temperature decay of this heat pulse is monitored to determine in-situ thermal conductivity. The probe was pulled out of the sediment at 5 m/min and then raised to approximately 100 m above the seafloor at 45 m/min while the ship transited at 1-2 kts to the next site.

MPHF probe data were converted to ascii text (heatpro.exe), parsed into individual penetration files (pro51.exe) and processed using SlugHeat, a Matlab

based program (A. Fisher, written commun., 2005). Thermistors are calibrated and set equal to each other by hanging the probe just above the bottom and assuming that over the 3.5 m probe length the bottom water temperature is constant.

All heat flow measurements are listed in Table A-1 and their locations are shown in Figures I-2 and I-3 for the northern and southern area, respectively. Additional analysis will be required to finalize the heat flow values listed in this report, but values are unlikely to change by more than a few percent as a result of reanalysis. In total, 17 heat flow stations consisting of 191 heat flow measurements were attempted. Of these, 163 were successful. No corrections have been applied for the influence of changing bottom water temperature, sedimentation, or local topography. While this cruise report is publically available soon after the end of the cruise, access to Table A-1 is restricted until 2 years after the end of the cruise (June 18, 2017). Further information about each heat flow station can be found in Appendix 1 (available June 18,2017). For more information, please contact Chief Scientist Rob Harris directly.

IV. High-resolution multi-channel seismic reflection

The objectives of the seismic surveys conducted during RR1508 were threefold:
1) Characterize the site conditions beneath ocean bottom seismometers (OBS) deployed in 2014 for the HOBBITS project and retrieved on RR1509. The shots will also be used to relocate and orient the components of the seismometers.
2) Obtain additional seismic reflection transects across the deformation front of the Hikurangi subduction zone to decrease line spacing and better define along-strike structural changes.
3) Acquire high-resolution grids of seismic reflection data over targets indicating complex gas hydrate dynamics. These targets were identified on existing seismic reflection data and had previously been imaged only on single profiles. Consequently their three-dimensional geometrical configurations were unknown prior to RR1508.

We used the portable seismic reflection system operated by the SSG group at the Scripps Institute of Oceanography. This system comprised 2 GI guns, which we shot in 45/105 mode, mounted on a 2-m long frame suspended from a float, and a 600-m long, 48 channel Geometrics GeoEel digital hydrophone streamer, deck unit and acquisition system. Compressed air was provided by the R/V Revelle's compressors, operated by the ship's engineers. During the first survey (HKS01), only the nearest 40 data channels were recorded (the streamer's connection to the last section of eight channels failed). During HKS02, 48 data channels were recorded. The clock time break is recorded on each shot record as an auxiliary channel (ch 41 for HKS01 and ch 49 for HKS02). The two shot instant hydrophones mounted on the gun assemblies were recorded and archived in separate SEGY files. System geometry is shown in Figure IV-1A, including offsets between the components and the GPS antenna providing shot location. Timing information is given in Figure IV-1B, and the configuration of the recording system is shown in Figure IV-1C.

The streamer and guns were each towed at a nominal 3.5 m depth, comparable to the swell height of 3-5 meters during most of the survey. Shot spacing was 25

meters (shooting on distance for all but a small subset of the HKS01), record length was 8 s, and sample rate was 1 ms.

Data were recorded in SEGD format and merged with navigation data to generate SEGY format files for each line that included ship location information in the headers for each shot. Shot instant data were also recorded in a separate file to ms precision for use in cutting continuous OBS data into record sections. Additional details on seismic reflection acquisition and processing are given in Appendix 2.

Data were acquired as 2 surveys. Figure IV-2 shows the location of Lines HKS01_01 to HKS01_10 from survey HKS01 on the northern Hikurangi margin in the region of the HOBBITS OBS deployment. Eleven out of the 14 OBSs were crossed during the survey. In addition, Lines L06 to L09 cross a part of the deformation front that had not been crossed in prior surveys. These lines were motivated by an enigmatic structure observed on the existing line coincident with HKS01-02, which was unlike that observed on other prior crossings of the deformation front in this region. HKS01_10 crosses the deformation front between two existing lines to image incipient seamount subduction. Starting and ending times, geographic coordinates and shot numbers for each line are given in Table IV-1.

The GI-gun source was shut down several times during HKS01 due to either the presence of marine mammals or problems with the compressor. The first shut-down occurred during shots fired to the OBSs prior to the start of the first seismic reflection line and lasted 14 minutes. The second shut-down extended beyond the 15 minute window within which we could firing the guns without a full mitigation start procedure, and we decided to loop around to pick up the line where we had left off (with a short overlap). This took 113 minutes, equivalent to a loss of ~8 nm of lost line length since we had to shorten the total survey to stay within out allotted time. We experienced a short loss of data soon after restarting the line due to a compressor problem, resulting in a short gap in the line HKS01-L05A. Additional shut-down periods were required on L08 (14 min) and L09 (5 min). We continued on the line through these shut-downs, leaving small data gaps. The total amount of shutdown time for marine mammals was 146 minutes, equivalent to approximately 18 km at 4 kts or 3.5% of the total survey time; the total shut-down time due to compressor problems was 20 minutes (0.5% of total survey time).

Figure IV-3 shows the location of survey HKS02 on the southern Hikurangi margin. Three high-resolution grids were obtained across features indicative of gas migration and gas hydrate formation that had been previously observed on single, lower-resolution regional profiles. Because of delays due to weather and to frequent marine mammal sightings, extensions of the lines joining these three surveys that crossed the deformation front had to be sacrificed. The guns were shut own for approximately 11% of the total line length acquired (0.2% for compressor servicing and the rest because of fur seal sightings). None-the-less, this survey was very successful because of the new insights we expect to obtain about gas hydrate dynamics from these data.

Initial processing of data, including application of geometry, sorting, trace editing, normal moveout correction, stack, filtering and finite-difference migration, was performed on each line soon within several hours of acquisition, and data were used to fine-tune upcoming acquisition.

Selected examples of data are shown in Figures IV-4 and IV-5. Figure IV-4 shows an image across the deformation front in the northern survey area and Figure IV-5 shows a gas "finger" within the gas hydrate stability zone in the southern study area.

Raw shot data and processed sections have been archived in the R2R database and with the ASP (Academic Seismic Portal) maintained at the University of Texas Institute for Geophysics. Data will be freely available after an initial proprietary period of 2 years. Contact Andrew Gorman, Stuart Henrys or Anne Tréhu for further information.

V. Auxiliary data sets

A number of auxiliary data set were recorded in addition to the primary heat flow and seismic reflection data. *These data are archived through the Rolling Deck to Repository (R2R) web site (www.rvdata.us/RR1508), which also includes a copy of this data report.*

A. EM-122 swath bathymetry

The EM122 swath bathymetric system was operated during all transits and seismic surveys. Water depth, seafloor reflectivity and water column data were recorded. During the heat flow transects, the EM122 was turned off to not interfere with the 12 kHz pinger on the heat flow probe. At each measurement site it was briefly turned on to verify water depth. The sound velocity profile was updated approximately daily using data from XBTs and one CTD (see sections on XBT and CTD for details). Quality of the data is quite variable, with noisy data during bad weather.

Although most of the data were loaded into the Caris multibeam processing system on board, the science party did not include any multibeam processing specialists. Moreover, these data were acquired along tracks that were not ideal for bathymetric mapping and will have to be incorporated with data from other cruises (including the HOBBITS cruise that follows RR1508) for eventual broader use. Consequently we decided to abandon plans to thoroughly "clean" the raw data since it was likely that whoever was merging the various data sets would want to start with raw data anyway. None-the-less, access to the Caris processing system was greatly appreciated as a learning tool.

All EM-122 data are available through the R2R repository. Figure V-1 shows a screen grab of the EM122 seafloor reflectivity of Gisborne Knoll generated by the onboard Mosaic processing software. Note bright streaks, which may indicate younger lava flows.

B. 3.5/12 kHz Knudsen echosounder

The 3.5 hKz echosounder operated during most of the cruise, except during heat flow transects, when the 12 kHz transducer was used to listen to the pingers from the heat flow probe (see section III). The ping interval was synchronized with the EM-122 resulting in a decrease in the ping rate, especially in deep water, and consequent degradation of the data. This was done to avoid adding noise from the 3.5 kHz system to the EM-122 data. Data were recorded in native Knudsen "keb" format and can be played back using the free software package "PostSurvey." Table V-1 shows times where 3.5 kHz data were not acquired.

C. CTD

After completing heat flow station HK-09, we made a CTD cast to measure the temperature and salinity structure of the water column. The CTD temperature profile was used to calibrate the heat flow probe thermistors through the water column. This calibration was necessary so that the probe could be used to accurately measure the thermal structure of the water column. This step is not necessary for heat flow measurements because only temperature differences are needed for the thermal gradient calculation and interthermistor differences are removed during the bottom water temperature measurement that precedes each heat flow measurements. In this manner heat flow deployments at each station can be used to obtain the temperature structure of the water column.

The temperature structure of the water column is shown in Figure V-2a. The raw temperature data from the heat flow probe is about 7° C higher than the CTD temperatures. Each thermistor was fit to the CTD temperatures using a cubic function. The thermistor string has 11 thermistors where 1 is at the bottom. The 12^{th} thermistor monitors bottom water and is located at the top of the weight stand. Data between 15 m and 3500 m were analyzed and best-fitting coefficients, determined through a least-squares inversion, for each thermistor are given in Table V-2. The optimum fit is shown in Figure V-2b. The standard deviation of the fit to each thermistor to the CTD temperatures is shown as an inset.

D. XBTs

XBTs were generally taken at least once/day to provide sound velocity profiles through the water column for processing EM122 data. However the wires broke or became entangled in the seismic gear for many of the attempts. All XBTs are listed in Table V-3 and results of successful casts are shown in Figure V-3. Unless otherwise indicated, seasurface temperature and salinity were taken from the sensors at the bow to calculate the temperature and sound velocity profiles from the raw data.

E. Gravity

Marine gravity measurements were carried out throughout the voyage using the GNS Science gravity meter: a Lacoste & Romberg S-80 gravimeter with ZLS Ultrasys upgrade. To minimise pitch and roll, the meter was secured in the ships Electronic Lab, close to the ship's centre of motion. Data were sampled using the ZLS Ultrasys software at 1 Hz. Data were recorded during the entire cruise and are available from the R2R web site. Correction of the data for ship motion and other standard data processing will be conducted post-cruise by GNS.

F. ADCP

ADCP data were acquired during the entire cruise and are available through the R2R web site. Data were used during the cruise to evaluate local currents but no additional analysis of these data was done.

G. Meterological data

Figure V-4 shows meteorological data and ship heave as a proxy for wave height. Much of the cruise had winds in excess of 20 knots, which peaked at about 50 knots. The low pressure around May 24th coincided with the storm that shut down science operations for a several days. All standard meterological data acquired during the cruise are available through the R2R web site.

VI. Marine mammal observations

Three observers kept constant watch for marine mammals from daybreak to nautical twilight during all seismic operations. We followed standard procedures indicated by NOAA in our permit to mitigate the impact of our operations on marine mammals by observing before starting up the GI-guns and by starting the guns incrementally. The observers would also call for a shut-down off the seismic sources when marine mammals were sighted within distances specified in the permit. Table VI-1 and Table VI-2 summarizes their observations. More complete results of their observations have been submitted to NOAA.

VII. Broader Impacts and Outreach

Broader impacts and outreach during the cruise consisted of undergraduate, graduate and postdoctoral training in heat flow data acquisition and processing and in seismic data acquisition and processing. Outreach included a cruise blog "http://stingscruise.wordpress.com/" that was advertised through Oregon State University, University of Otago, and Gelogical and Nuclear Sciences, New Zealand. Additionally we successfully recruited an IDES (Increasing Diversity in Earth Sciences - http://ides.science.oregonstate.edu/) student to participate on the cruise.

After arriving in port in Napier, we led tours of the R/V Revelle arranged through the Napier museum and colleagues sailing on cruise RR1509. Posters communicating the excitement of working at sea and new results from this cruise were displayed.

Acknowledgments

The success of this cruise stemmed from crew of the R/V Roger Revelle. Funding for this project came from the NSF through grants OCE- 1355878 and OCE-1355870.

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Wakeman	Chief Mate
Galiher	2nd Mate
Crump	3rd Mate
Curry	Bosine
Lewis	AB
Martino	AB
Vinkovitis	AB
Cummings	Ordinary
Healy	Chief Engineer
Peer	1st Engineer
Clifford	2nd Engineer
Elliott	Ellectrician
Sullivan	Oiler
Myers	Oiler
Messenger	Oiler
Hunt	Oiler
Brown	Wiper
Smith	Chief Cook
Maluda	Cook

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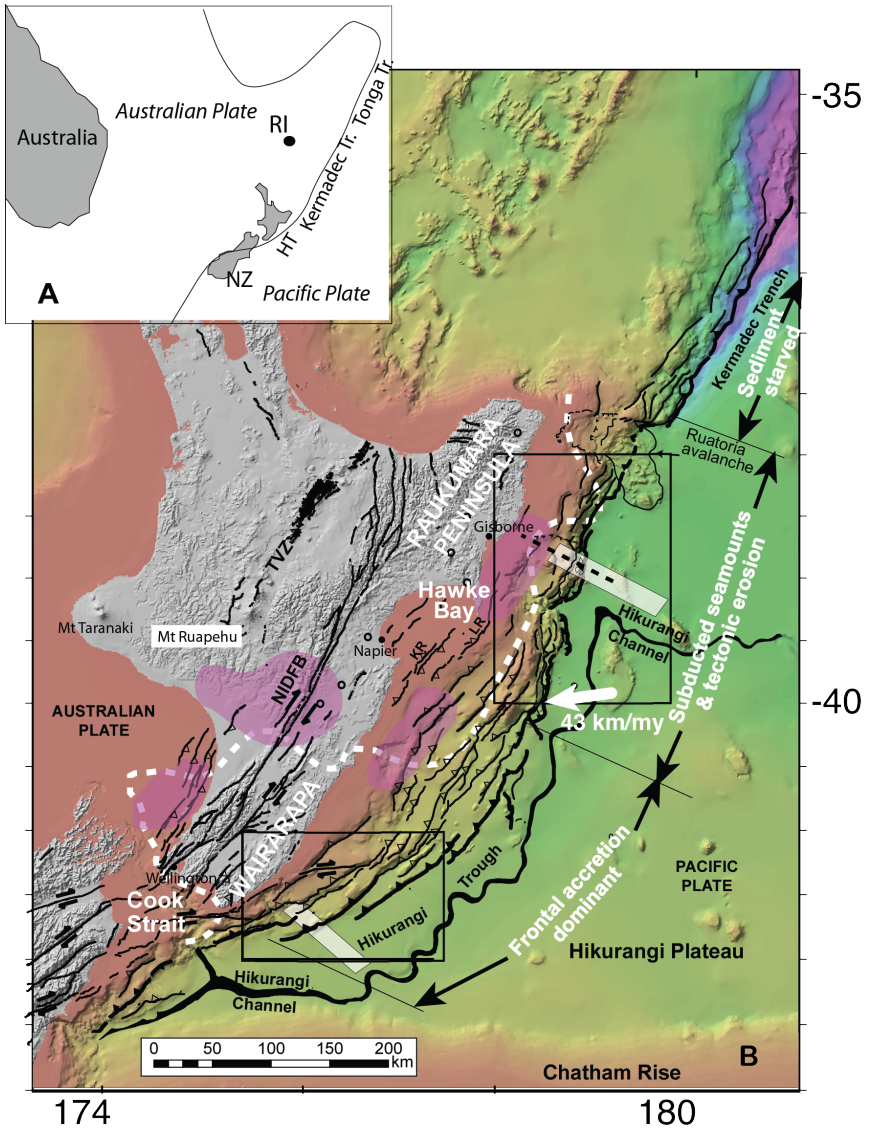


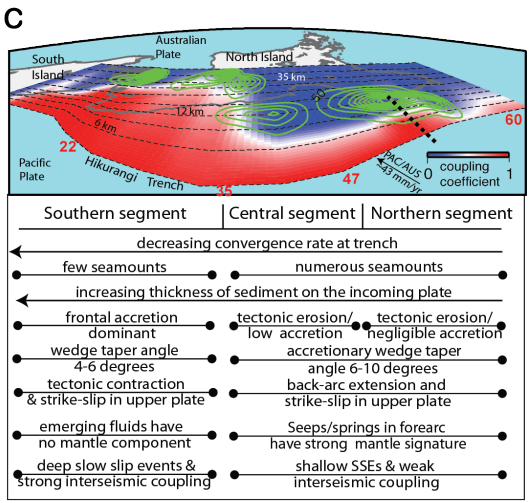


Figure I-1. Overview and tectonic setting of the Hikurangi margin, New Zealand [Barnes et al., 2010]. A) New Zealand within the context of the SW Pacific. B) Detailed bathymetry, topography, and active faulting of the onshore and offshore margin. White arrow shows plate converge rate and azimuth. Bold white dashed line shows position of 20 mm yr^{-1} slip deficit [Wallace et al., 2004]. Magenta areas show region of observed slow slip events. The position of strong coupling is between the white contour and the deformation front. Boxes show location of Figure 2 and white rectangles show proposed focus of north and south heat flow areas. C) Perspective view of Hikurangi margin [modified from Wallace and Beavan, 2010] illustrating the portions of the subduction interface that undergo stick-slip and aseismic slip in terms of the coupling coefficient. Coupling coefficients of one indicate locked areas and coefficients near zero indicate regions of steady aseismic slip. Green contours show areas of slip in slow slip events since 2002. Along strike variations in convergent margin properties are summarized below the plot.

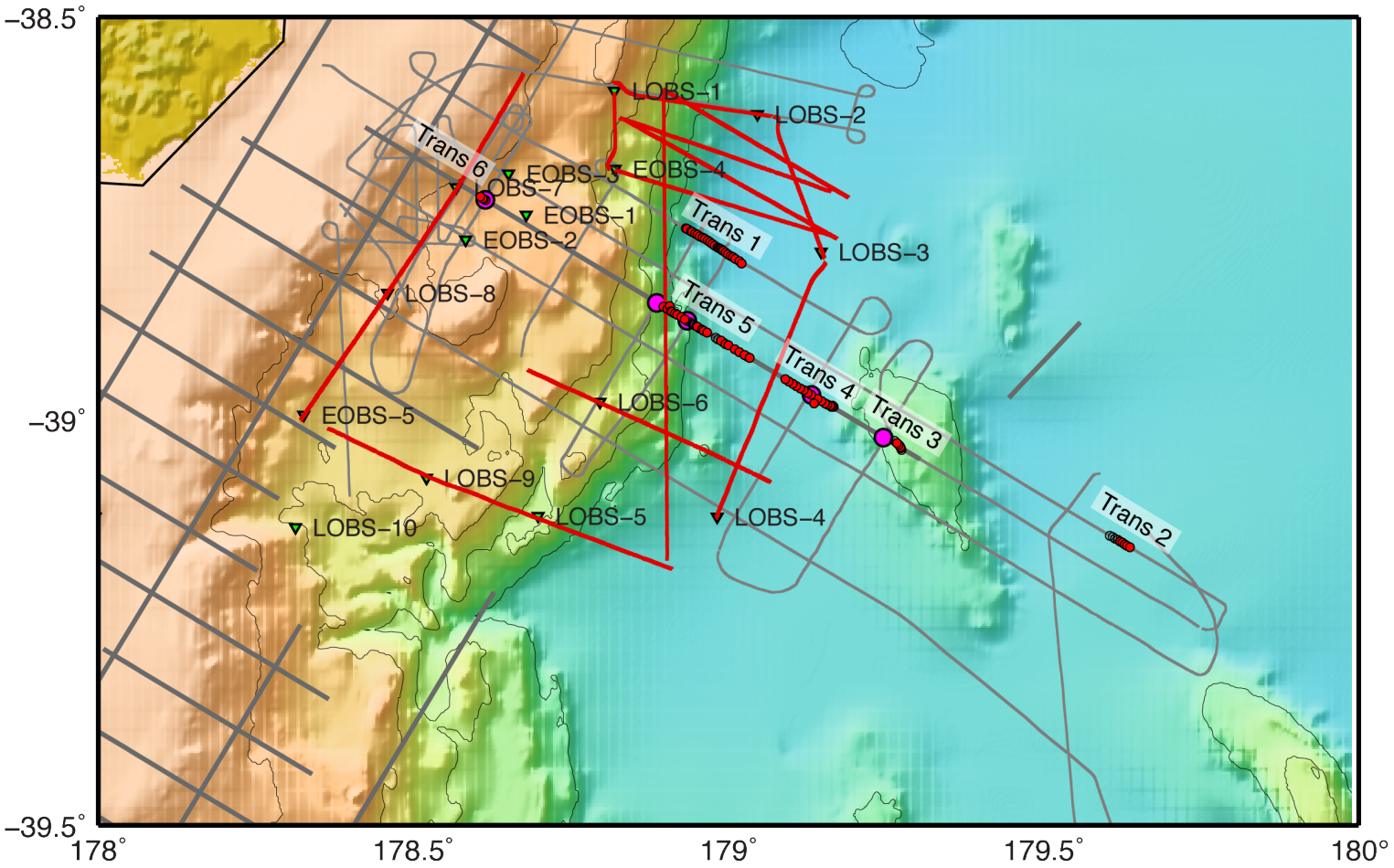


Figure I-2. Location map for northern field area showing existing seismic lines (gray), newly acquired seismic lines (red) and heat flow measurments (red circles). Heat flow transects are labeled. Also shown are proposed IODP drilling sites (magenta circles) and ocean bottom seismometers (inverted triangles).

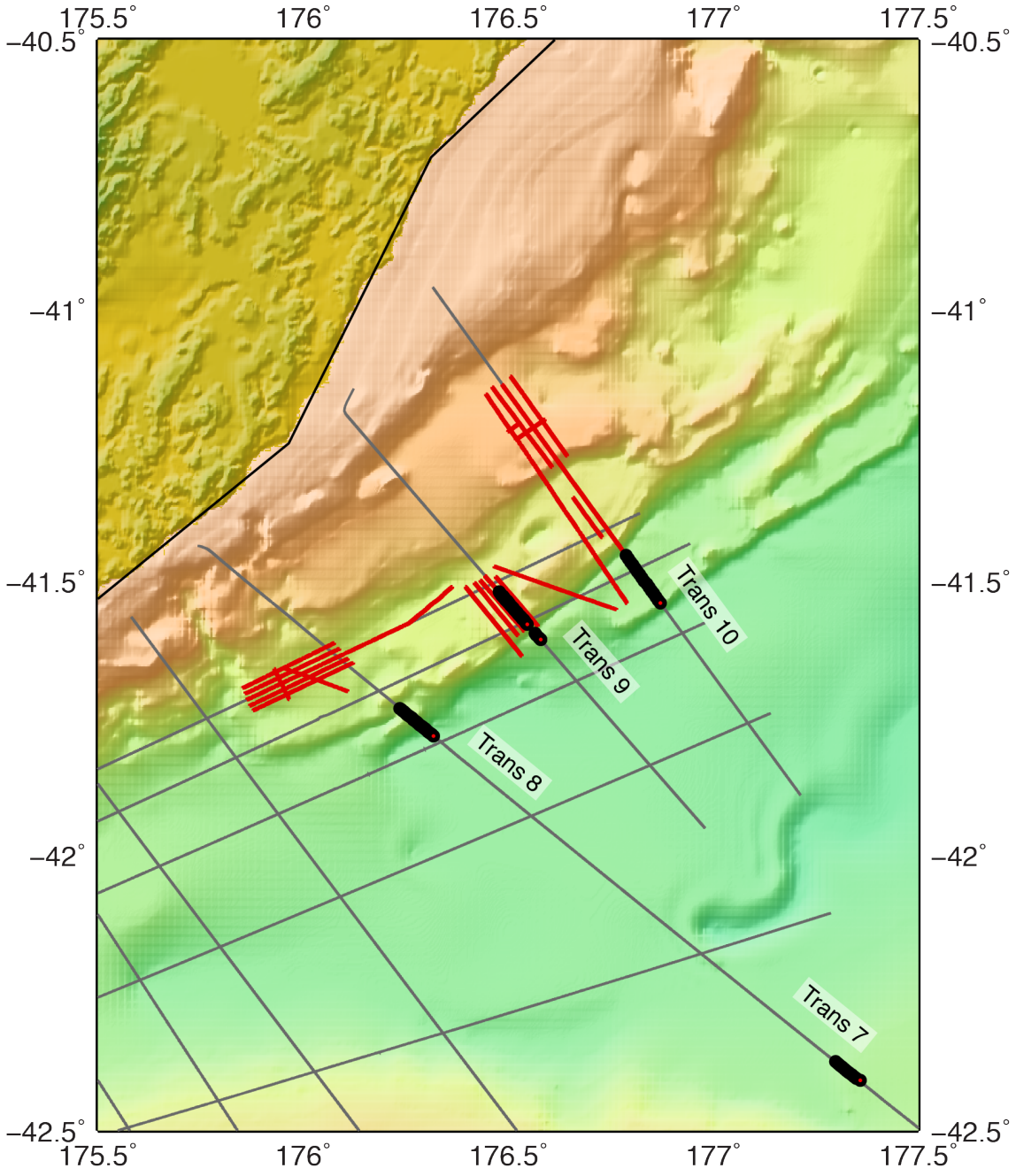


Figure I-3. Location map for the southern field area showing existing seismic lines (gray), newly acquired seismic lines (red) and heat flow measurments (red circles). Heat flow transects are labeled.

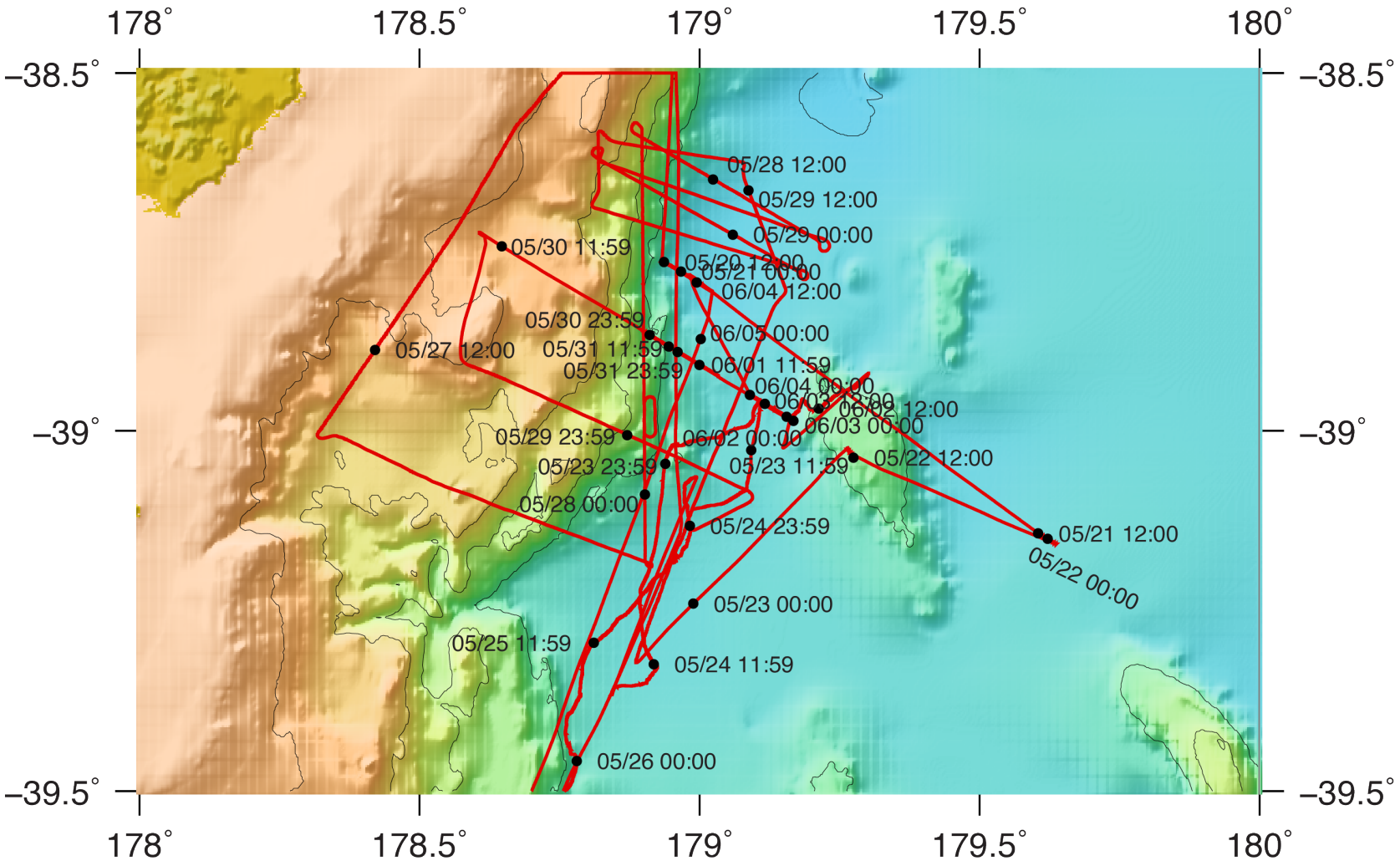


Figure II-1. Track chart of northern field area. Times are shown in 12 hour increments.

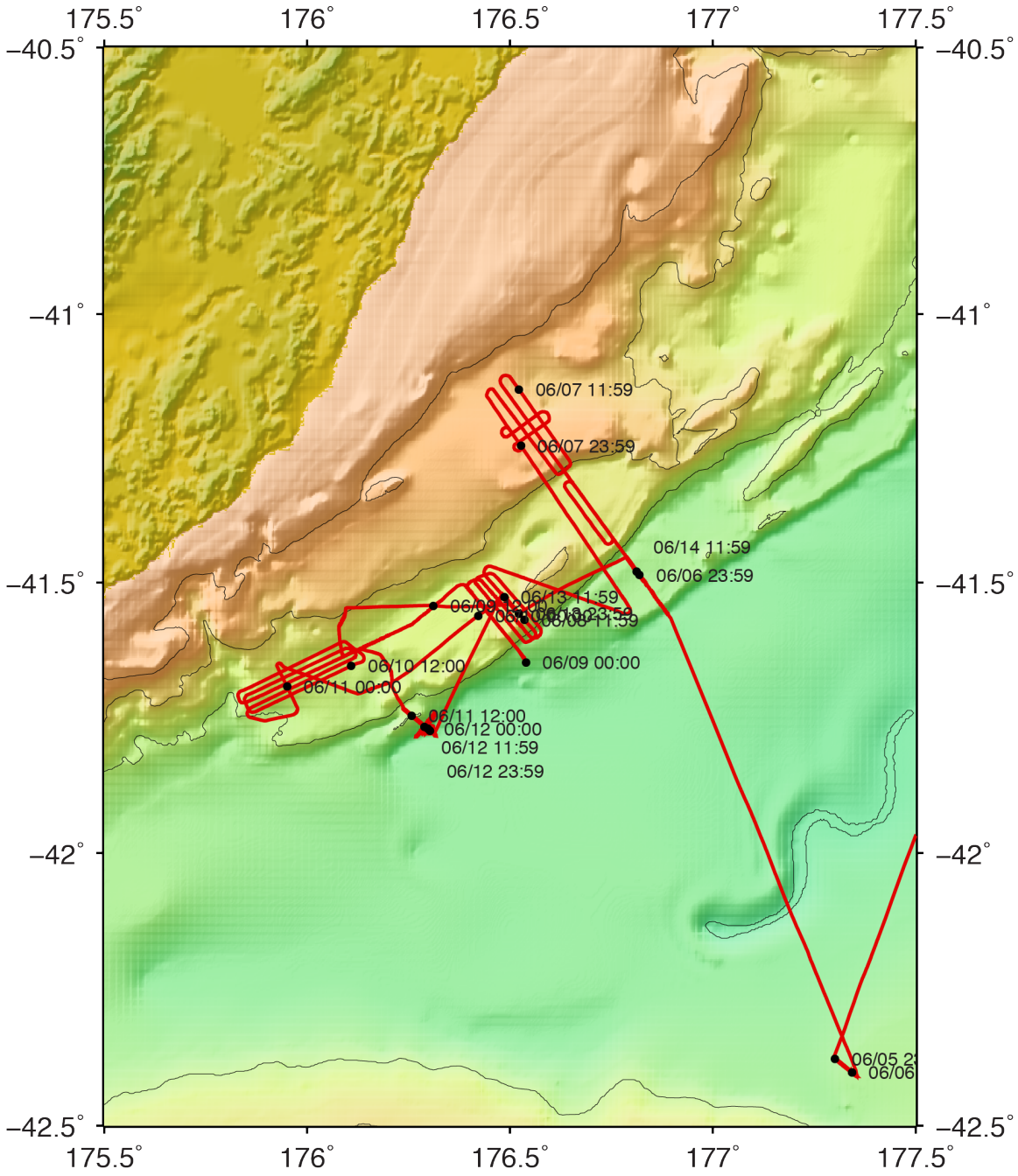


Figure II-2. Track chart of southern field area. Times are shown in 12 hour increments.

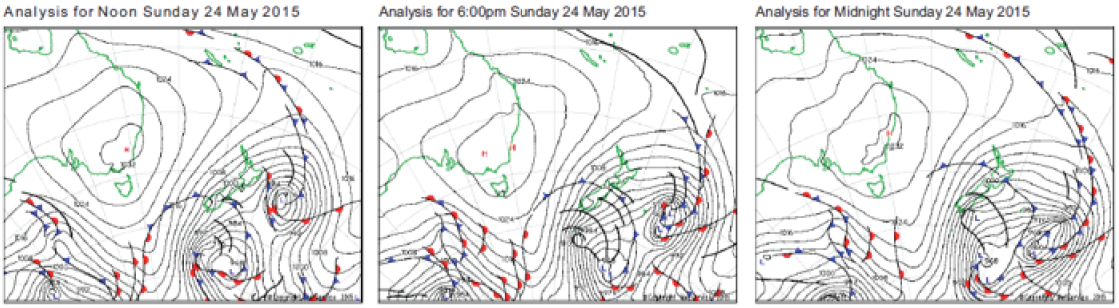


Figure II-3. Atmospheric pressure maps for Sunday 24 May, 2015.

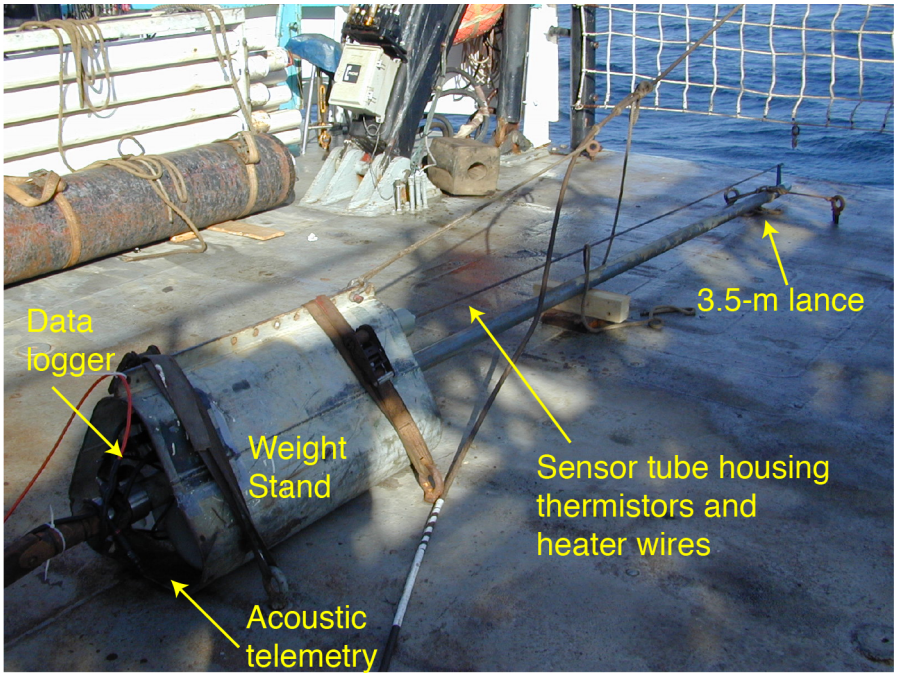


Figure III-1. Oregon State University heat flow probe used during cruise RR-1508

Geometry

SIO Portable Marine Seismic System

Cruise: **RR1508**
Vessel: **R/V Robert Revelle**
Date: **May-June 2015**
Chief Sci: **Rob Harris**

Techs:
Lee Ellett
Jay Turnbull

Item or Channel	Distance (m) from Stern	Distance (m) from Source	Distance (m) From GPS	Distance (m) port/stbd	Depth/Height from water
1	106.25	80.25	142.25	6.7 port	3-4
48	693.75	667.75	729.75	6.7 port	3-4
Source	26	0	62	6.7 stbd	2
GPS	36	62	0	0	0

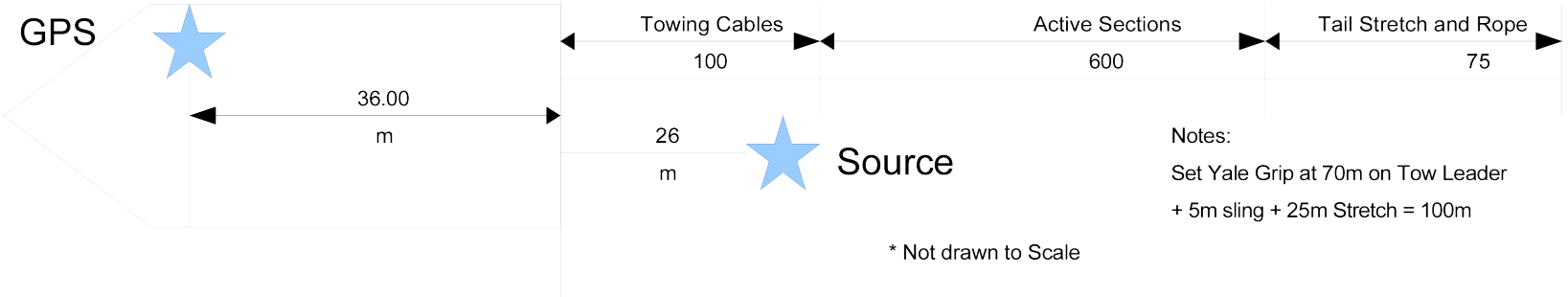
F"/%A#=	Length (m)	Number of Channels
Towing Calbles	100	
Active Sections	600	48
Tail Stretch and Rope	75	
Group Int	12.5	

Bird Locations (Steamer, GPS, Ref Plate)

Bird 1	Start of Tow Stretch, (111x, 6.7y)
Bird 2	Start of Ch 17 (Active 3), (336x, 6.7y)
Bird 3	Start of Ch 33 (Active 5), (536x, 6.7y)
Bird 4	Start of Tail Stretch (736s, 6.7y)

Source:	Gl gun	45/105 True Gl	**Qty:**	2
Acq. Sys.	GeoEel	**PreAmp Gain:**	18 db	
Sample Int:	1 ms	**# of Channels**	48	
File Format:	SEGD	D 8058 Rev 1		
Rec. Length	8-10 sec	**Shot Interval:**	25m/50m	

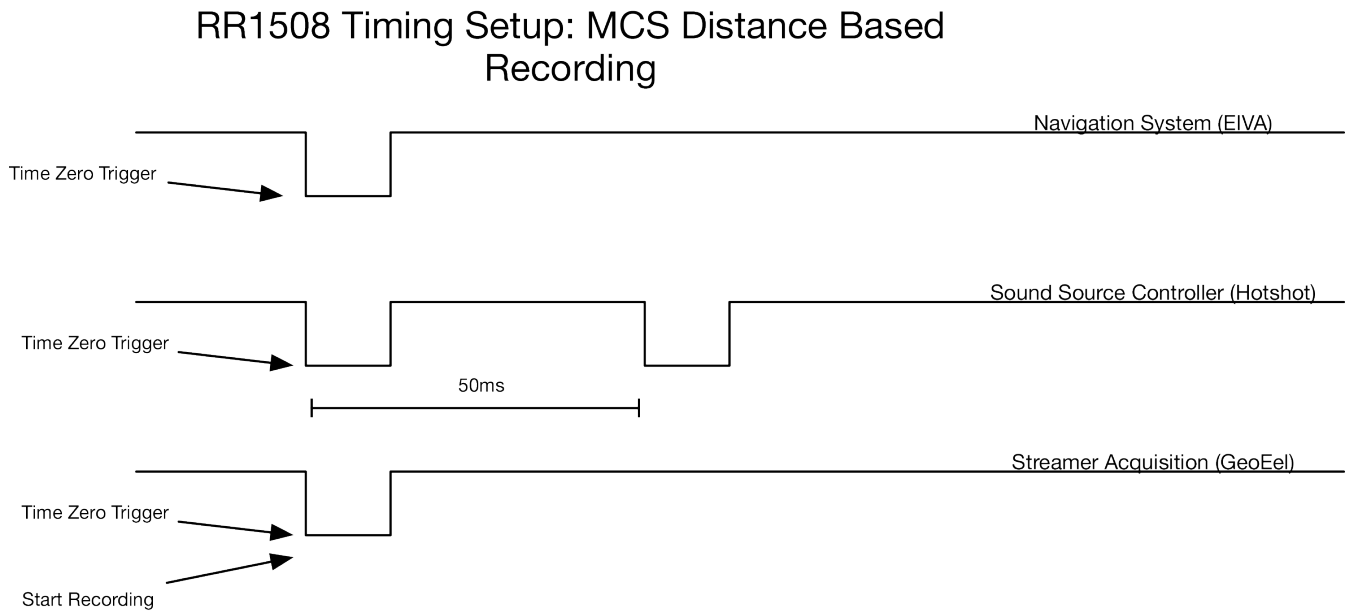
FOLD=
No. Traces * Grp. Int
2*(Shot Interval)



Notes:
Set Yale Grip at 70m on Tow Leader
+ 5m sling + 25m Stretch = 100m

* Not drawn to Scale

Figure IV-1A. Configuration of the SIO high-resolution seismic data acquisition system during RR1508.



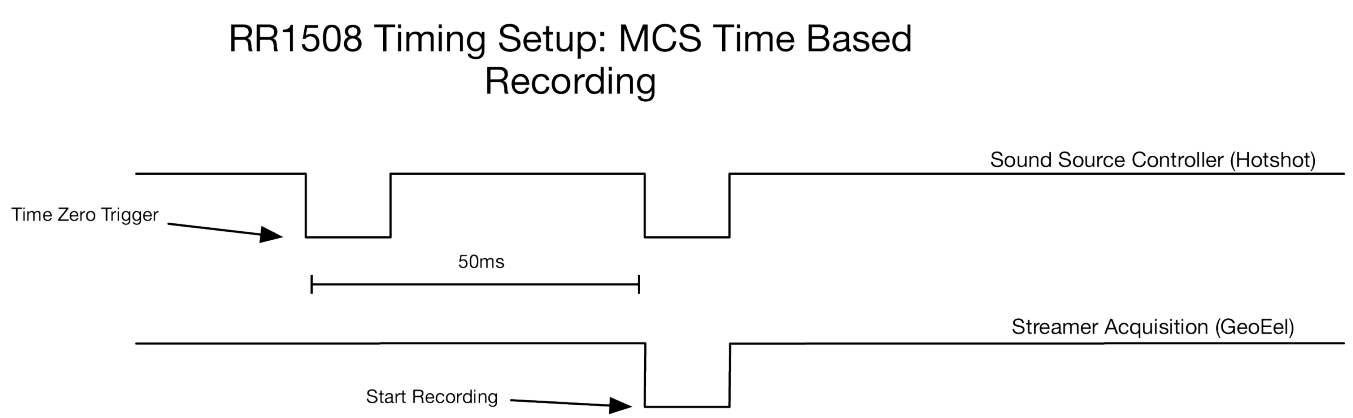


Figure IV-1b. Timing Setup during RR1508.

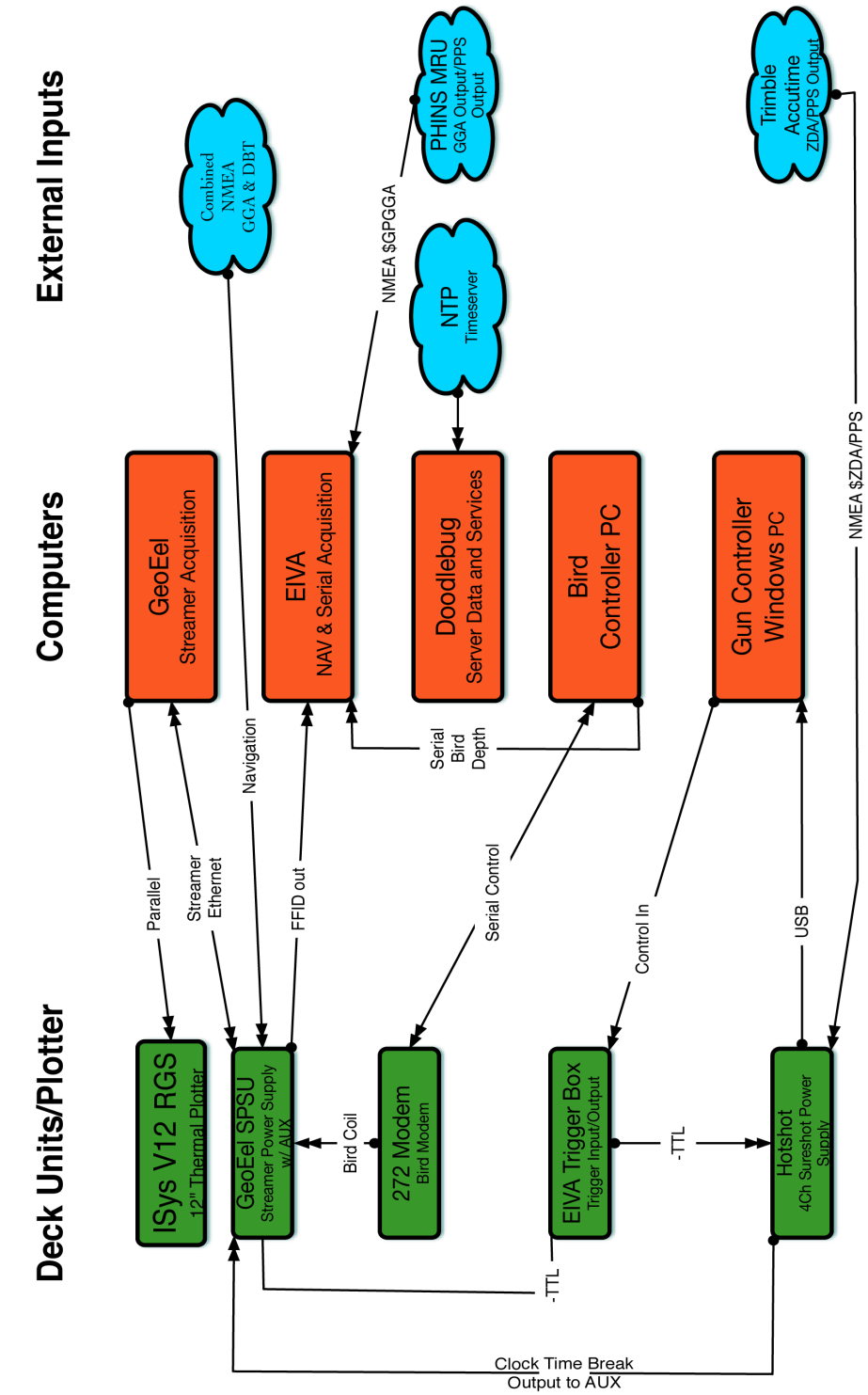


Figure-IV-1c. Recording system configuration.

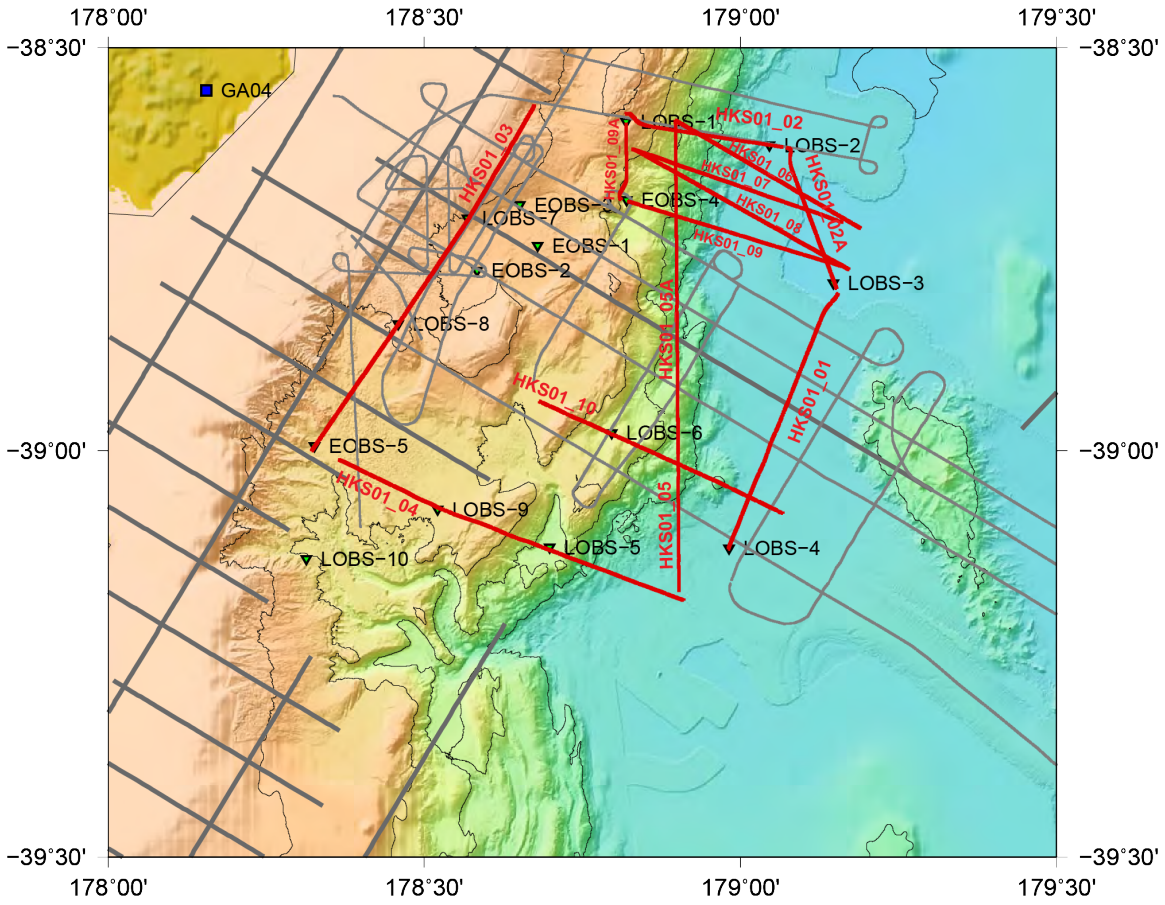


Figure IV-2. Northern field area showing seismic reflection line locations HKS01_01 through HKS01_10.

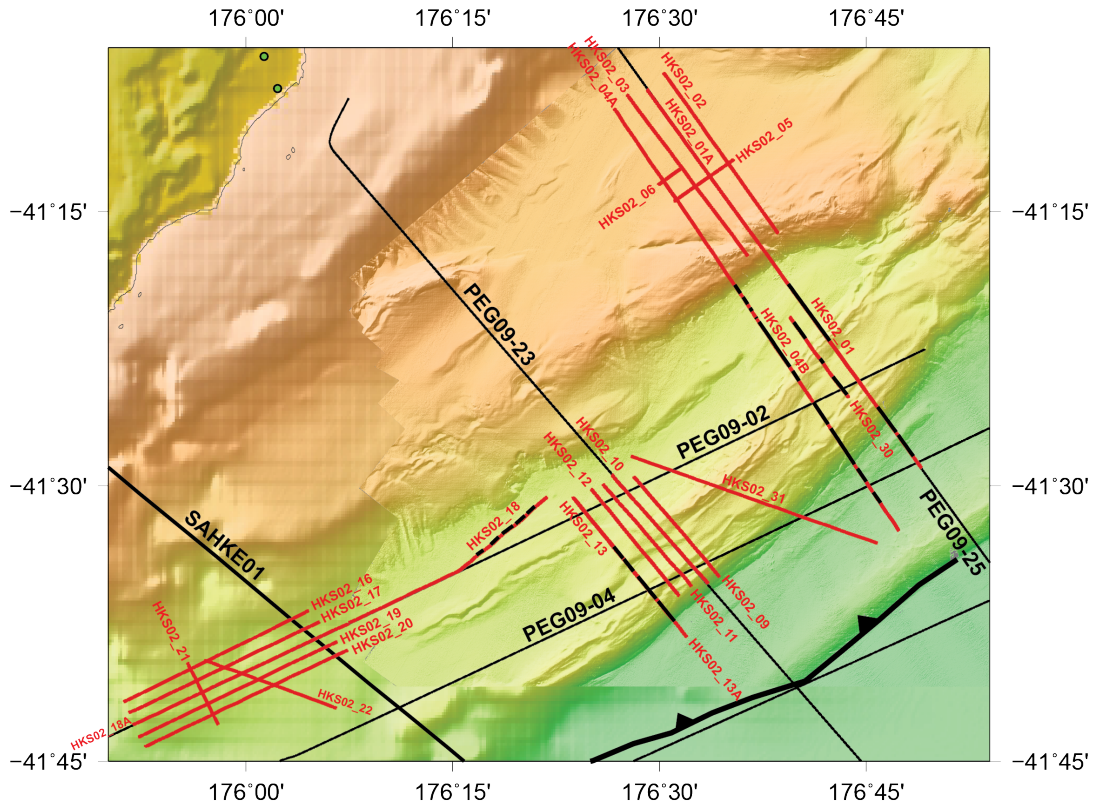


Figure IV-3. Southern field area showing siesmic reflection lines (red) collected during survey HKS-02. Gaps in seismic lines due to marine mammals are shown in black.

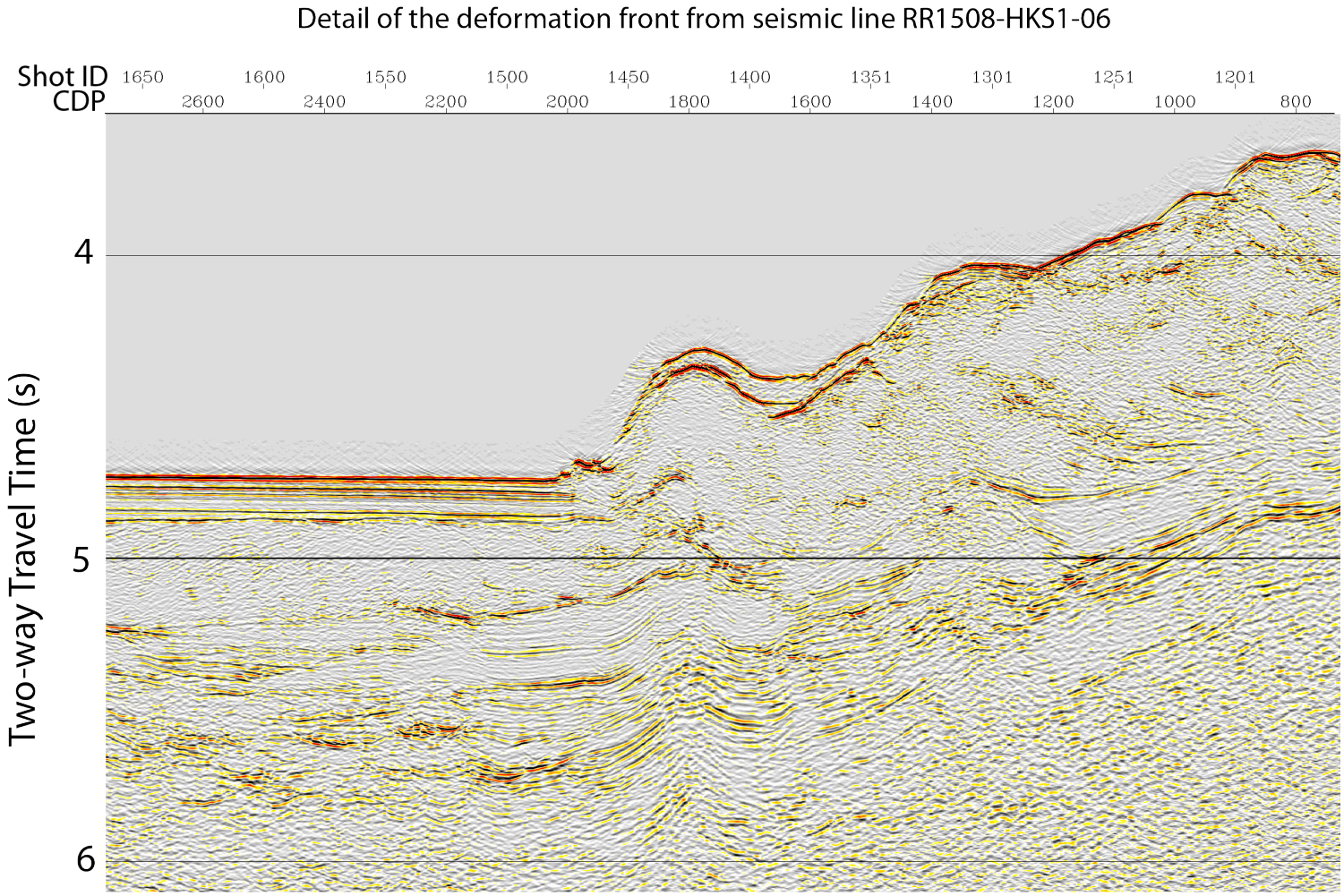


Figure IV-4. An example from seismic line RR1508-HKS01-06 across the deformation front. Data were nmo-corrected, stacked and migrated with a finite difference time-migration algorithm. An AGC with a window length of 500 ms was applied prior to display.

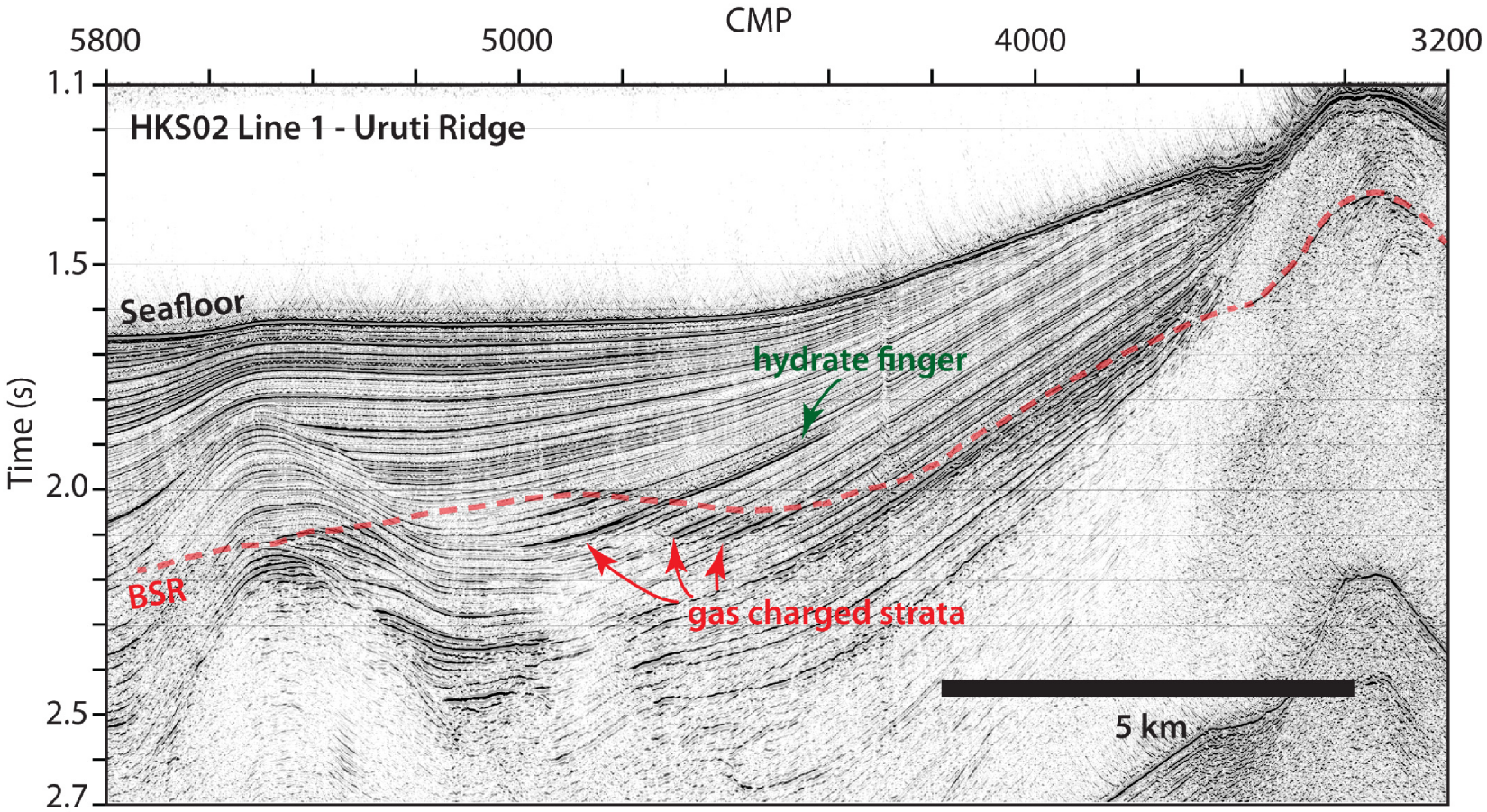


Figure IV-5. An example of a gas hydrate anomaly informally referred to as the "hydrate finger." This segment of the margin was of interest both because of high amplitude anomalies above and below the BSR as well as because of an anomalous apparent deepening of the BSR beneath the finger. Although the finger was observed prior to RR1508 on line PEG09-25, the new data provide higher frequency data and information on its geometry perpendicular to the older seismic line.

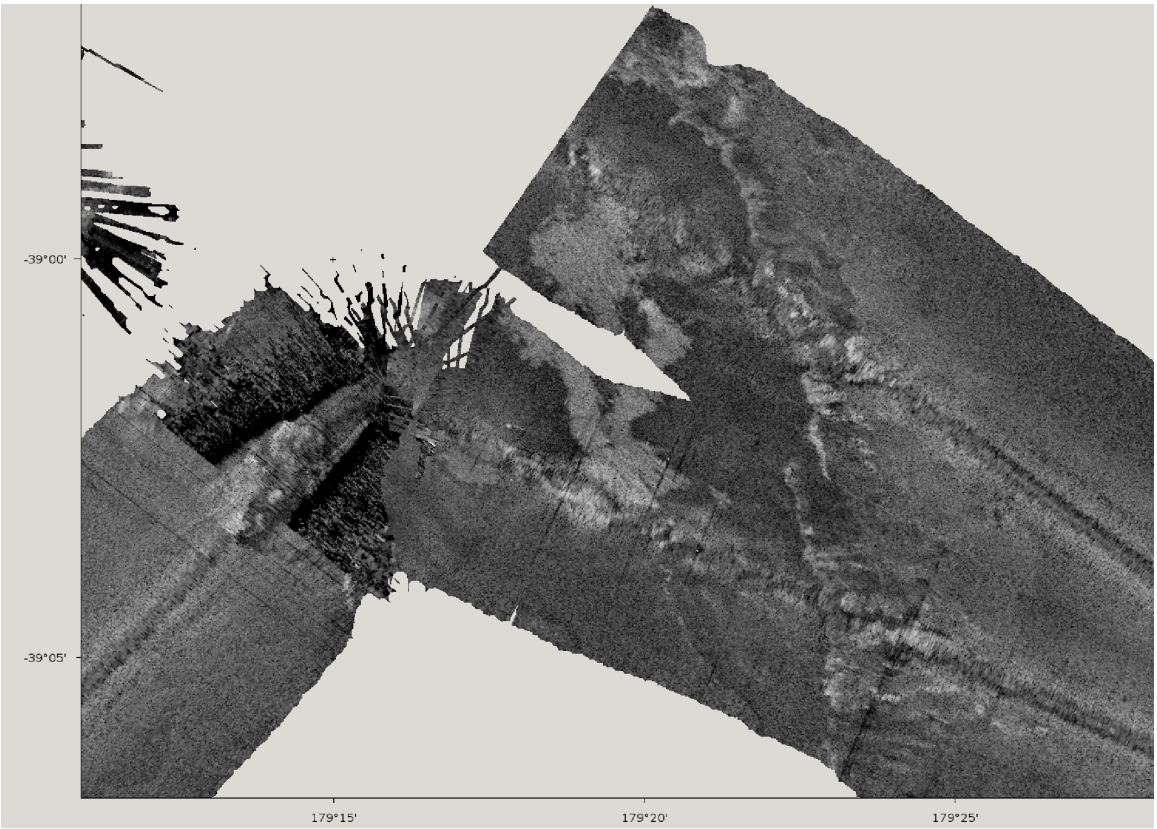


Figure V-1. Example of EM-122 seafloor reflectivity data.

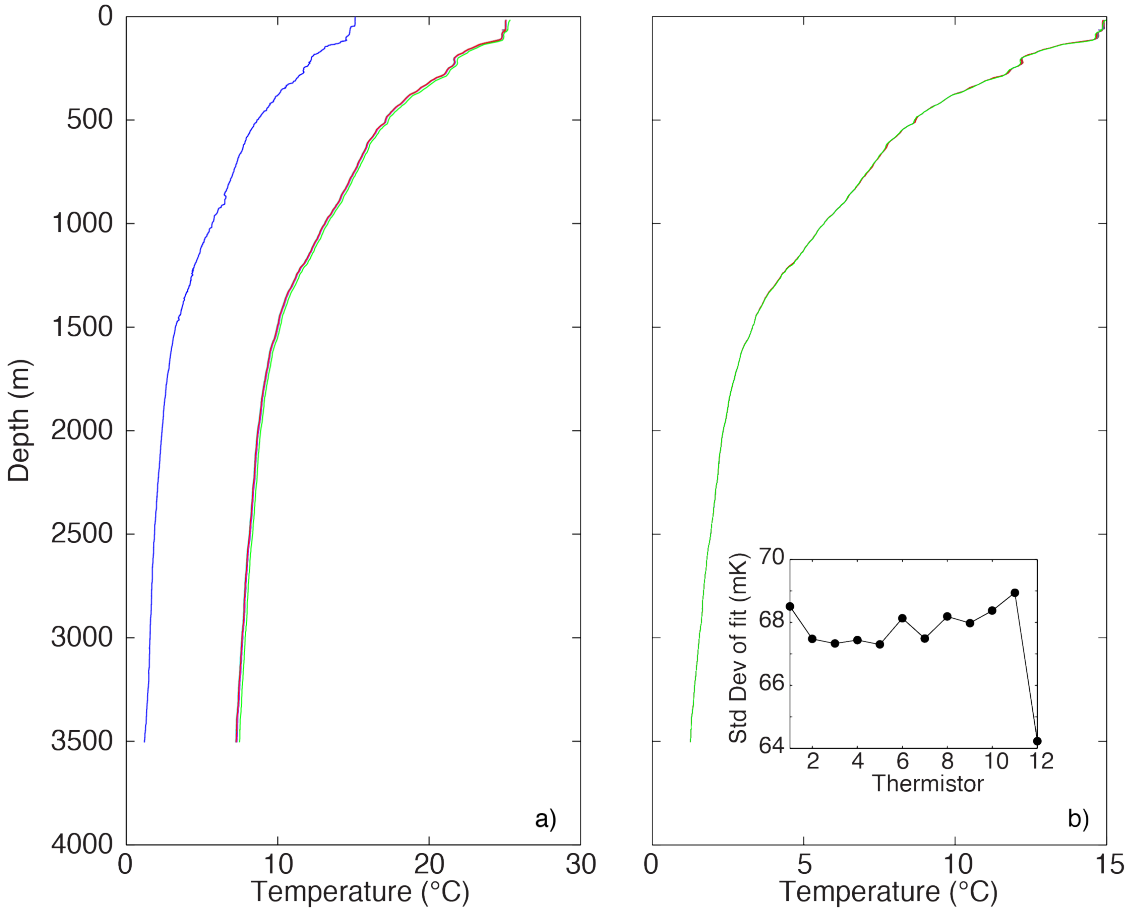


Figure V-2. Calibration of heat flow probe water column temperatures. a) CTD cast temperature at heat flow station HK9. a) CTD temperature (blue line) and probe thermistor temperatures. b) Calibration of probe thermistor temperatures. Inset shows standard deviation of probe temperature fit to CTD temperature plotted by thermistor number.

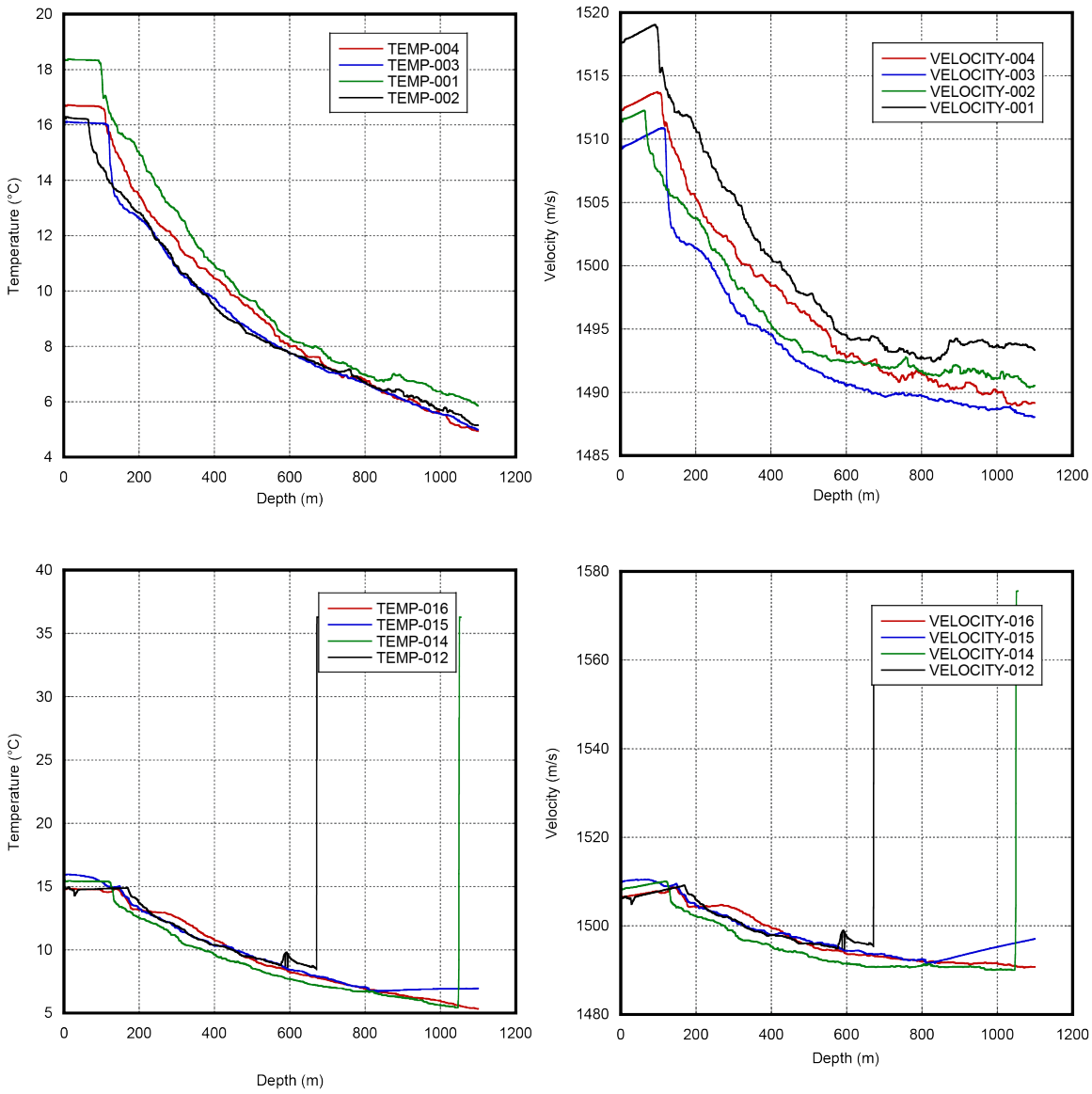


Figure V-3. XBT data. Temperature is shown on the left; acoustic velocity is shown on the right. See Table V-2 for location of all 25 XBT casts attempted during RR1508.

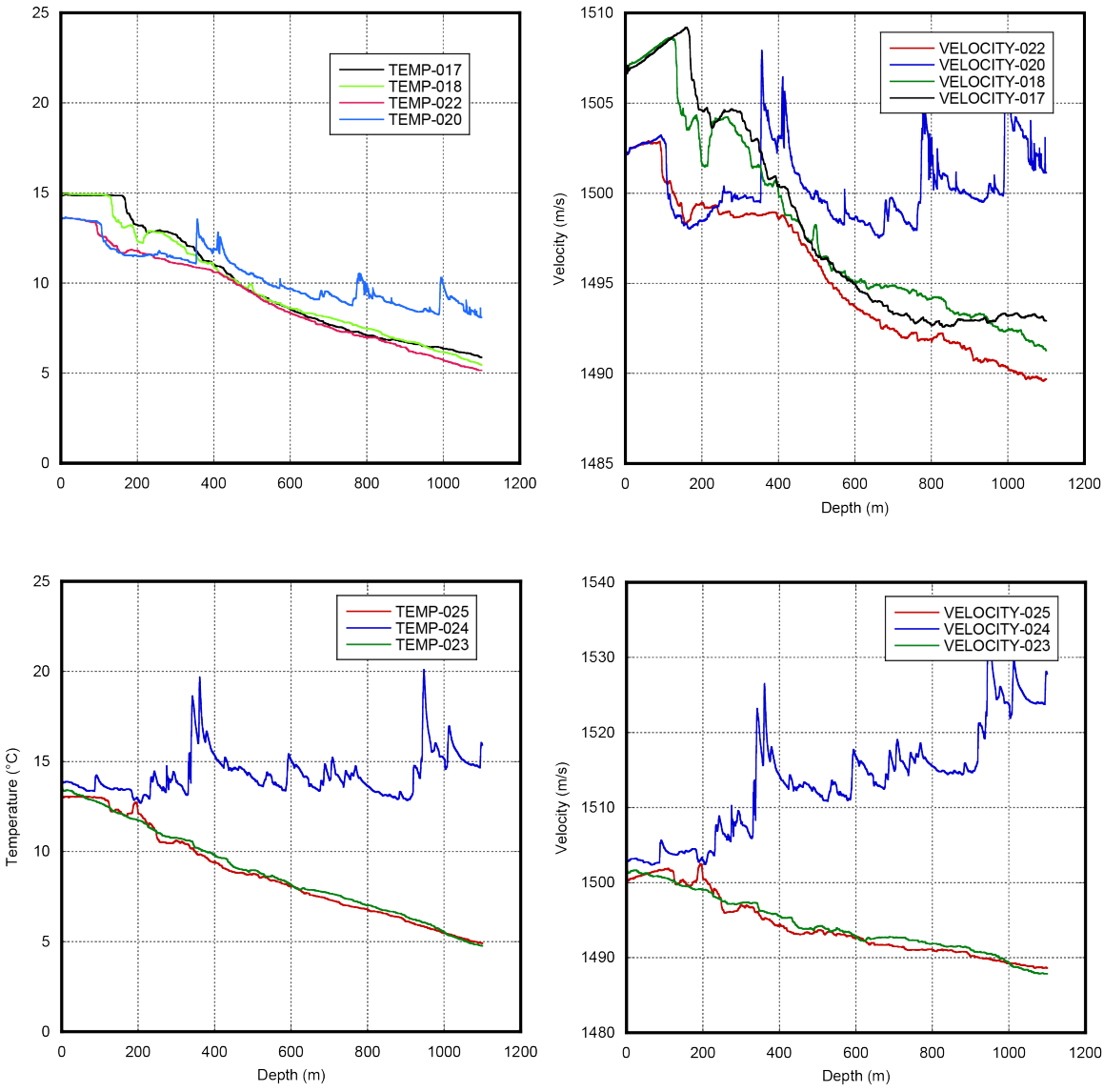


Figure V-3. XBT data continued.

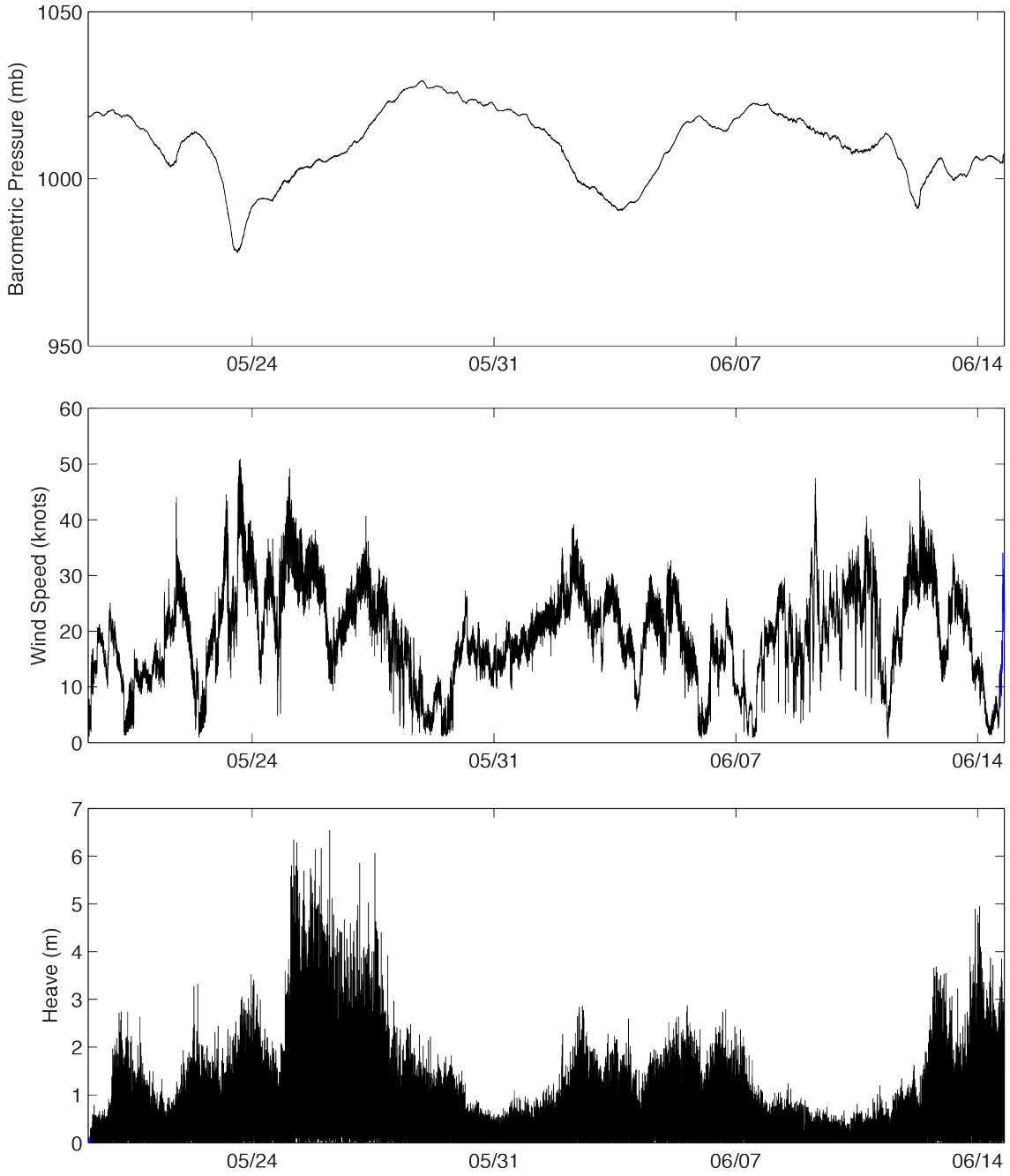


Figure V-4. Meteorological data collected during RR-1508. Heave is used as a proxy for swell height. The R/V Revelle can not hold position in winds greater than about 30 knots.

Table IV-1. Starting and ending points for each seismic line

Seismic Line	First SP	Last SP	First Day (JJJ)	First Hr:Min	Last Day (JJJ)	Last Hr:Min	First CDP	Last CDP	Max CDP Fold	Line Length (km)	First CDP Location		Last CDP Location	
											Longitude Deg	Latitude Deg	Longitude Deg	Latitude Deg
HKS01_03	1001	3262	147	5:00	147	14:31	100	9209	17	57	178.6742	-38.5703	178.3214	-39.0004
HKS01_04	3264	5298	147	15:22	147	22:22	100	8301	14	51	178.3638	-39.0108	178.9104	-39.1843
HKS01_05	5343	6280	147	22:45	148	2:00	100	3941	15	24	178.9025	-39.1741	178.9017	-38.9586
HKS01_05A	6101	7931	148	3:11	148	9:24	100	7477	14	46	178.9014	-39.0038	178.8969	-38.5897
HKS01_06	1002	2176	148	10:14	148	14:20	100	4846	14	30	178.8967	-38.5900	179.1900	-38.7244
HKS01_07	2179	3540	148	15:51	148	20:01	100	5053	14	31	179.1627	-38.7169	178.8277	-38.6257
HKS01_08	3543	4900	148	21:04	149	1:27	100	5488	14	34	178.8353	-38.6276	179.1718	-38.7755
HKS01_09	1002	2233	149	2:13	149	6:13	100	5078	14	31	179.1623	-38.7717	178.8209	-38.6907
HKS01_09A	1002	1421	149	6:21	149	7:51	100	1860	15	11	178.8117	-38.6892	178.8189	-38.5932
HKS01_02	1001	1877	149	8:02	149	11:15	100	3723	20	23	178.8179	-38.5825	179.0676	-38.6237
HKS01_02A	1001	1825	149	11:21	149	14:06	100	3480	20	21	179.0720	-38.6243	179.1524	-38.7995
HKS01_01	1828	3347	149	14:13	149	19:17	100	6254	14	38	179.1545	-38.8049	178.9807	-39.1213
HKS01_10	3349	4809	149	21:32	150	2:21	100	6001	14	37	179.0674	-39.0773	178.6819	-38.9386
HKS02_01	1002	1880	158	0:05	158	3:05	100	3664	16	22	176.8176	-41.4841	176.6611	-41.3220
HKS02_01A	2002	3496	158	5:54	158	11:00	100	6130	17	38	176.7491	-41.4132	176.4852	-41.1388
HKS02_02	1002	1792	158	11:44	158	14:14	100	3311	18	20	176.5053	-41.1236	176.6442	-41.2706
HKS02_03	1002	1810	158	15:07	158	17:51	100	3383	18	21	176.6074	-41.2912	176.4610	-41.1433
HKS02_04A	1003	1451	158	18:16	158	19:39	100	1941	16	12	176.4456	-41.1563	176.5234	-41.2415
HKS02_04B	1002	2710	158	23:35	159	5:22	100	6988	17	43	176.5032	-41.2201	176.7902	-41.5414
HKS02_05	1002	1287	158	20:17	158	21:14	100	1288	15	7	176.5178	-41.2412	176.5903	-41.2029
HKS02_06	1002	1099	158	22:30	158	22:50	100	536	14	3	176.5254	-41.2117	176.4990	-41.2261
HKS02_09	1002	1524	159	15:59	159	17:37	100	2237	16	13	176.4691	-41.4920	176.5731	-41.5833
HKS02_10	1002	1577	159	10:34	159	12:22	100	2450	17	15	176.4428	-41.4901	176.5594	-41.5891
HKS02_11	1002	1537	159	18:24	159	20:30	100	2290	15	14	176.5393	-41.5919	176.4321	-41.4989
HKS02_12	1002	1548	159	13:12	159	15:14	100	2334	16	14	176.5243	-41.6001	176.4178	-41.5033
HKS02_30	1002	1395	158	3:57	158	5:18	100	1720	16	10	176.6581	-41.3466	176.7295	-41.4201
HKS02_31	1002	2044	159	6:03	159	9:54	100	4333	16	26	176.7643	-41.5527	176.4658	-41.4733
HKS02_13	1003	1620	159	21:15	159	23:11	100	2618	15	16	176.3989	-41.5132	176.5181	-41.6229
HKS02_13A	1002	1721	160	0:12	160	2:55	100	3027	17	18	176.5337	-41.6379	176.3953	-41.5103
HKS02_16	1003	1822	161	8:22	161	10:45	100	3428	15	21	175.8523	-41.6964	176.0762	-41.6136
HKS02_17	1003	1842	161	15:26	161	18:00	100	3505	16	21	175.8585	-41.7061	176.0892	-41.6240
HKS02_18	1002	1934	160	3:24	160	7:31	100	3931	18	24	176.3644	-41.5105	176.1243	-41.6248
HKS02_18A	2002	2950	161	3:47	161	7:28	100	3943	15	24	176.1239	-41.6256	175.8630	-41.7175
HKS02_19	1002	1879	161	18:37	161	21:33	100	3658	17	22	176.1108	-41.6419	175.8701	-41.7286
HKS02_20	1002	1892	161	11:53	161	14:41	100	3715	16	23	176.1230	-41.6497	175.8783	-41.7372
HKS02_21	1002	1268	161	23:41	162	0:27	100	1212	16	7	175.9667	-41.7170	175.9295	-41.6610
HKS02_22	1003	1557	162	0:54	162	2:32	100	2365	16	14	175.9499	-41.6588	176.1096	-41.7023

Table V-1. Gaps in 3.5/12 kHz data.

Start time	End time	Comment
2015_140_0518	2015_140_2001	transit
2015_141_0955	2015_141_1313	heat flow measurement
2015_142_1127	2015_142_1329	probe recovery
2015_143_0105	2015_147_1158	hove to for weather
2015_147_1445	2015_150_0706	seismic acquisition
2015_150_1241	2015_150_1411	transit
2015_152_0751	2015_152_0822	heat flow measurement
2015_153_0108	2015_153_0205	probe recovery
2015_154_2233	2015_155_0402	heat flow measurement
~2015_156_0230	2015_160_1532	3 full, non-contiguous files recorded in this time window; seismic
2015_161_0239	2015_162_0722	1 full file recorded in this time window; seismic acquisition
2015_163_0249	2015_163_2240	heat flow measurement

Table V-2. Calibration Coefficients for the Heat Flow Probe

Thermistor	A	B	C	D
1	-4.430	0.807	-4.340E-03	1.184E-04
2	-4.465	0.813	-4.933E-03	1.324E-04
3	-4.480	0.814	-4.981E-03	1.333E-04
4	-4.432	0.811	-4.782E-03	1.284E-04
5	-4.418	0.810	-4.753E-03	1.275E-04
6	-4.388	0.801	-3.952E-03	1.084E-04
7	-4.438	0.808	-4.545E-03	1.221E-04
8	-4.384	0.799	-3.885E-03	1.063E-04
9	-4.405	0.800	-3.951E-03	1.077E-04
10	-4.336	0.795	-3.566E-03	9.819E-05
11	-4.345	0.791	-3.239E-03	9.023E-05
12	-4.946	0.896	-1.073E-02	0.000252

CTD $T=A + B\,T + C\,T^2 + D\,T^3$

T is temperature.

Table V-3. XBTs during RR1508

Station Name	Date	Time	Latitude Deg Min		Longitude Deg Min		Water Depth (m)	XBT Depth (m)	Salinity PSU	Sea surface Temp C	Comment
drop001	19-May-2015	19:05:47	-37	08.04	177	50.91	1829	1100	34.79	18.44	
drop002	21-May-2015	08:06:15	-38	48.33	179	01.28	3000	1100	34.32	16.2	
drop003	21-May-2015	09:13:12	-38	56.09	179	14.50	6000?	1100	34.21	16.07	
drop004	22-May-2015	09:10:21	-39	09.45	179	38.17	3628	1100	35.27	16.74	
drop005											no drop005
drop006	27-May-2015	00:20:38	-38	25.97	178	49.17	650	1100	35.16	15.66	ignore data below 650m
drop007	27-May-2015	14:09:30	-38	58.75	178	20.41	1295	128	35.14	15.64	
drop008	27-May-2015	14:16:47	-38	59.26	178	19.93	1369	200	35.15	15.68	premature stop
drop009	27-May-2015	14:43:31	-39	00.27	178	19.08	1345	95	35.17	15.79	premature stop
drop010	27-May-2015	14:54:22	-39	00.00	178	19.00	1350	180	na	na	retry - drop011
drop011	28-May-2015	00:42:40	-39	02.86	178	54.09	2772	326	35.02	14.82	premature stop
drop012	28-May-2015	01:14:41	-39	01.62	178	54.11	3000	650	na	NA	retry with stick - drop013
drop013											no drop
drop014	29-May-2015	10:16:17	-38	36.82	178	59.02	3000	1055	35.17	15.48	
drop015	30-May-2015	04:47:29	-38	48.76	178	35.66	760	1100	45.24	15.87	ignore data below 760 m
drop016	05-Jun-2015	04:31:05	-39	34.37	178	40.01	3040	1100	35.256	14.90	
drop017	05-Jun-2015	20:02:03	-42	05.45	177	26.36	2835	1100	35.279	14.88	
drop018	06-Jun-2015	22:01:10	-41	33.71	176	53.53	2850	1100	35.29	14.93	
drop019	08-Jun-2015	04:09:28	-41	25.95	176	41.62	1644	152	34.99	13.50	premature stop
drop020	08-Jun-2015	03:39:23	-41	26.53	176	43.14	1648	1100	34.99	13.49	not reliable below ~300 m
drop021	08-Jun-2015	04:01:06	-41	27.45	176	42.92	1700	199	34.99	13.5	premature stop
drop022	08-Jun-2015	04:09:28	-41	28.20	176	43.61	3200	1100	35.00	13.52	
drop023	09-Jun-2015	03:39:52	-41	30.68	176	21.78	2000	1100	34.83	13.30	questionable
drop024	10-Jun-2015	02:14:44	-41	39.79	176	12.34	2100	1100	34.86	13.71	not reliable
drop025	11-Jun-2015	04:11:07	-41	42.46	176	13.15	1996	1100	34.97	13.08	

Table VI-1

Sgt Id	Time (UTC)	Species	Sgt Dist (km)	Beh State	Count	Age/Sex/ Size	Reax	Take?	Notes	Sgt Lat	Sgt Lon	Depth (m)
1	2015-05-19T 21:12:18	Unid Beaked Whale	0.1	Moderate Travel	1	unknown	None	N	Very brief glimpse of back and dorsal fin as it swam away on terminal dive. Light brown body, slightly falcate smallish dorsal fin, one white mark on back was probably a scar. Body length approx 5 to 6 meters. Depth about 1500m.	-37.2957	178.3660	-1821
2	2015-05-20T00:52:20	New Zealand Fur Seal	0.1	Slow Travel	1	Female	None	N		-37.6599	179.0068	-555
3	2015-05-20T 01:13:00	Unid Pilot Whale	0.5	Moderate Travel	25	1 calf and males and females	Paralleling	N	Pilot whales associated with dolphins. Turned and paralleled ship, traveling in opposite direction from ship. Abput 950 m deep. Associated with dolphins also reported with this sighting number. -	-37.7294	179.0056	-1134
3	2015-05-20T 01:20:40	Unid Dolphin or Porpoise	0.5	Moderate Travel	10	unknown	Bow Ride	N	Not sure of spp, but most likely a couple duskys and some bottlenose. Associated with pilot whales also reported with this sighting number.	-37.7542	179.0035	-1276
4	2015-05-20T 02:54:28	Unid Mysticete	0.6	Slow Travel	4	unknown	None	N	Saw during drills from deck. They were heading down our stb side slowly away from the ship.	-38.0435	178.9767	-598
5	2015-05-20T 04:29:50	Unid Pilot Whale	3	Slow Travel	15	Male and female	None	N	Males and females, blowing and traveling at the surface, moving opposite the ship's course - -	-38.3584	178.9705	-2070

6	2015-05-22T 00:32:16	Unid Pilot Whale	0.05	Milling	75	6+ calves (one to two with fetal folds), only one adult male seen	None	N	Seen out galley window on weather check. Likely same group reported by crew to PSOs at lunch. They were also diving, riding large waves,	-39.1494	179.6220	-3360
7	2015-05-27T 03:23:37	Unid Pilot Whale	0.35	Fast Travel	40	unknown	Other	Y	##########################	-38.5128	178.7352	-801
8	2015-05-28T 01:41:42	Unid Pilot Whale	0.4	Moderate Travel	20	two juveniles	Approach Boat	N	Whales still nearby after 15 minutes so decision made to turn vessel and circle back to trackline.	-38.9808	178.9005	-2760
9	2015-05-28T 21:01:32	Unid Pilot Whale	1.36	Fast Travel	30	some calves	Other	Y	15 taken within 400m; approached boat within 50 m off starboard side, then continued, changing heading to 160L.Group was spread out.	-38.6338	178.8478	-2001
10	2015-05-28T 21:19:25	Bottlenose Dolphin	0.15	Surface Active	4	unknown	None	N	2 lept out of the water; picture taken. Seem to be loosely associated with the pilot whales.	-38.6387	178.8569	-2001
11	2015-05-28T 22:16:57	Bottlenose Dolphin	6.11	Unknown	20	adults	None	N		-38.7048	178.9853	-3616
11	2015-05-28T 22:16:57	Unid Pilot Whale	6.11	Surface Active	60	adults, m/f, juveniles	None	N	##########################	-38.7048	178.9853	-3616
12	2015-05-29T 01:45:22	New Zealand Fur Seal	0.1	Milling	1	female	Other	Y	Dove/sunk before the guns were turned off and I didn't see her again.	-38.7884	179.1920	-3544

12	2015-05-29T 02:04:14	New Zealand Fur Seal	1.24	Other	1 unknown	None	N	Resting (jug-handle position) on surface. No movement. Likely same individual seen by PH on line above.	-38.7644	179.1664	-3549
13	2015-05-29T 02:38:25	New Zealand Fur Seal	0.75	Other	1 juvenile	None	Y	Resting at surface, very small. No noticeable reaction as we passed within 50 meters.	-38.7595	179.1178	-3537
14	2015-05-29T 03:10:02	Unid Mysticete	6.11	Moderate Travel	2 unknown	None	N	Very falcate pointed fin, Probably minke but very far to tell for sure. JO also got a look at it in big eyes after some minutes as it surfaced at 35 R.	-38.7171	179.0234	-3586
15	2015-05-29T 21:17:13	Bottlenose Dolphin	0.89	Surface Active	2 unknown	None	N	Saw a splash then one jumped out of the water. Never saw them again. Very close to sun glare so not 100% on ID.	-39.0745	179.0834	-3512
16	2015-05-29T 22:37:26	Bottlenose Dolphin	2.79	Moderate Travel	6 unknown	None	N	Moderate speed swimming. With the pilot whales on the next line.	-38.9920	178.8691	-2597
16	2015-05-29T 22:37:26	Unid Pilot Whale	2.79	Moderate Travel	12 calves, females, poss juvenile males	Parall eling	N	very active, splashes, fast-swimming when first sighted. group was not very tight relative to previous sightings. surface activity continued but decreased somewhat as the group pass behind ships' beam. -	-39.0239	178.9615	-3367
17	2015-05-30T 03:59:26	Unid Dolphin or Porpoise	7.52	Fast Travel	50 unknown	Appr oach Boat	N	##########	-38.8452	178.5406	-736

18	2015-06-04T 01:53:21	Killer Whale	1.6	Slow Travel	15	Couple of adult males	None	N	Saw many blows close together for about a minute, then no animals for about 3 to 4 minutes, then up again. Animals traveling slowly away from us; no reaction, and ship finishing CTD.	-38.9425 179.1060 -3500
18	2015-06-04T 02:05:20	Killer Whale	2.28	Slow Travel	6	Couple of adult males	None	N	Seen concurrently by all observers.	-38.9695 179.0943 -3504

Table VI-2.

Sgt Id	Time (UTC)	Species	Sgt Dist (km)	Beh State	Count	Age/Sex/ Size	Reax	Take?	Notes	Sgt Lat	Sgt Lon	Depth (m)
19	2015-06-05T 02:54:42	Unid Pilot Whale	0.35	Approaching	7	one calf and maybe two adult males	Approach Boat	N	Saw two on fast approach coming most of the way out of the water, then saw group of 3 at 550m behind ship, then another group of 4 including one calf at 120L, approaching, then paralleling, then falling behind the ship. Initial two and group that fell behind is likely the same group.	-39.3323	178.7850	-3317
20	2015-06-05T 20:36:54	New Zealand Fur Seal	0.1	Other	1	unknown	Run from Boat	N	Initial behavior was resting, then it dove, reappeared and dove again. It moved slowly away from the ship.	-43.0915	177.5835	-232
21	2015-06-05T 22:17:10	Unid Mysticete	7.52	Slow Travel	1	unknown	None	N	Large, blue. A few blows ~25second apart, then disappeared	-42.3959	177.3858	-2472
22	2015-06-06T 21:12:48	New Zealand Fur Seal	0.31	Resting	1	female	None	N		-41.6841	176.9634	-2864
23	2015-06-06T 21:18:14	New Zealand Fur Seal	0.4	Resting	1	unknown	Run from Boat	N	Resting at surface and dove as we approached.	-41.6671	176.9526	-2854
24	2015-06-06T 22:18:37	New Zealand Fur Seal	0.18	Resting	2	females	None	N	Resting. Separation about 2 meters.	-41.5501	176.8783	-2871
25	2015-06-06T 23:57:27	New Zealand Fur Seal	1.44	Resting	4	unknown	None	N	Resting at surface. 2 jughandling. Pace = 0.	-41.4782	176.8109	-2579

25	2015-06-07T 00:11:52	New Zealand Fur Seal	0.08 Resting	1 unknown	Run from Boat	N	Seen ~80m from observer platform, so still >100m from gear. Animal is one of the 4 seen by Julia previously; others were further away. Animal was lounging at the surface but swam away (not really running") about 20m when the ship was alongside. Reaction seemed to be more from the ship than guns. "	-41.4753	176.8088	-2579
26	2015-06-07T 00:20:11	New Zealand Fur Seal	0.21 Resting	2 unknown	None	N	Guns were already shut down when I saw them; not taken.	-41.4680	176.8001	-2611
27	2015-06-07T 00:27:19	New Zealand Fur Seal	0.88 Other	3 unknown	None	N	Guns were already shut down, so no take.	-41.4580	176.7874	-2643
28	2015-06-07T 00:32:27	New Zealand Fur Seal	0.31 Resting	1 unknown	None	N	flippers held outside the water, while animal apparently drifting with the current--> this behavior is referred to as resting in the behavior column	-41.4562	176.7892	-2643
29	2015-06-07T 00:36:18	New Zealand Fur Seal	0.74 Other	1 unknown	None	N	Single gun firing; shut off in time to not take.	-41.4501	176.7822	-2643
30	2015-06-07T 00:42:38	New Zealand Fur Seal	0.22 Other	1 unknown	None	N	Guns already shut down. Animal passed ~30m from ship.	-41.4480	176.7815	-2643
31	2015-06-07T 00:45:02	New Zealand Fur Seal	0.69 Resting	3 unknown	None	N	Guns off. flippers held outside the water, while animal apparently drifting with the current -	-41.4416	176.7779	-2606

32	2015-06-07T 00:48:55	New Zealand Fur Seal	1.24 Resting	2 unknown	None	N	flippers held outside the water, while animal apparently drifting with the current	-41.4326	176.7779	-2606
33	2015-06-07T 00:50:41	New Zealand Fur Seal	1.24 Resting	1 unknown	None	N	flippers held outside the water, while animal apparently drifting with the current	-41.4403	176.7623	-2589
34	2015-06-07T 00:51:11	New Zealand Fur Seal	1.24 Resting	2 unknown	None	N	flippers held outside the water, while animal apparently drifting with the current -	-41.4359	176.7638	-2589
35	2015-06-07T 00:51:55	New Zealand Fur Seal	1.72 Resting	1 unknown	Run from Boat	N	Swam away from boat; not really running.	-41.4281	176.7649	-2319
36	2015-06-07T 01:04:13	New Zealand Fur Seal	0.81 Resting	1 unknown	None	N		-41.4250	176.7584	-2157
37	2015-06-07T 01:15:07	New Zealand Fur Seal	0.58 Resting	1 unknown	None	Y		-41.4187	176.7502	-2157
38	2015-06-07T 01:36:59	New Zealand Fur Seal	0.88 Resting	1 unknown	None	N		-41.4015	176.7277	-1719
39	2015-06-07T 01:47:24	New Zealand Fur Seal	0.4 Resting	1 female	Run from Boat	Y	Resting. Was two together but this one rested and the following sighitng dove in a direction 90L, moved away and was not taken.	-41.3931	176.7243	-1549
40	2015-06-07T 01:51:35	New Zealand Fur Seal	0.52 Resting	1 unknown	None	N	Resting	-41.3912	176.7202	-1549
41	2015-06-07T 01:54:54	New Zealand Fur Seal	0.4 Milling	1 unknown	Unknown	Y	Dove. Saw again at 300m with flippers up.	-41.3830	176.7189	-1549

42	2015-06-07T 01:59:17	New Zealand Fur Seal	0.89 Resting	1 unknown	None	N	Resting.	-41.3735	176.7203	-1523
43	2015-06-07T 02:02:31	New Zealand Fur Seal	0.27 Resting	2 female	None	Y	Resting.	-41.3761	176.7151	-1523
44	2015-06-07T 02:02:44	New Zealand Fur Seal	0.4 Resting	2 unknown	None	N	Resting.	-41.3748	176.7143	-1523
45	2015-06-07T 02:04:22	New Zealand Fur Seal	0.31 Resting	2 unknown	Other	Y	Resting.	-41.3752	176.7170	-1523
46	2015-06-07T 02:09:54	New Zealand Fur Seal	0.27 Fast Travel	6 unknown	Run from Boat	Y	Saw them porpoising away from boat and finally stopped and rested at surface at about 450m from us.	-41.3705	176.7120	-1523
47	2015-06-07T 02:11:19	New Zealand Fur Seal	0.06 Resting	3 female	None	N	Came within 50m of ship. Take at > 100m.	-41.3701	176.7082	-1523
48	2015-06-07T 02:14:02	New Zealand Fur Seal	0.1 Resting	2 juvenile	Run from Boat	N	Resting. Swam away from ship when we were next to them.	-41.3681	176.7044	-1523
49	2015-06-07T 02:17:35	New Zealand Fur Seal	0.6 Other	2 unknown	None	N	Guns shut down already. flippers held outside the water, while animal apparently drifting with the current -	-41.3624	176.6961	-1543
50	2015-06-07T 02:20:53	New Zealand Fur Seal	0.1 Fast Travel	5 unknown	Run from Boat	N	Guns off.	-41.3610	176.7003	-1543
51	2015-06-07T 02:21:40	New Zealand Fur Seal	1.9 Resting	2 unknown	None	N	Resting	-41.3482	176.6840	-1574
52	2015-06-07T 02:23:31	New Zealand Fur Seal	1.72 Resting	2 unknown	None	N	Resting.	-41.3439	176.6975	-1591

53	2015-06-07T 02:28:24	New Zealand Fur Seal	0.76	Resting	1	unknown	None	N	Resting.	-41.3482	176.6914	-1574
54	2015-06-07T 02:37:02	New Zealand Fur Seal	0.31	Resting	10	unknown	Run from Boat	N	Resting and then porpoising away.	-41.3465	176.6818	-1574
55	2015-06-07T 02:59:48	New Zealand Fur Seal	4.91	Fast Travel	7	unknown	None	N	Maybe chasing prey? Porpoising and resting and porpoising and diving.	-41.3117	176.6097	-1847
56	2015-06-07T 03:01:34	New Zealand Fur Seal	0.22	Milling	1	female	None	N	Doing headstands with back end straight up out of water, then twisted around and porpoised away from us.	-41.3226	176.6632	-1729
57	2015-06-07T 03:06:16	New Zealand Fur Seal	1.36	Resting	1	unknown	None	N	Resting.	-41.3099	176.6511	-1797
58	2015-06-07T 03:07:39	New Zealand Fur Seal	1.07	Resting	1	unknown	None	N	Resting	-41.3158	176.6462	-1757
59	2015-06-07T 03:08:36	New Zealand Fur Seal	1.07	Resting	1	unknown	None	N	Resting	-41.3153	176.6452	-1757
60	2015-06-07T 03:09:12	New Zealand Fur Seal	0.83	Resting	1	unknown	Run from Boat	N	Resting, then swim away from ship (not run")."	-41.3146	176.6480	-1757
61	2015-06-07T 03:20:56	New Zealand Fur Seal	0.08	Moderate Tra	1	unknown	Run from Boat	N	Looked small.	-41.3137	176.6411	-1787
62	2015-06-07T 03:21:56	New Zealand Fur Seal	4.15	Resting	2	unknown	None	N	Jughandling	-41.3222	176.5918	-1868
63	2015-06-07T 03:23:29	New Zealand Fur Seal	2.66	Fast Travel	4	unknown	None	N	Porpoising when first seen, so marked as no reaction.	-41.2953	176.6194	-1825

64	2015-06-07T 03:27:38	New Zealand Fur Seal	2.41	Resting	1	unknown	None	N	Resting.	-41.3275	176.6083	-1868
65	2015-06-07T 03:29:38	New Zealand Fur Seal	1.1	Resting	1	unknown	None	N	Resting.	-41.3262	176.6233	-1834
66	2015-06-07T 03:34:20	New Zealand Fur Seal	2.79	Resting	2	unknown	None	N	Resting. flippers held outside the water, while animal apparently drifting with the current	-41.3447	176.6623	-1687
67	2015-06-07T 03:42:24	New Zealand Fur Seal	1.1	Resting	1	unknown	None	N	Resting.	-41.3423	176.6550	-1725
68	2015-06-07T 03:55:28	Unid Dolphin or Porpoise	4.37	Fast Travel	60	unknown	None	N	Breaching and fast travel.	-41.3099	176.6748	-1774
69	2015-06-07T 03:58:38	New Zealand Fur Seal	0.48	Resting	1	unknown	Run from Boat	N	Resting at first, seemed to be heading away, then surfaced within 400m zone.	-41.3543	176.6631	-1623
70	2015-06-07T 04:06:37	New Zealand Fur Seal	2.41	Resting	1	unknown	None	N	Resting. flippers held outside the water, while animal apparently drifting with the current -	-41.3790	176.6719	-1578
71	2015-06-07T 04:10:37	New Zealand Fur Seal	1.57	Resting	4	unknown	None	N	Resting.	-41.3739	176.6802	-1545
72	2015-06-07T 04:11:49	New Zealand Fur Seal	2.12	Resting	1	unknown	None	N	Resting. flippers held outside the water, while animal apparently drifting with the current	-41.3796	176.6835	-1560
73	2015-06-07T 04:36:12	New Zealand Fur Seal	0.05	Moderate Tra	1	unknown	Run from Boat	N	Surfaced near ship and then immediately dove and swam away from us.	-41.3845	176.6948	-1539
74	2015-06-07T 04:42:26	New Zealand Fur Seal	2.12	Resting	1	unknown	None	N	Resting.	-41.4083	176.7066	-1607

75	2015-06-07T 04:42:42	New Zealand Fur Seal	1.9 Resting	1 unknown	None	N	Resting. Additional behavior is dive. Dove while >400m away from ship, probably not in reaction.	-41.4024	176.7156	-1655
76	2015-06-07T 19:38:27	New Zealand Fur Seal	0.05 Approaching	1 unknown	Other	N	Saw animal swimming toward us with its head out of the water. Immediately shutdown guns. Animal kept swimming toward the ship, then turned and porposed away a couple times (after guns were shut down), then stopped and looked back at us. No apparent reaction to guns on; probably just to ship, or even to guns being turned off.	-41.2418	176.5238	-946
77	2015-06-07T 20:11:09	New Zealand Fur Seal	0.31 Resting	2 unknown	None	N	2 animals hangin' out at the surface (resting). Shut down guns immediately; no reaction. -	-41.2404	176.5130	-946
78	2015-06-07T 21:51:59	New Zealand Fur Seal	0.42 Milling	2 at least one adult male	Unknown	N	Saw them together but one had head up and one only saw a bit of its back. Then I lost them.	-41.1915	176.5676	-1080
78	2015-06-07T 21:55:19	New Zealand Fur Seal	0.35 Slow Travel	1 adult male	Unknown	N	Saw only one, only the back but it was large, and it dove. I believe it is one of the animals from the sighting line just above this.	-41.1931	176.5637	-1080

79	2015-06-07T 22:13:30	New Zealand Fur Seal	0.01 Moderate Tra	1	probably female	None	N	Saw it swimming to starboard from just port of the bow. It swam just in front of the ship and kept going. One gun shut down immediately (we were in ramp up).	-41.2019	176.5421	-1086
80	2015-06-07T 22:15:39	New Zealand Fur Seal	0.03 Resting	2	2 juveniles	Run from Boat	N	Saw 2 resting in front of ship, then they porpoised away from the ship and dove. Guns not on when seen.	-41.2031	176.5395	-1144
79	2015-06-07T 22:21:13	New Zealand Fur Seal	0.43 Moderate Tra	1	unknown	None	N	JO resighted them behind the boat through BigEyes	-41.2060	176.5377	-1144
80	2015-06-07T 22:23:27	New Zealand Fur Seal	0.74 Moderate Tra	2	2 juveniles	None	N	JO resighted them behind the boat through BigEyes.	-41.2069	176.5387	-1144
81	2015-06-07T 22:59:20	New Zealand Fur Seal	1.44 Moderate Tra	1	unknown	None	N		-41.2174	176.4779	-1047
82	2015-06-07T 23:06:34	New Zealand Fur Seal	0.05 Moderate Tra	1	unknown	Other	N	Looked at boat and dove.	-41.2232	176.4802	-1047
83	2015-06-07T 23:15:22	New Zealand Fur Seal	0.74 Resting	1	unknown	None	N	Might be resight of one of the animal in sighting just above this line.	-41.2217	176.4831	-1047
84	2015-06-08T 01:33:31	New Zealand Fur Seal	0.02 Slow Travel	3	unknown	Run from Boat	N	Mate saw 3 animals swimming in generally same direction as ship. They swam at our speed, crossed under the bow and came up on port, still traveling at ~4 kts. Then changed direction to head away from the ship (90L) and we slowly pulled away from them.	-41.3302	176.6028	-1840

85	2015-06-08T 01:43:07	New Zealand Fur Seal	0.05 Fast Travel	2	one possible male	Unknown	N	JO saw 2-3 animals just off bow, running away from the ship. Unsure if they were running before the ship was close or if we influenced them.	-41.3386	176.6106	-1814
86	2015-06-08T 01:58:02	New Zealand Fur Seal	0.25 Moderate Tra	1	juvenile	Approach Boat	N	BW saw it swimming toward us from in front of the ship with its head out of the water looking at us. Then lost from view. Julia then saw it porpoising toward the ship off the starboard quarter, keeping pace with us. Last seen at 02:04. Waiting 15 min to start ramp up.	-41.3500	176.6215	-1797
87	2015-06-08T 02:18:47	New Zealand Fur Seal	0.2 Fast Travel	1	unknown	Approach Boat	N	Porpoising out of water coming towards ship.	-41.3721	176.6379	-1687
88	2015-06-08T 02:25:40	New Zealand Fur Seal	0.48 Resting	2	unknown	Run from Boat	N	Flippers up and down, appear to be grooming, perhaps. two separted by about 4m. As we approached to approx 200m they looked at ship and swam away 90left together.	-41.3776	176.6485	-1628
89	2015-06-08T 02:29:34	New Zealand Fur Seal	0.05 Moderate Tra	1	juvenile	Run from Boat	N	Came within 20m of ship.	-41.3800	176.6468	-1590

90	2015-06-08T 02:48:09	New Zealand Fur Seal	0.07	Moderate Tra	2	unknown	Run from Boat	N	Julia saw them come up from below, look at the boat and move away. They stopped moving away and looked at boat again around 300m from ship. They went into sun glare.	-41.3976	176.6638	-1623
91	2015-06-08T 03:17:11	New Zealand Fur Seal	0.48	Fast Travel	2	unknown	Approach Boat	N	Saw them porpoising out of wave headed towards ship.	-41.4284	176.6848	-1706
92	2015-06-08T 03:26:33	New Zealand Fur Seal	0.58	Diving	1	unknown	Unknown	N	Saw a dive and then lost it. Outside zone, and guns shut down anyway.	-41.4385	176.6928	-1954
93	2015-06-08T 03:40:56	New Zealand Fur Seal	0.27	Fast Travel	3	unknown	Approach Boat	N	Porpoising against swell direction towards boat.	-41.4502	176.7074	-2074
94	2015-06-08T 03:53:17	New Zealand Fur Seal	0.4	Fast Travel	1	unknown	Approach Boat	N	Animal seen heading toward boat from directly ahead.	-41.4569	176.7180	-2268
93	2015-06-08T 04:02:40	New Zealand Fur Seal	0.06	Fast Travel	4	two juveniles, at least one adult female	Approach Boat	N	Likely same sighting as two lines above.Porpoising towards bow and then passing in front and continuing at 20L heading.	-41.4701	176.7260	-2526
95	2015-06-08T 04:17:28	New Zealand Fur Seal	0.05	Fast Travel	2	unknown	Unknown	N	Porpoising.	-41.4846	176.7399	-2610
96	2015-06-08T 04:39:42	New Zealand Fur Seal	0.03	Fast Travel	3	juveniles	Approach Boat	N	Porpoising on approach to ship, then milling around it for awhile, then moving away and putting flippers in the air.	-41.5059	176.7586	-2623
97	2015-06-08T 21:56:41	New Zealand Fur Seal	0.48	Resting	7	at least two juveniles	None	N	Resting. Lots of kelp in area. Closest approach about reticle 7.	-41.5606	176.4466	-1718

98	2015-06-08T 22:01:37	New Zealand Fur Seal	0.35	Resting	4	1 juvenile	None	N	Resting and one has no flippers in the air.	-41.5607	176.4546	-1718
99	2015-06-08T 22:08:08	New Zealand Fur Seal	0.81	Resting	4	unknown	Run from Boat	N	Resting on surface. They were ahead of us and as we approached they looked at ship and moved away 75R.	-41.5719	176.4637	-1757
100	2015-06-08T 22:28:04	New Zealand Fur Seal	0.35	Resting	1	juvenile	Unknown	N	Saw flipper tips very briefly, then back, then nothing. Very small animal.	-41.5861	176.4797	-2284
100	2015-06-08T 22:38:52	New Zealand Fur Seal	0.22	Slow Travel	1	juvenile	Unknown	N	Saw surface 3x close to port side of ship but swam into sun glare and lost it.	-41.5934	176.4893	-2284
101	2015-06-08T 22:51:55	New Zealand Fur Seal	0.48	Surface Activ	2	one juvenile	Approach Boat	N	Saw one animal porpoise out of water and then a second animal join.	-41.6070	176.5055	-2820
101	2015-06-08T 22:55:50	New Zealand Fur Seal	0.27	Milling	2	one juvenile	None	N	Saw surface several times and put flippers up briefly.	-41.6084	176.5062	-2820
102	2015-06-08T 23:06:21	New Zealand Fur Seal	0.4	Slow Travel	2	females or younger males	Other	N	Looked at ship a few times.	-41.6198	176.5180	-2940
103	2015-06-08T 23:11:11	New Zealand Fur Seal	0.13	Slow Travel	3	unknown	Other	N	Looking at boat occasionally and rolling around at surface.	-41.6234	176.5194	-2940
104	2015-06-08T 23:34:17	New Zealand Fur Seal	0.15	Slow Travel	1	unknown	None	N	Looking at boat, swimming slowly perpendicular to boat's heading -	-41.6466	176.5188	-2906
105	2015-06-08T 23:39:17	New Zealand Fur Seal	0.81	Resting	5	unknown	Run from Boat	N	group of 3 and group of 2 nearby each other. All resting, but then resighted porpoising away from ship.	-41.6529	176.5281	-2875

106	2015-06-09T 00:48:22	New Zealand Fur Seal	0.41	Resting	4 1 juvenile	Run from Boat	N	4 resting, then started to moderate-travel in same direction as ship when we were beside them (guns shut down when first seen), then slowly making their way away from us. Probably same sighting as before but don't know which one so made it a new sighting.	-41.5990	176.4951	-2820
107	2015-06-09T 01:18:57	New Zealand Fur Seal	0.4	Resting	2 unknown	None	N	Resting as the ship passed by.	-41.5775	176.4672	-1757
108	2015-06-09T 01:27:13	New Zealand Fur Seal	0.31	Resting	1 unknown	Other	N	Looked at ship. Swam parallel at slow pace for a bit, then away (90L) at slow pace.	-41.5710	176.4609	-1757
109	2015-06-09T 03:20:23	New Zealand Fur Seal	0.41	Milling	5 unknown	Unknown	N	Saw milling around and then at 90L moving quickly away from the ship. Only saw two at time of shutdown.	-41.5128	176.3643	-1903
109	2015-06-09T 03:22:38	New Zealand Fur Seal	0.52	Fast Travel	5 unknown	Run from Boat	N	PH got this resight and there are more than seen at shutdown time. Several stopped and looked back at ship.	-41.5145	176.3679	-1908
110	2015-06-09T 03:33:33	New Zealand Fur Seal	0.07	Fast Travel	1 unknown	Approach Boat	N	Saw one porpoising out of water heading towards stern of ship.	-41.5197	176.3507	-1905
111	2015-06-09T 03:45:07	New Zealand Fur Seal	0.1	Moderate Tra	2 unknown	Approach Boat	N		-41.5287	176.3386	-1908
112	2015-06-09T 03:48:54	New Zealand Fur Seal	0.03	Fast Travel	8 unknown	Run from Boat	N	Several times individuals in group stopped to rise high up and look at ship.	-41.5308	176.3344	-1917

113	2015-06-09T 03:58:37	New Zealand Fur Seal	0.15	Resting	1	unknown	None	N	flippers in the air. -	-41.5377	176.3228	-1927
113	2015-06-09T 04:07:38	New Zealand Fur Seal	0.58	Moderate Tra	1	unknown	Unknown	N		-41.5467	176.3181	-1984
114	2015-06-09T 04:16:08	New Zealand Fur Seal	0.25	Fast Travel	1	unknown	None	N	Animal kept pace beside the orange ball for several minutes	-41.5487	176.3033	-1974
115	2015-06-09T 04:35:31	New Zealand Fur Seal	0.1	Fast Travel	2	unknown	Unknown	N	Animals seen porpoising fast across the front of the ship, in no particular direction	-41.5584	176.2880	-1974
116	2015-06-10T 02:12:24	New Zealand Fur Seal	0.3	Resting	1	unknown	Unknown	N	Lost after entering sighting time in computer.	-41.6642	176.2089	-2056
117	2015-06-10T 02:22:59	New Zealand Fur Seal	0.4	Moderate Tra	1	unknown	Unknown	N	Saw animal porpoising away from ship and watched it until it cleared the 400-m zone. It stopped to look at the ship a couple times but otherwise kept moving away.	-41.6576	176.1993	-2062
118	2015-06-10T 21:36:51	New Zealand Fur Seal	0.05	Fast Travel	4	at least one juvenile	Run from Boat	Y	Saw one briefly at surface moving slowly, then suddenly they started to travel quickly, porpoising, away from the ship. At 90R and 10 ret (300m) when restarted guns.	-41.7305	175.8648	-2320

119	2015-06-10T 21:53:57	New Zealand Fur Seal	0.04	Milling	4 adult females	Run from Boat	Y	Saw them slowly milling at surface, then look at boat, mill some more, and finally move away 90R. Saw at 11 ret (250m) when the guns were turned back on.	-41.7467	175.8541	-2340
120	2015-06-11T 02:59:28	New Zealand Fur Seal	0.04	Other	1 adult female	Paralleling	N	Saw at stern and was very curious, it finally paralleled the course next to the starboard side, porpoising as it progressed towards the bow.	-41.7009	176.1458	-2053
121	2015-06-11T 03:11:29	New Zealand Fur Seal	0.04	Milling	1 unknown	Paralleling	N	Likely same as prior animal, still very curious about the ship.	-41.6972	176.1583	-2053
122	2015-06-14T 01:26:37	Unid Odontocete	1.86	Slow Travel	40 unknown	None	N	Hard to get a look with wave height today. Then we started traveling away from them. Saw them again traveling down wave towards us, but so brief look with lots of wave splashing. Could be dolphins. Could be pilot whales.	-41.5749	176.5220	-2180
123	2015-06-14T 01:56:09	New Zealand Fur Seal	0	Resting	1 unknown	Other	N	Animal's fins were straight up out of the water; it sank as we passed by and I didn't see it again.	-41.5179	176.6105	-2371
124	2015-06-14T 02:17:13	New Zealand Fur Seal	0.35	Resting	3 unknown	Run from Boat	N	Resting at surface, as we approached they looked at us and finally moved quickly away from us. Saw one porpoising.	-41.4845	176.6990	-2449

125	2015-06-14T 02:21:54	New Zealand Fur Seal	0.4	Diving	1 unknown	Unknown	N	Only saw a small bit of the back once.	-41.4760	176.7168	-2414
126	2015-06-14T 02:24:33	New Zealand Fur Seal	0.06	Resting	3 females	Parallelin g	N	Looked at ship then they porpoised a couple of times going the same direction as us when about parallel with bow, then didn't see them.	-41.4747	176.7249	-2414
127	2015-06-16T 01:07:53	Unid Pilot Whale	0.02	Moderate Tra	40 all types at least 3 juveniles seen	Approach Boat	N	They seemed interested in the ship.	-41.6080	176.5740	-2752