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U.S. Law of the Sea Cruise to Map the Southern Flank of the Kingman Reef-Palmyra Atoll section of the Line Islands, Equatorial Pacific Ocean

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CRUISE REPORT

RV *Kilo Moana*

U.S. Law of the Sea Cruise to Map the Southern Flank of the Kingman Reef-Palmyra Atoll section of the Line Islands, Equatorial Pacific Ocean

CRUISE KM1009

May 17, to June 16, 2010

Pago Pago, American Samoa to Honolulu, HI

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UNH-CCOM/JHC Technical Report 10-002

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Introduction

The cruise objective was to map the bathymetry of the southern flank of the Line Islands in the vicinity of Kingman Reef and Palmyra Atoll, central equatorial Pacific (Fig. 1) for the U.S. Extended Continental Shelf (ECS) Task Force. The exhaustive study of the U.S. data holdings pertinent to the formulation of U.S. potential claims of an extended continental shelf under the United Nations Convention of the Law of the Sea (UNCLOS) (Mayer, et al., 2002) identified this area as one of the regions where new bathymetric surveys are needed. The Mayer et al. (2002) report recommended that multibeam echosounder (MBES) data are needed to rigorously define (1) the foot of the slope (FoS), a parameter in the two UNCLOS-stipulated formula lines, and (2) the 2500-m isobath, a parameter in one of the UNCLOS-stipulated cutoff lines. Both of these parameters, the first one a precise geodetic isobath and the second one a geomorphic zone, are used to define an extended continental shelf claim. The Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) of the University of New Hampshire was directed by the U.S. Congress, through funding to the U.S. National Oceanic and Atmospheric Administration (NOAA) to conduct the new surveys and archive the resultant data.

This area of the Line Islands (Fig. 1) has had no previous systematic surveys and only 8 modern bathymetry lines cross the ridge in the area of interest. Consequently, the only guide for survey planning was the 2010 updated 1-arc minute predicted bathymetry dataset of Smith and Sandwell (1997) (http://topex.ucsd.edu/cgi-bin/get_data.cgi).

NOAA contracted through NSF-UNOLS (National Science Foundation University National Oceanographic Laboratory System) with the University of Hawai'i to use their 186-ft, 3060-ton RV *Kilo Moana* (Fig. 2), a SWATH (small water area twin hull) vessel with a newly installed hull-mounted Kongsberg EM122 MBES as well as a Knudsen 3260 B/R 3.5-kHz chirp sub-bottom profiler and a Carson gravimeter, for the mapping survey.

The UNH chief scientist was responsible for organizing and conducting the cruise, as well as collecting and processing the bathymetry, acoustic-backscatter and chirp sub-bottom data aboard ship. The University of Hawai'i was responsible for the post-cruise processing of the gravity data.

The cruise began with a one-day transit to Pago Pago, American Samoa because no fuel was available in Western Samoa. After fueling, a 4.5 day, 2250 km, transit from Pago Pago, American Samoa to a deep-water area within the survey region (Fig. 1). A full patch test, including a calibration of the XBT system with a CTD cast, was performed here. The next 22 days consisted of systematically mapping the southern flank of this area of the Line Islands. The cruise ended with 3.5 day 2000 km, 1800 km, transit to Honolulu, HI. The cruise mapped a total of 107,435 km^2 in 22 survey days and collected 9942 line km of MBES lines with an average speed of 11.6 knts. A summary of the cruises is given in Table 1.

Table 1. Cruise Statistics

Julian dates	JD137 to JD168
Dates	May 17 to June 16
Weather delays	0 days
Total non-mapping days (transits)	8 days
Total mapping days	22 days
Total area mapped	107,435 km^2 (41,481 mi^2)
Total line kilometers	9942 km (5369 nmi)
Beginning draft	7.62 m
Ending draft	7.13 m
Average ship speed for survey	11.0 kts

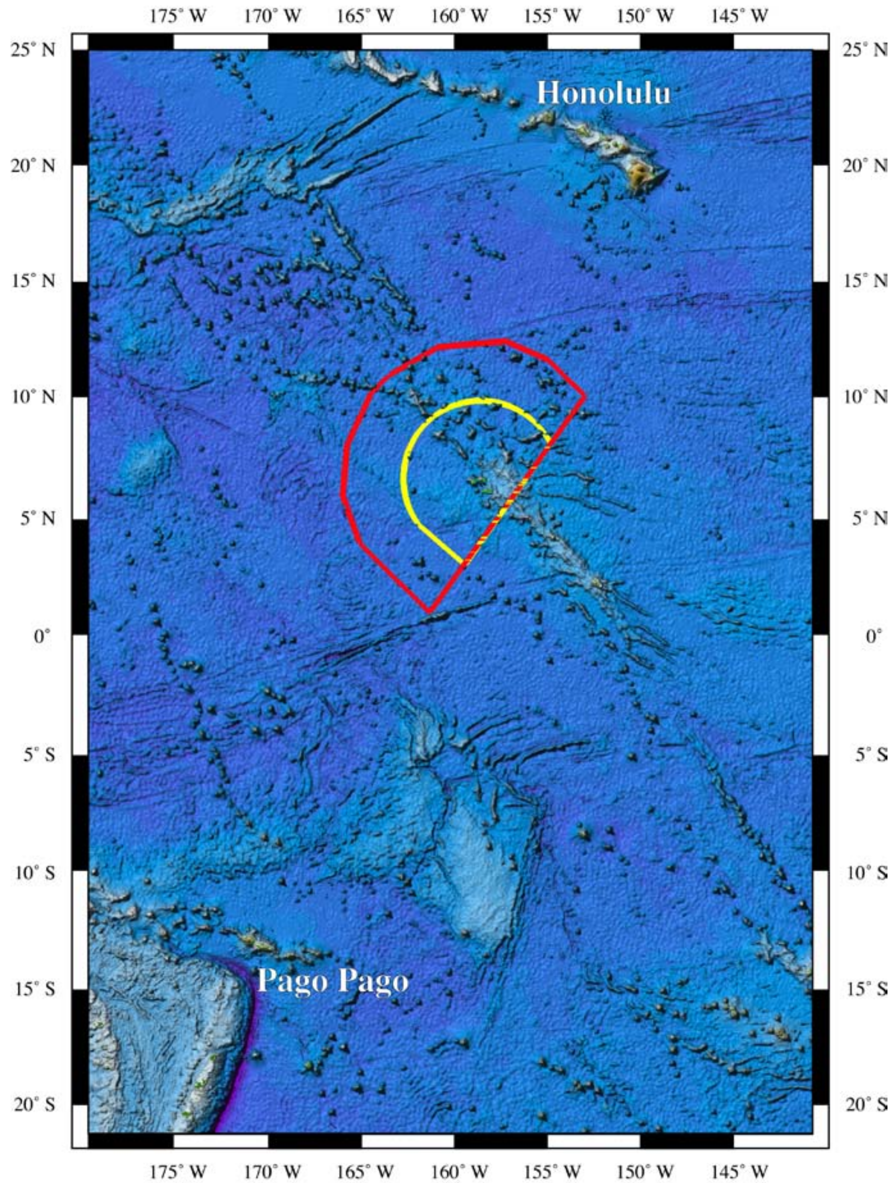

Figure 1. Location of eastern Kingman Reef-Palmyra Atoll area. Yellow polygon is U.S. EEZ and red polygon is 350 nmi from Kingman Reef.

Figure 2. RV *Kilo Moana* used to map the Kingman-Palmyra area.

The Multibeam Echosounder System and Associated Systems

The hull-mounted Kongsberg Maritime EM122 MBES system aboard RV *Kilo Moana* is a 12-kHz multibeam echosounder that transmits a ˚1wide (fore -aft) acoustic pulse and then generates 432-2˚ receive apertures (“beams”) over a 150˚ swath. The system can automatically adjust the pointing angles of the receive beams to maximize the achievable coverage or a maximum aperture can be defined by the operator. The transmit cycle can be rapidly duplicated to provide two swaths per ping, each transmitted with a small along-track offset that compensates for water depths and ship speed to generate a constant sounding spacing in the along-track direction. This mode can provide as many as 864 soundings per transmit cycle swath (432 soundings per swath) in the high-density dual-swath mode. With more than one sounding generated per beam in the high-density mode, the horizontal resolution is increased and is almost constant over the entire swath when run in the equidistant mode. In addition, the receive beams can be steered as much as 10° forward or aft to reduce the effects of specular reflection at nadir and near-nadir angles.

The EM122 uses both continuous wave (CW) and frequency modulation (FM) pulses with pulse compression on reception to increase the signal-to-noise ratio. The transmit pulse is split into several independently steered sectors to compensate for vessel yaw. The system is pitch, yaw and roll stabilized to compensate for vehicle motion during transmission. Kongsberg Maritime states that, at the 10-ms pulse length used during this survey (deep mode), the system is capable of depth accuracies of 0.3 to 0.5% of water depth. The Konsberg Maritime EM122 Product Description should be consulted for the full details of the MBES system.

A hull-mounted Applied Microsystems Ltd Smart SV&T sound-speed sensor (SN 4844) was used to measure the sound speed at the MBES array for accurate beam forming. The sensor was calibrated at the factory in January 2010. Beam forming during this cruise used the high-density equidistant mode with FM enabled and Automatic mode in deep water. For receive beams at near-normal incidence, the depth values are determined by center-of-gravity amplitude detection, but for most of the beams, the depth is determined by split-beam phase detection. The spacing of individual sounding is approximately every 50 m, regardless of survey speed.

An Applanix POS/MV model 320 version 4 inertial motion unit (IMU) (with TrueHeave) was interfaced to a NovAtel OEM2-3151R global positioning system (GPS) to provided position fixes with an accuracy of ~±5 m. The IMU provides roll, pitch and yaw at accuracies of better than 0.1˚ at 1 Hz. The TrueHeave component of the POS/MV version 4 virtually eliminates residual heave at the start of each line, thereby requiring only a 5-minute run-in for each line. The MBES system can incorporate transmit beam steering up to ±10˚ from vertical, roll compensation up to ±10˚ and can perform yaw corrections as well. All horizontal positions were georeferenced to the WGS84 ellipsoid and vertical referencing was to instantaneous sea level.

The Kongsberg Maritime EM122 is capable of simultaneously collecting full time-series acoustic backscatter that is co-registered with each bathymetric sounding. The full time-series backscatter is a time series of acoustic-backscatter values across each beam footprint on the seafloor. If the received amplitudes are properly calibrated to the outgoing signal strength, receiver gains, spherical spreading, and attenuation, then the corrected backscatter should provide clues as to the composition of the surficial seafloor. However, the interpreter must be cautious because the 12-kHz acoustic signal undoubtedly penetrates the seafloor to an unknown, but significant (meters) depth, thereby generating a received signal that is a function of some unknown combination of acoustic impedance, seafloor roughness and volume reverberation.

The derived sound-speed profiles were used to raytrace each MBES receive signal to the seafloor and back to the receiver to compensate for the refraction effects within the water column.

In addition to the MBES, the RV *Kilo Moana* is equipped with a Knudsen 3260 high-resolution CHIRP profiler and a Carson gravimeter. These data were continuously collected throughout the cruise.

The University of Hawai'i (UH) assigned the cruise designator *KM1009* to the cruise. All raw MBES files were initially labeled with a unique Kongsberg file designator but the files were renamed to KingmanPalmyra_line_X, where X is a consecutive line number starting with 1 (see Appendix 1). Transit lines and patch-test lines were given line numbers prefixed with "transit" or "patch". The renaming was done so that the individual lines would be unequivocally identified with the survey area.

Water-column sound-speed profiles were routinely collected every 6 hrs during the cruise as well as anytime the sound speed measured at the transducers differed by 0.5 m/s from the value at the transducer depth from the XBT-derived sound speed. Sound speeds were calculated from measurements of water temperature vs depth using Sippican Deep Blue expendable bathythermographs (XBTs). Deep Blue XBTs have a 760-m maximum depth of measurement so the profiles were extrapolated to 12,000 m to provide a profile throughout the water column. A Sea Bird Electronics model SBE-911+917+ CTD was used to calibrate the XBTs during the patch test. The two temperature sensors (serial no. 2013 and 2700), the conductivity sensor (serial no. 3326) and pressure sensor (serial number 92859) were last calibrated by Sea Bird Electronics on June 17, 2009. Derived sound-speed profiles derived from the two systems (CTD vs XBT) from data collected during the patch test were compared between the systems to calibrate the XBT (Fig. 3).

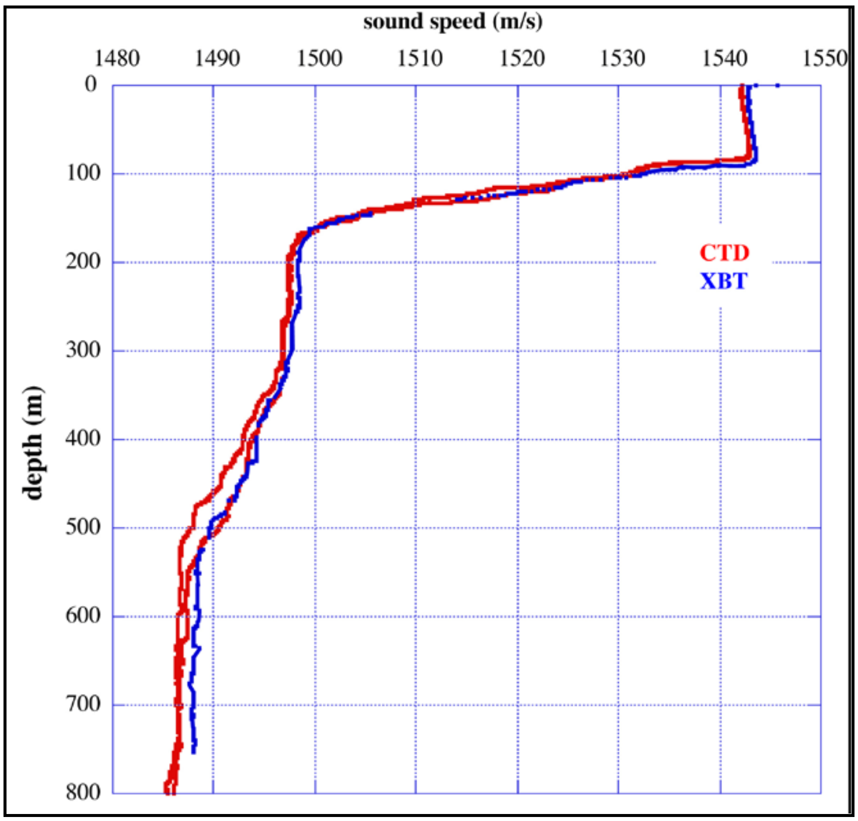

Figure 3. Comparison of sound speeds calculated from CTD (red) and XBT (blue).

A full patch test was conducted in the survey area to ensure sensor offsets were correct. Tables 2 and 3 show the sensor offsets used for the survey.

Table 2. Initial system sensor offsets

	Location Offsets			Angular Offsets		
Sensor	**Forward**	**Stbd**	**Down**	**Roll**	**Pitch**	**Heading**
POS 1	0.00	0.00	0.00	–	–	–
POS 2	0.00	0.00	0.00	–	–	–
POS 3	0.00	0.00	0.00	–	–	–
Tx tdr	-3.27	-0.053	0.803	-0.064	0.024	0.026
Rx tdr	1.156	-1.225	0.804	-0.092	0.044	0.046
Attitude 1	0.00	0.00	0.00	0.09	0.00	0.00
Attitude 2	0.00	0.00	0.00	0.00	0.00	0.00

Departure draft….7.9 m bow Final draft….7.16 m

Table 3. Offset corrections determined by Patch Test

Offset	Value
roll	-0.03°
pitch	0
yaw	0
latency	0

Ancillary Systems

Knudsen 3260 chirp subbottom profiler

A Knudsen 3260 chirp subbottom profiler was deployed throughout the cruise. The system is a hull-mounted 3.5-kHz system that produces an FM signal with a 1-kHz bandwidth. The system has adjustable pulse lengths, power and gain settings allowing it to acquire good bottom detection and subbottom resolution to about 50 m subbottom. The digital data were recorded in SEG-Y format and processed with Chesapeake Technologies, Inc. SonarWeb software. SEG-Y line names were synchronized with the MBES line names (Appendix 2) so that they correspond with one another.

Carson gravity meter

A Carson gravimeter (Carson Gravity Meter and Instrument Co. model 6300), a refurbished LaCoste-Romberg Model S-33 meter, was run on a hands-off basis, not to interfere with the MBES operations. A land tie was made at Pago Pago, American Samoa before the cruise and at Honolulu at the end of the cruise (see Appendix 3). Post-cruise processing of the gravity data will be done by the University of Hawai'i geophysics group.

MBES Data Processing

The raw multibeam bathymetry and acoustic backscatter data were processed aboard ship using the University of New Brunswick's SwathEd software suite, version 20091218. Each Kongsberg .all file was collected by the onboard Kongsberg SIS data-acquisition system. Once a line was completed, the .all file was copied to a server that could be accessed by the UNH computer via the shipboard network. Each .all file was renamed from the Kongsberg-generated file name to *KingmanPalmyra line_n.all* (see Appendix 1) so that later each file could be easily identified to the area. The line numbers commenced with KingmanPalmyra_line_tran1 for the transit to the map area and then commenced to KingmanPalmyra_line_33 when the actual mapping began. Each .all file is composed of individual data packets of beam bathymetry (range and angle), beam average and full time-series acoustic backscatter, navigation, parameters, sound-speed profiles, orientation and sound speed at the transducer. The first step in the processing separates each of these data packets into the individual files.

The second step in the processing plots the navigation file so that any bad fixes can be flagged. Once this step is completed, the validated navigation is merged with the bathymetry and acoustic backscatter files.

The third step involves editing (flagging) individual soundings that appear to be fliers, bad points, multipaths, etc. The entire file of soundings is viewed and edited in a sequence of steps through the file. Once the bathymetry file has been edited, the valid individual soundings are gridded into subarea DTM maps and the co-registered valid acoustic backscatter full beam time series is assembled into a file and gridded into subarea mosaics.

The entire region to be mapped was subdivided into 86 subarea bathymetry maps and (Fig. 4). Each subarea map was designed to maximize the spatial resolution allowed by the mapped water depths within the area.

The Area: the Central Section of the Line Islands Ridge

The area mapped during the Kingman-Palmyra cruise is limited on the southeast by the EEZ boundary between Kiribai and the U.S. (straight NE-SW red line in Fig. 1) and a 350-nmi-radius semicircle drawn from Palmyra Atoll. In order to satisfy the requirements of UNCLOS Article 76, the region between the ~1000 and 5000-m isobaths were mapped to provide the necessary bathymetry for the development of a potential U.S. extended continental shelf claim beyond the U.S. EEZ.

The general region is located in the central equatorial Pacific Ocean about midway between Samoa and Honolulu, HI (Fig. 1). The main physiographic feature is called the “Line Islands” or “Line Island chain” in the scientific literature but there are very few actual island on the feature in the section mapped. In fact, only Kingman Reef and Palmyra Atoll project above sea level within the area of U.S. UNCLOS interest. This report will call the main feature the *Line Island ridge* to distinguish it from the islands proper.

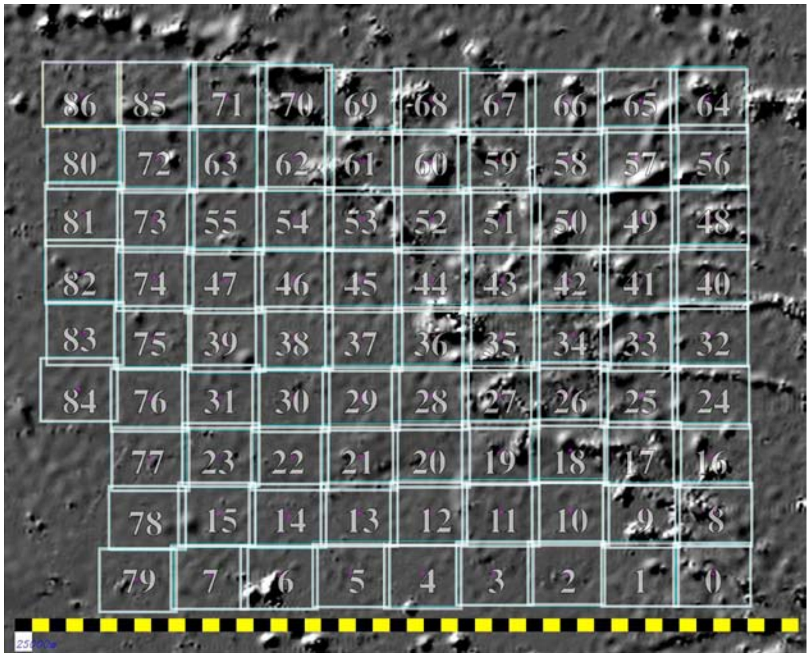

Figure 4. Eighty-six subarea maps.

The mapped area is roughly encompassed by the Clarion Fracture Zone on the north, the Clipperton Fracture Zone on the south, the western summit of the Line Island ridge on the east and the 350-nmi UNCLOS limit line on the west. Morphologically, the entire Line Island ridge extends >4000 km from the Tuamotu chain in the south to the Mid Pacific Mountains in the north with widely spaced, isolated seamounts and ridges. The main ridge has a remarkably consistent trend of 147 -327˚ throughout its length (Fig. 5), a feature that has generated widely differing interpretations of its origin (Morgan, 1972; Clague and Jarrard, 1973; Winterer et al., 1973; Jackson and Schlanger, 1976; Natland, 1976; Schlanger et al, 1976; Crough and Jarrard, 1981; Davis et al., 2002). Some authors, Morgan (1972) and summarized in Natland (1976), interpret the Line Island ridge as a hotspot trace with a younging to the south. Other authors, summarized in Davis et al. (2002), interpret the ridge as a huge buildup of volcanics that was constructed during two periods (86 to 81 Myr and 73 to 68 Myr) within a zone of lithospheric extension along pre-existing areas of weakness.

The Line Island ridge is composed of submarine volcanoes with a large range of chemistries, sizes and shapes (Davis, et al., 2002). The area of interest is the northern portion of the Line Island ridge, an area dominated by a huge broad ridge structure, as opposed to a chain of seamounts, composed of isolated and amalgamated seamount peaks that rises ~1500 m above the adjacent seafloor. This 170-km-long main ridge is ~225 km wide in the north and narrows to ~50 km wide in the south (out of the survey area) before it eventually disappears. Two chains of seamounts form the eastern and western margins of the main ridge summit and are separated by ~40 km in the south and ~100 km in the north of the survey area. The two ridges rise 500 to 1000 m above the ridge summit and both Kingman Reef and Palmyra Atoll lie along the western summit ridge. Water depths of the main ridge range from 2000 to 3000 m with isolated seamounts that rise to depth of less than 1000 m. Winterer (1976) subdivided the Line Island ridge into a Northern, Central and Island Province, each with its distinct gross morphology. The Kingman-Palmyra area spans the boundary of the southern part of Winterer's Central Province and northern part of Winterer's Island Province.

Two prominent cross chains of seamounts intersect this area of the Line Island ridge from the east on trends that range from 005˚ to 010˚. The cross chain trends meet the Line Island ridge with angles of 38˚ to 43˚.

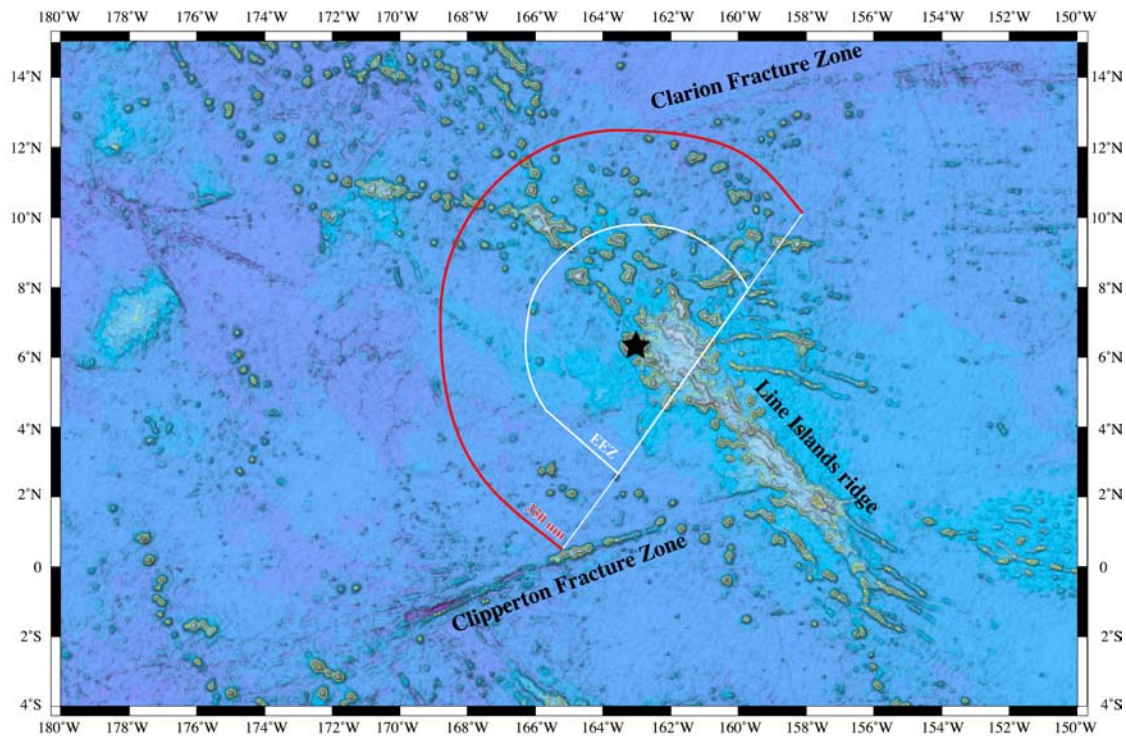

Figure 5. Overview map of physiographic features in Kingman Reef-Palmyra area. White semicircle is U.S. EEZ; red semicircle is 350 nmi limit from Palmyra Atoll (black star).

Daily Log

JD 133 (Thursday, May 13, 2010)

We performed a gravity land tie at the Apia pier (see Appendix 5), after some effort figuring out how to use the land meter. The folks at the University of Hawai'i helped with numerous phone calls. However, a search for the Apia Observatory gravity base station proved fruitless. The geophysist at the Department of Natural Resources at the Apia Observatory had no idea where the base station is located, although he suggested the base station might be on a pier. Strangely, there is no pier at the Apia Observatory. We located three concrete blocks; one standing 1 m high on the seawall with no markings, one in the lawn with a rusted pipe standing vertically in the middle of it, again with no markings and a third concrete block sitting half buried and tilted on its side on the beach. None of these looked promising, so we left without a base station reading in Apia.

A BIST test was performed on the Kongsberg EM122 in the afternoon and it passed all tests (see BIST test results Apia Harbor dock, Appendix 6).

The Captain informed us in the afternoon that the repair work on engine No. 2 failed and the engine had to be completely rebuilt. Both the engineers that arrived for the port repairs and the ship's engineers were exhausted and one had been severely injured during the repairs. The Captain estimated that the repair work would be complete by Sunday afternoon or evening. This meant that the ship would sail for American Samoa no earlier than Monday morning, it would fuel in Pago-Pago, American Samoa on Monday evening and we would begin the transit to the survey area no earlier than Tuesday morning. This is the best-case scenario.

JD 134 (Friday, May 14, 2010)

The day was spent tied up alongside the main pier in Apia, Samoa, as before while the engineers continued to rebuild the No. 2 engine. The Captain's assessment at breakfast was that the engine repairs should be complete by the evening, and that testing would be possible early on Saturday with possible departure Saturday evening should they be successful. The primary difficulty was then likely to be getting fuel in Pago Pago, American Samoa because our delayed departure caused us to lose our slot in the queue at the fuel dock.

JD 135 (Saturday, May 15, 2010)

Testing of No. 2 engine continued during the morning. The Captain informed us, around 1030L, that No. 2 blew a fuel injector as soon as it was lit off. Once the injector was replaced, the Captain wanted to get underway this evening for Pago Pago, American Samoa and wait outside the harbor for a "chance" of fueling on Sunday, realizing that Sundays typically are a day when everything is closed in American Samoa.

We finally got underway from Apia at 0313 UTC (1613L) and began the transit to Pago Pago, American Samoa. We ran the EM122 and Knudsen 3260 subbottom profiler to adjust settings and familiarize the watchstanders with the systems but did not stand at-sea watches because of the anticipated 2-day anchor in Pago Pago.

JD 136 (Sunday, May 16, 2010)

We arrived off the SW corner of American Samoa during the night and waited for space at the dock. We were tied up to the Pago Pago cargo dock by 1230L where we spent the night.

A gravity land-tie was made at the pier and then at the base station, which is ~40 km outside of town, was measured.

JD 137 (Monday, May 17, 2010)

Fueling was completed and we were underway at 1545L (138/0245 UTC). The draft after fueling was 7.62 m (Fig. 6). We steamed out of Pago Pago and began the long transit to the patch-test site. Recordings of EM122 and Knudsen 3260 data were started once in ~100 m water depths at 1635L.

Figure 6. Draft (in feet) after fueling in Pago Pago, American Samoa.

JD 138 (Tuesday, May 18, 2010)

Continued the transit to the work area. Knudsen SEGY output lines have been out of synch with the EM122 line numbers so the SEGY lines were renumbered to correspond to the EM122 line numbers. It appears that Knudsen SEGY line numbers change at random intervals, and appends longer and longer filenames over time. Consequently, we constructed lines tran5a-tran5d to match the EM122 line tran5, then stopped automatic line number incrementation on the Knudsen and manually set the line number to tran6.

At 1622 UTC: SIS flashed warning of position missing; no evidence that POS/MV was bad, or other warning signs; system appeared to recover without loss.

The weather was hot and the seas were calm; perfect weather for mapping. In 5200+ m water depth, the EM122 was achieving ~2.2 x water depth, although at times it would get as much as 3 x water depth. Forcing the EM122 mode to stay in Deep mode seemed to keep the widest swath. The data have two noticeable artifacts. In flat seafloor areas, there is a pronounced negative nadir (Fig. 7). The second artifact is a large increase in depth scatter that appears to occur at one of the sector boundaries on both port and starboard sides Although the scatter can be flagged during editing, any actual seafloor relief is potentially compromised by the large range of depth scatter (Fig. 8). The depth scatter starts at ±31˚ from nadir.

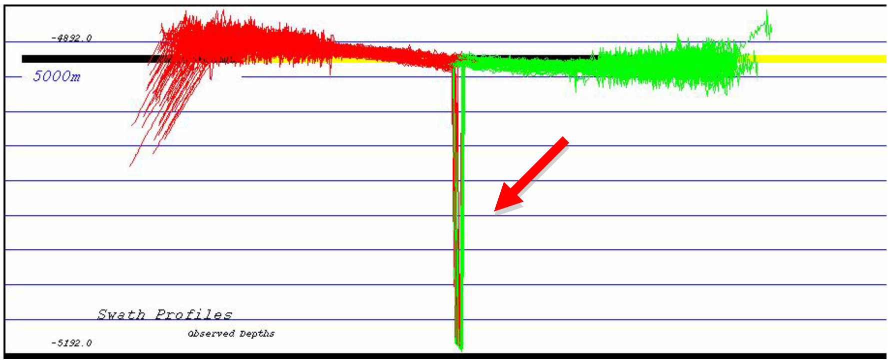

Figure 7. Sixty pings of Line tran5 on flat seafloor in 4900 m water depth. Red arrow points to pronounced nadir artifact.

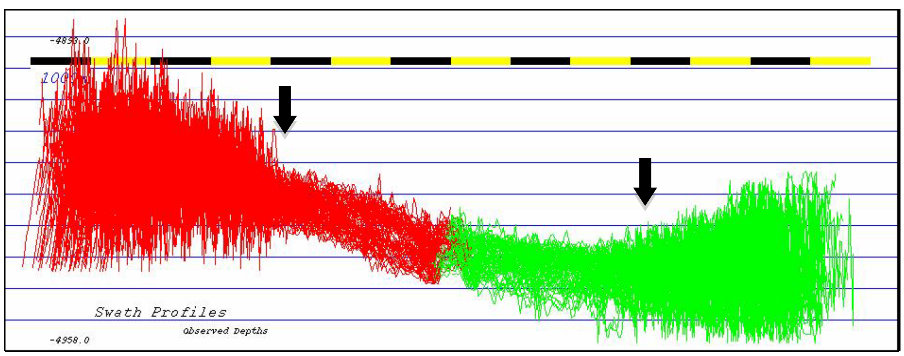

Figure 8. Line tran5 showing a pronounced increase in sounding scatter possibly correlated with one of the sector boundary (black arrows).

At 139/0130 UTC we saw that the nadir area and the entire port side on the EM122 lost bottom detection. This lasted for about 5 minutes and then the nadir and port side reacquired bottom detection but then the starboard side lost bottom detection. No noise appeared on Knudsen record. The engineers were quizzed to see what fuel pumps may have been just turned on, but found that the fuel pumps had been working all morning and nothing had changed in the past 30 minutes. The deck crew was needle gunning but we had previously run a test of needle gunning on the main deck and saw no noise on the Knudsen record. About 10 minutes after bottom detection was regained, the same thing happened again. Then everything settled down and the EM122 performed as it had been all day.

At 0235 UTC, the KVM switch that controls the monitor that shows the SIS and Knudsen died. A keyboard and mouse had to be directly connected to the SIS computer and another mouse had to be connected to the Knudsen box.

A full BIST test (km1009_transit_11knts_fullBIST.txt; see Appendix 6) was run at 0600 UTC at the end of Line_tran8 to record noise levels, etc. while underway. The Knudsen 3260 was stopped for the test.

JD 139 (Wednesday, May 19, 2010)

Continued the transit to the work area. A perfect day for mapping; calm seas and gentle breezes. All systems running and collecting high-quality data.

JD 140 (Thursday, May 20, 2010)

Continued the transit to the work area. At 1503 UTC, the EM122 flashed a warning light for the time synchronization portion of the real-time numeric display. The warning disappeared within 1 s, but the time difference between the Processing Unit (PU) and the incoming time string (ZDA from the POS/MV motion sensor increased immediately to ~60 (units not specified, presumably seconds) and then slowly decreased to ~1 (normal operation) over the next half hour. The message service log indicated that the system had noted the absence of an expected ZDA string on the COM1 input (from the POS/MV), which presumably caused the difficulty. No other effects were evident, and the log showed that this had been happening at irregular intervals over the last several days; inquiries with the UH technicians indicated that this has been happening ever since the installation of the EM122 in January 2010. Messages about GGA strings missing on COM1 were also observed at about the same intervals.

The installation parameters for the EM122 and the most recent wiring diagram shows that the system receives its attitude data at 19200 baud from a BlackBox data distributor rather than the POS/MV itself. (This is done so that both EM1002 and EM122 can receive the same data.) Therefore, it is unclear whether the problem is the POS/MV dropping data because of data-rate issues, the BlackBox data repeater dropping and/or mangling data packets for similar reasons, a communications problem on the line (e.g., bad connections) or the EM122 is dropping packets because of processor load internally (PU load was reported as 5/6 (no units given) at the time).

A series of emails with Knudsen suggested we collect the Knudsen subbottom data in SEG-Y “detected” mode. This mode takes the envelope of data at the orignal signal sampling rate prior to a resampling to a fixed 1600 samples (a requirement for the KEB format not used here). This “detected” SEG-Y format greatly improved the processed Knudsen data.

We crossed over the equator at almost exactly 0010 L (JD 141 1110 UTC).

JD 141 (Friday, May 21, 2010)

Weather and seas calm. All systems performing well. We surveyed an area for a potential patch-test site (Line_tran22) and found a suitable area for the CTD-XBT intercalibration and the pitch test. The Knudsen was secured and we turned around and returned to the CTD-XBT site (Line_tran23). We arrived at the patch-test site, hove-to and deployed the CTD in 5300 m water depth at 2350 UTC (1250 L). The CTD was deployed to 5000 m and was back on deck at 0445 UTC (1745 L). Data were recorded both descending and ascending. Once the CTD was on the deck, a Deep Blue XBT (number TD_00548; Table 6) was launched for a comparison of the derived sound speeds from the two different sensors (Fig. 3). The comparison shows that the sound speed calculated from the XBT closely follows sound speed calculated from the CTD, especially in the upper 400 m. Consequently, the XBTs were deemed reliable for calculating sound speed.

The pitch, timing and yaw parts of the patch showed no offset corrections were necessary. The roll test (Lines patch27 and patch28) showed a -0.03˚ roll error so that value was applied to the receiver installation parameters and the roll test was rerun (Lines patch 29 and patch30) to confirm the correction. The rerun confirmed our offset correction.

Line 33 commenced the dipline of the survey running the EM122 multibeam echosounder and the Knudsen 3260 subbottom profiler.

JD 142 (Saturday, May 22, 2010)

The day was overcast and breeze but the seas were only ~5 ft. All systems performing well. An email from John Hughes Clarke suggested we go into the terminal of the EM122 and type >detectmode = 0 to turn off the latest bottom-detection algorithm, which appeared to be causing some mistracking difficulties on other systems. The command was implemented but we saw no difference in the 5300 m depths we were in. The swath was also forced to ±65˚ to cut down on the ragged outer beams.

JD143 (Sunday, May 23 2010)

The ship was forced to slow down to ~8 knts at 1545 UTC in order for Engineering to check systems; returned to 12 knts at 1600 UTC. The dipline was completed on Line 38. Lines 39, 40 and 40a were run to the SE to the start of the first long E-W line (Line 43). There are no Lines 41 and 42 so as to get the line numbers of the EM122 and Knudsen back in sync with one another.

The weather was warm and cloudy (Fig. 9) with brisk 15-knt winds and a lumpy 7 to 8 ft sea but the data quality remained high. Our position placed us directly under the Intertropical Convergence Zone. By early afternoon it was raining.

The SIS had to be rebooted at 1330 L because the SVP editor would not start up. The reboot fixed the problem.

JD144 (Monday, 24 May, 2010)

At the 1800 UTC XBT cast, the SIS system again refused to start the SVP editor on command from the CCU process. (The CCU process catches the SSP being sent from the ship’s computers and is meant to start the SVP editor automatically.) An email was sent by UH/OTG technicians to Kongsberg to inquire as to the possible causes of this difficulty, and local troubleshooting was attempted to determine if the SVP editor could be started by hand. This did not appear possible; however, at 1920 UTC, without further ntervention, the system did restart the SVP editor and was able to have the SSP updated in the system.

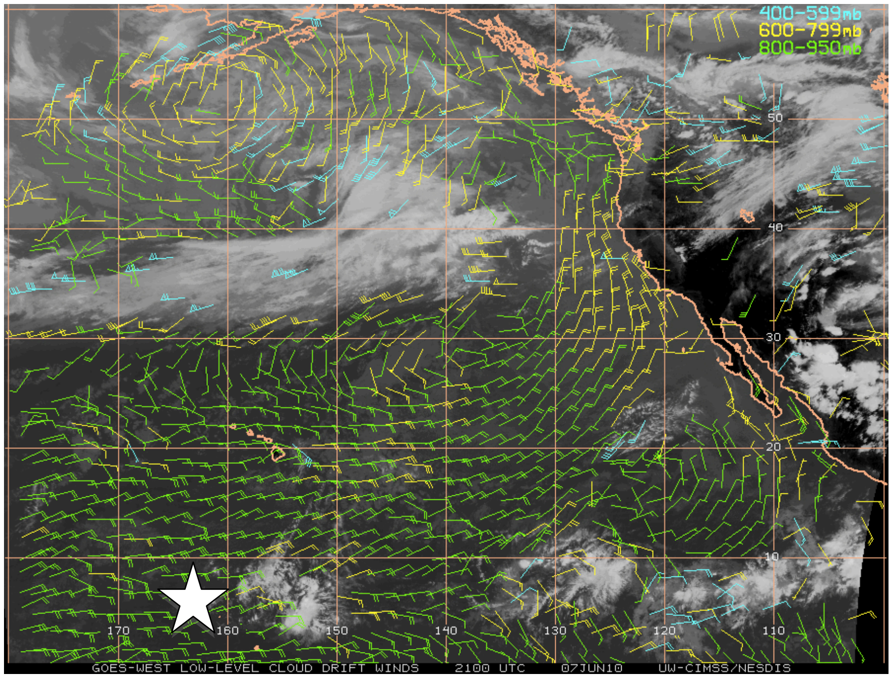

Figure 9. Satellite infrared image with lower level winds for day JD144 (Sunday May 23. Green wind arrows are for 850 mbar (1500 m altitude). White star is ship position.

A cross-check analysis was performed on the dipline (Line 40a) versus Line 44. The results show that the depth precision of the EM122 at this crossing is 0.95% of water depth (2σ) (Appendix 7). The analysis used 995,906 sounding comparisons to produce a mean difference of 1.6 m ±18.25 σ.

The day was bright with 7 to 9 ft swells and 20 knt winds. The data quality was excellent on both the multibeam and Knudsen subbottom profiler. By early afternoon (local), a large section of flat seafloor had been mapped. The single line was analyzed and found to have a pronounced “wobble” to the data (Fig. 10). The “wobble has an amplitude of 5 to 10 m with a wavelength of ~300 m, the distance the ship travels at 12 knts in ~8 min. This is much longer than the roll period of the ship. The cause of the wobble appears related to the wide scatter of soundings beyond the boundary of the inner-beams sectors and the outer-beam sectors shown on Figure 10). The wide scatter of soundings occurs regardless of whether the FM mode is on or off.

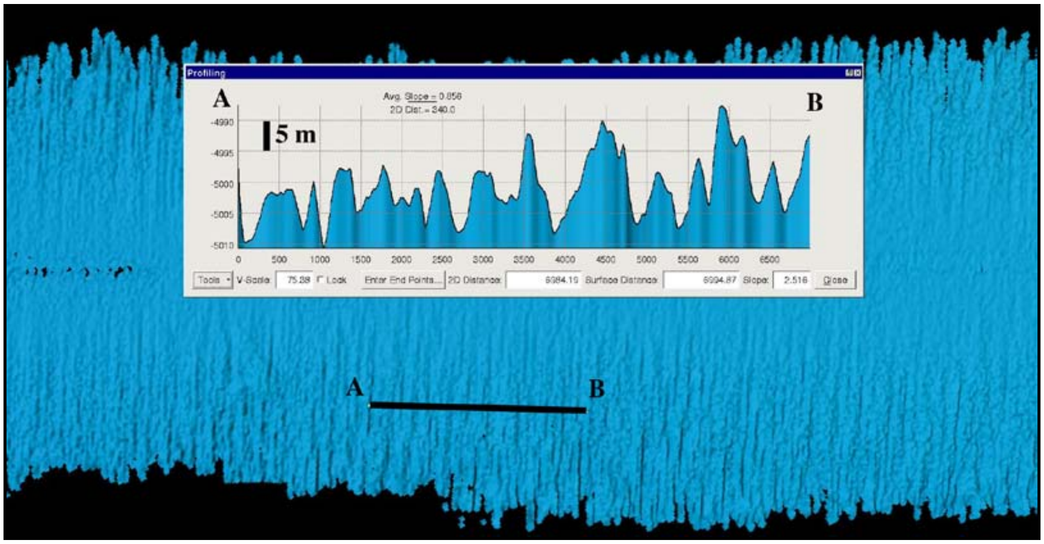

Figure 10. Plan view of DTM showing "wobbles" on Line 46. Profile A-B is shown in insert. The amplitude of the "wobbles" is 5 to 10 m and the wavelength is ~300 m.

At 145 0823 UTC, the bridge was entering the next waypoints into the bridge computer and they mistyped a coordinate. The ship immediately changed course for the mistyped coordinate. The bridge quickly realized the error and they reentered the proper coordinate. The ship then returned to the original line. The entire episode lasted about 5 minutes.

JD 145 (Tuesday, May 25, 2010)

We reached the end of the first east-west line at 1301 UTC, line 49. We stopped logging data and pinging and rebooted the SIS computer. The ship held 10 knts to provide a little extra time in order to ensure that any potential problems that may have led to the SVP editor issues encountered previously were reset. The system rebooted cleanly, and we restarted mapping Line 50 at 1352 UTC, heading 120˚.

The morning was partly sunny, warm with 20 knt winds and 7 to 9 ft swells. The afternoon evening brought torrential rain and lumpy seas. Weather maps show we are mapping within the Intertropical Convergence Zone. Data quality is high despite the conditions.

JD 146 (Wednesday, May 26, 2010)

The day was cloudy, rather cool with 15 knt winds ad 7 to 8 ft seas. All systems performing fine. Routine day of mapping.

Line 55 crossed the dipline and a cross-check analysis (Appendix 7) shows that the system is continuing to achieve a precision of 1.9% of water depth at 2σ (mean Δ = 2.2 m, σ = ±22.5 m, n = 101,998 soundings), even though the crossing is in very rough bathymetry.

At 1230 L, we closed to within ~8 km of Palmyra Atoll on a short line transit to the beginning of Line 57. All we could see was a low-lying, rather flat-topped, jungle-covered lump on the horizon.

JD 147 (Thursday, May 27, 2010)

We started seeing a lot of beam dropouts while mapping in 5080 m depths. Most of the dropouts were in the nadir and near-nadir sectors, although some of the outer-sector beams also lost bottom detection. The system was forced into Very Deep mode and this cleared up the bottom-detection problem, but we were curious why we suddenly had this problem whereas it did not occur on the previous long line in these water depths. We eventually tracked the problem down to needle-gunning operations on the port hull; the hull where the EM122 transducers are installed. We requested to the Captain that all needle gunning on the port hull be terminated for the duration of the cruise. Once the needle gunning ceased, the problem went away.

The day was overcast to partly sunny, warm and breezy with winds of 20 knts and seas of 7 to 8 ft. All systems collecting high-quality data.

JD 148 (Friday, May 28, 2010)

Routine day of mapping. Weather holding clear, winds 15-20 knts and swells 6-8 ft. Data continues to be high quality. There was an unexplained ~+2 dB shift in average backscatter value across the entire swath of Line 63 (Fig. 11). No gains, filters, etc. were altered during the recording of that line.

Figure 11. Mosaic showing Line 63 (most southerly line) overlapping Line 60. Line 63 has a +3 dB shift in average backscatter values relative to Line 60.

JD 149 (Saturday, May 29, 2010)

The day was overcast and drizzly. Swells were 6-7 ft and winds of 8-10 knts. Routine day of mapping with all systems producing high-quality data. A cross-check analysis was performed on Line 67 vs the dipline. The analysis consisted of 81,691 soundings at a mean water depth of 3357.6 m and showed an astonishing mean difference Δ = 0.1 m (σ =±23.1 m), giving a precision of 2.6% of water depth at 2σ (Appendices 7).

The wind picked up to 30 knts, with gusts to 40 knts, in the evening. There was some ship motion but the data did not suffer.

JD 150 (Sunday, May 30, 2010)

The day was partly cloudy but calm with winds of 10 to 15 knts and swells of ~8 ft. Routine day of mapping with all systems collecting high-quality data. At 0610 UTC, the POS/MV lost GAMS and the heading light on the console turned red. A bird was found sitting on one of the POS/MV satellite antennas. The bird was harassed away from the antenna and the POS/MV reset back to normal. The ship maintained a steady course throughout the 15 minute "bird" episode.

JD 151 (Monday, May 31, 2010)

Routine day of mapping. The day was clear but windy with 20 knt winds and 9-10 ft swells. Although there was quite a lot of ship motion, the MBES data quality remained high but the Knudsen subbottom data quality suffered.

JD 152 (Tuesday, June 1, 2010)

Routine day of mapping. The day was rainy with 20 knt winds and 7-9 ft seas.

JD 153 (Wednesday, June 2, 2010)

Routine day of mapping. The day was sunny in the morning and showers in the afternoon and evening with 15 knt winds and 6-8 ft swells.

JD 154 (Thursday, June 3, 2010)

Routine day of mapping. The day was overcast with showers. Wind was blowing 20 to 18 knts and 6-8 ft lumpy seas. The SIS computer and SIS software were rebooted at the end of Line 93 as a precaution against slowed performance.

Throughout the mapping a pronounced "nadir trough" has been evident in data that varies from 2 to ~ 8 m deep (Fig. 12) while mapping in pelagic sediments of the flat deep-ocean floor, both during the editing of the data as well as in the processed DTM. One hypothesis is that the trough is caused by the bottom detection at nadir and near nadir is from the acoustic wave that has penetrated the low-impedance pelagic sediments. The penetration filter had been set to "off" throughout the mapping. To test this hypothesis, the filter was changed to "medium" during Line 95, but there was little change in the trough. However, near-nadir "Eric's horns"-type artifacts appeared on either side of nadir when the penetration filter was on (Fig. 13). Consequently, the penetration filter was turned off.

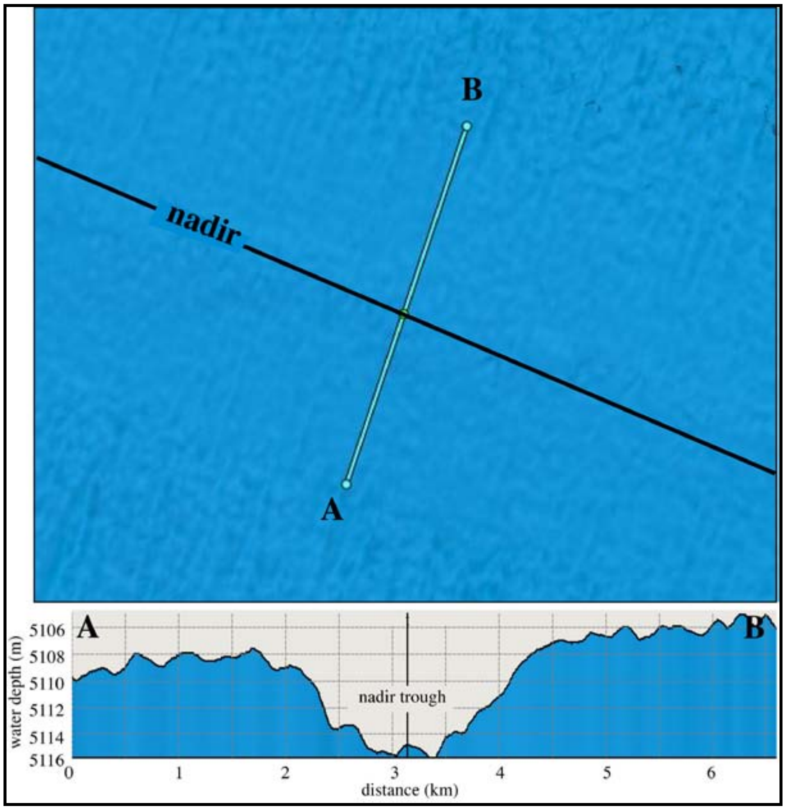

Figure 12. (upper) map view of Line 94 DTM on flat deep-ocean floor. (lower) The nadir trough appear as an anomalously low zone ± 1 km on either side of nadir.

JD 155 (Friday, June 4, 2010)

Routine day of mapping. The day was sunny, warm with 15 knt breezes and a 5-7 ft sea. The multibeam collecting high-quality data. The Knudsen chirp subbottom profiler continued to puzzle us as to the proper setting for this environment. Nothing seems to improve a somewhat poor record.

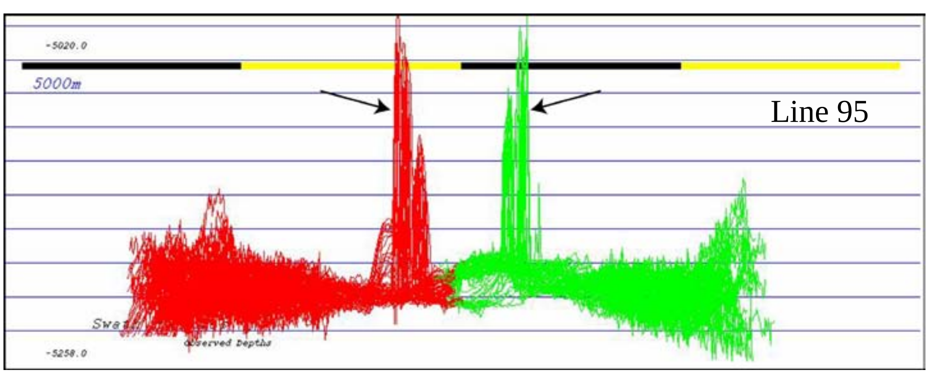

Figure 13. "Eric's horns"-type artifacts (arrows) generated by turning on the penetration filter.

JD 156 (Saturday, June 5, 2010)

The day was overcast, showery with 15 knt winds and 5-7 ft swells. Routine day of mapping. The SIS gridding engine died about noon (local time), losing from the screen all the gridded DTM up to now. However, present data are showing up. We decided not to do anything until the end of the line, which will be tomorrow. The lack of the previous DTM will not hamper us in plotting the next line and, because we are already in the deep basin, overlap is not an issue.

JD 157 (Sunday, June 6, 2010)

Around 1245 UTC, the EM122 stopped pinging, but the auxiliary displays on the data capture system continued to update as normal: the system appeared to be operating correctly and did not flash any warning indicators. Line 105 was aborted, and we then rebooted the SIS computer, the EM122 transceiver, and finally the SIS computer again in order to recover functionality; meanwhile, the ship back-tracked a little way to minimize loss of data coverage. The reboots also resolved the gridding engine problem discussed yesterday, although of course the grid did not contain the coverage plot since the time that the real-time gridding engine crashed.

The day was cloudy, drizzly with 15 knt winds and 5-7 ft swells. Data quality remained high.

JD 158 (Monday, June 7, 2010)

Routine day of mapping. The day was calm and bright with 5-7 ft swells. The noisy outer sectors and the extremely noisy port array really show up on the flat ocean floor in 5000+ m water depths (Fig. 14).

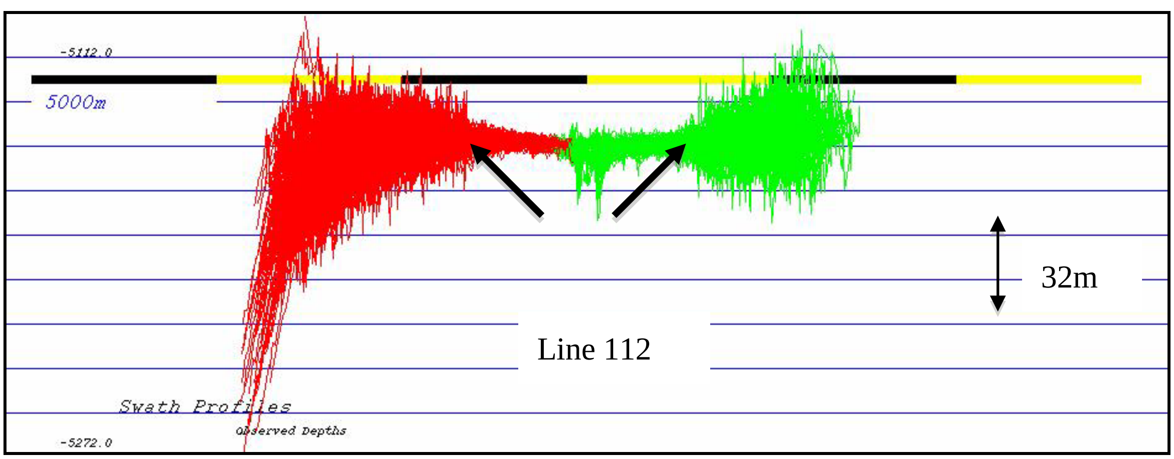

Figure 14. Unedited Line 112 showing typical very noisy outer sectors. Note very noisy port side (red).

JD 159 (Tuesday, June 8, 2010)

Routine day of mapping. Weather is cloudy, rainy and cool. Winds at 16 knts and swells 6-8 ft. The wind increased to 25 knts in the evening. All systems collecting high-quality data. The SIS and EM122 computers were rebooted at the end of Line 115 for preventative maintenance sake.

At 1830 L the satellite receiver failed that is used for email, etc. There is no connection between the communications satellite transceiver and the survey system, however.

JD 160 (Wednesday, June 9, 2010)

Satellite service resumed ~0030 L after a reboot of the gimbaled platform. Routine day of mapping under cloudy skies with 15 knt winds and 5-7 ft swells.

JD 161 (Thursday, June 10, 2010)

Routine day of mapping. The day was sunny with 10 knt breezes and a 5-7 ft swell. Multibeam collecting high-quality data; Knudsen struggling with 5000+ m depths.

JD 162 (Friday, June 11, 2010)

Routine day of mapping. The morning was overcast and drizzly with calm winds and 5-7 ft swells but the sun came out in the afternoon. Line 128 completed the long E-W lines and started filling in the large holidays in the area south of Palmyra Atoll as time permits before beginning the transit to Honolulu.

JD 163 (Saturday, June 12, 2010)

Routine day of mapping. The day was spent filling in holidays in the area south of Palmyra Atoll. The day was cloudy, rainy with calm winds and 5-7 ft swells. The mapping was completed an hour into Line 135 at 1030 UTC (2330 L) and we commenced the transit to Honolulu with Line tran136 collecting multibeam, subbottom profiler and gravity data. XBTs were cast during the transit only when sound speeds varied by more than 2 m/s for at least 5 minutes.

JD 164 (Sunday, June 13, 2010)

Transiting to Honolulu. All systems collecting data. Logging of the Knudsen profiler was stopped during Line tran139 because of poor-quality data in 5000+ m water depths. Eventually, a sufficient quality of data was produced to start recording again on Line 140.

JD 165 (Monday, June 14, 2010)

Transiting to Honolulu. All systems collecting data.

JD 166 (Tuesday, June 15, 2010)

Transiting to Honolulu. All systems collecting data.

JD 167 (Wednesday, June 16, 2010)

Transiting to Honolulu. Multibeam and Knudsen subbottom secured at 0800 L (1800 UTC). Arrived at the University of Hawai'i Snug Harbor dock at 1130 L (2130 UTC).

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Table 4. Cruise Personnel

Dr. James V. Gardner	UNH Chief Scientist
Dr. Brian R. Calder	UNH Co-Chief Scientist
Capt. Richard (Rick) Meyer	Ship's Master
Mr. Kahio Vellalos	UH Party Chief
Mr. Victor Polidoro	UH Technician
Mr. David Armstrong	UNH Watchstander
Mr. Brian O'Donnell	UNH Watchstander
Mr. Elliot Lim	NOAA Watchstander
Mr. Evan McQuinn	NOAA Watchstander

Appendix 1. Conversion table of Kongsberg SIS-assigned .all file names to UNH file names by Julian Day

JD	Data Folder	Kongsberg file name KM.all	UNH file name .all	Notes
136	**100516**	**0001_20100516_043731**	**KingmanPalmyra_line_tran1**	Apia to Pago Pago
		0002_20100516_051008	KingmanPalmyra_line_tran2	Apia to Pago Pago
		0003_20100516_071008	KingmanPalmyra_line_tran3	Apia to Pago Pago
138	**100518**	**0004_20100518_033631**	**KingmanPalmyra_line_tran4**	**Pago Pago to area**
		0005_20100518_060149	KingmanPalmyra_line_tran5	Pago Pago to area
		0006_20100518_120237	KingmanPalmyra_line_tran6	Pago Pago to area
		0007_20100518_180042	KingmanPalmyra_line_tran7	Pago Pago to area
139	**100519**	**0008_20100519_000014**	**KingmanPalmyra_line_tran8**	**Pago Pago to area**
		No line tran9	No line tran9	
		0010_20100519_061221	KingmanPalmyra_line_tran10	Pago Pago to area
		0011_20100519_120200	KingmanPalmyra_line_tran11	Pago Pago to area
		0012_20100519_180016	KingmanPalmyra_line_tran12	Pago Pago to area
140	**100520**	**0013_20100520_000021**	**KingmanPalmyra_line_tran13**	**Pago Pago to area**
		0014_20100520_060004	KingmanPalmyra_line_tran14	Pago Pago to area
		0015_20100520_121136	KingmanPalmyra_line_tran15	Pago Pago to area
		0016_20100520_180044	KingmanPalmyra_line_tran16	Pago Pago to area
		0017_20100520_234424	KingmanPalmyra_line_tran17	Pago Pago to area
141	**100521**	**0018_20100521_000017**	**KingmanPalmyra_line_tran18**	**Pago Pago to area**
		0019_20100521_060014	KingmanPalmyra_line_tran19	Pago Pago to area
		0020_20100521_102202	KingmanPalmyra_line_tran20	Pago Pago to area
		0021_20100521_140004	KingmanPalmyra_line_tran21	Pago Pago to area
		0022_20100521_180014	KingmanPalmyra_line_tran22	Pago Pago to area
		0023_20100521_223908	KingmanPalmyra_line_tran23	survey patch test site
142	**100522**	**0024_20100522_065043**	**KingmanPalmyra_line_patch24**	**patch test**
		0025_20100522_073708	KingmanPalmyra_line_patch25	patch test
		0026_20100522_082552	KingmanPalmyra_line_patch26	patch test
		0027_20100522_094057	KingmanPalmyra_line_patch27	patch test
		0028_20100522_101922	KingmanPalmyra_line_patch28	patch test
		0029_20100522_113014	KingmanPalmyra_line_patch29	patch test
		0030_20100522_121336	KingmanPalmyra_line_patch30	patch test
		0031_20100522_131444	KingmanPalymra_line_patch31	patch test
		0032_20100522_142421	KingmanPalymra_line_patch32	patch test
		0033_20100522_150849	KingmanPalymra_line_33	dipline
		0034_20100522_200015	KingmanPalymra_line_34	dipline
143	**100523**	**0035_20100523_000305**	**KingmanPalymra_line_35**	**dipline**
		0036_20100523_060418	KingmanPalmyra_line_36	dipline
		0037_20100523_120014	KingmanPalmyra_line_37	dipline
		0038_20100523_180014	KingmanPalmyra_line_38	dipline (end)
		0039_20100523_185709	KingmanPalmyra_line_39	traverse
JD	**Data**	**Kongsberg file name**	**UNH file name**	**Notes**

	Folder	**KM.all**	**.all**	
144	**100524**	**0040_20100524_000035**	**KingmanPalmyra_line_40**	**traverse**
		0040a_20100524_002240	KingmanPalmyra_line_40a	traverse
			No line 41	
			No line 42	
		0043_20100524_014955	KingmanPalmyra_line_43	1st E-W line
		0044_20100524_060013	KingmanPalmyra_line_44	1st E-W line
		0045_20100524_120009	KingmanPalmyra_line_45	1st E-W line
		0046_20100524_180027	KingmanPalmyra_line_46	1st E-W line
		0047_20100525_000001	KingmanPalmyra_line_47	1st E-W line
145	**100525**	**0048_20100525_060044**	**KingmanPalmyra_line_48**	**1st E-W line**
		0049_20100525_120020	KingmanPalmyra_line_49	1st E-W line
		0050_20100525_135215	KingmanPalmyra_line_50	W-E line
		0051_20100525_180017	KingmanPalmyra_line_51	W-E line
146	**100526**	**0052_20100526_000007**	**KingmanPalmyra_line_52**	**W-E line**
		0053_20100526_060041	KingmanPalmyra_line_53	W-E line
		0054_20100526_120013	KingmanPalmyra_line_54	W-E line
		0055_20100526_180020	KingmanPalmyra_line_55	W-E line
			No line 56	turn
147	**100527**	**0057_20100527_000004**	**KingmanPalmyra_line_57**	**E-W line**
		0058_20100527_060012	KingmanPalmyra_line_58	E-W line
		0058_20100527_120015	KingmanPalmyra_line_59	E-W line
		0060_20100527_180011	KingmanPalmyra_line_60	E-W line
148	**100528**	**0061_20100528_000008**	**KingmanPalmyra_line_61**	**E-W line**
		0062_20100528_070142	KingmanPalmyra_line_62	W-E line
		0063_20100528_120048	KingmanPalmyra_line_63	W-E line
		0064_20100528_180011	KingmanPalmyra_line_64	W-E line
149	**100529**	**0065_20100529_000007**	**KingmanPalmyra_line_65**	**W-E line**
		0066_20100529_060003	KingmanPalmyra_line_66	W-E line
		0067_20100529_120054	KingmanPalmyra_line_67	W-E line
		0068_20100529_180042	KingmanPalmyra_line_68	W-E line (end)
		0069_20100529_225629	KingmanPalmyra_line_69	S Palmyra E-W
150	**100530**	**0070_20100530_000007**	KingmanPalmyra_line_70	**S Palmyra E-W**
		0071_20100530_040100	KingmanPalmyra_line_71	S Palmyra W-E
		0072_20100530_060004	KingmanPalmyra_line_72	S Palmyra W-E
		0073_20100530_101818	KingmanPalmyra_line_73	E-W line
		0074_20100530_120118	KingmanPalmyra_line_74	E-W line
		0075_20100530_180050	KingmanPalmyra_line_75	E-W line
151	**100531**	**0076_20100531_000016**	**KingmanPalmyra_line_76**	**E-W line**
		0077_20100531_060007	KingmanPalmyra_line_77	E-W line
		0078_20100531_120053	KingmanPalmyra_line_78	E-W line
		0079_20100531_180118	KingmanPalmyra_line_79	E-W line
		0080_20100531_222058	KingmanPalmyra_line_80	W-E line
152	**100601**	**0081_20100601_000013**	**KingmanPalmyra_line_81**	**W-E line**
JD	**Data Folder**	**Kongsberg file name KM.all**	**UNH file name .all**	**Notes**

		0082_20100601_060012	KingmanPalmyra_line_82	W-E line
		0083_20100601_115811	KingmanPalmyra_line_83	W-E line
		0084_20100601_175925	KingmanPalmyra_line_84	W-E line
153	**100602**	**0085_20100602_000005**	**KingmanPalmyra_line_85**	**W-E line**
		0086_20100602_060043	KingmanPalmyra_line_86	W-E line (end)
		0087_20100602_141535	KingmanPalmyra_line_87	E-W line
		0088_20100602_175917	KingmanPalmyra_line_88	E-W line
154	**100603**	**0089_20100603_000004**	**KingmanPalmyra_line_89**	**E-W line**
		0090_20100603_060007	KingmanPalmyra_line_90	E-W line
		0091_20100603_115912	KingmanPalmyra_line_91	E-W line
		0092_20100603_180140	KingmanPalmyra_line_92	E-W line
155	**100604**	**0093_20100604_000019**	**KingmanPalmyra_line_93**	**E-W line**
		0094_20100604_020454	KingmanPalmyra_line_94	W-E line
		0095_20100604_060021	KingmanPalmyra_line_95	W-E line
		0096_20100604_120024	KingmanPalmyra_line_96	W-E line
		0097_20100604_180016	KingmanPalmyra_line_97	W-E line
156	**100605**	**0098_20100605_000020**	**KingmanPalmyra_line_98**	**W-E line**
		0099_20100605_060013	KingmanPalmyra_line_99	W-E line
		0100_20100605_120017	KingmanPalmyra_line_100	W-E line
		0101_20100605_160432	KingmanPalmyra_line_101	E-W line
		0102_20100605_180014	KingmanPalmyra_line_102	E-W line
157	**100606**	**0103_20100606_000024**	**KingmanPalmyra_line_103**	**E-W line**
		0104_20100606_060027	KingmanPalmyra_line_104	E-W line
		0105_20100606_120010	KingmanPalmyra_line_105	E-W line
		0106_20100606_161856	KingmanPalmyra_line_106	E-W line
		0107_20100606_180019	KingmanPalmyra_line_107	E-W line
158	**100607**	**0108_20100607_000015**	**KingmanPalmyra_line_108**	**E-W line**
		0109_20100607_060020	KingmanPalmyra_line_109	E-W line
		0110_20100607_085809	KingmanPalmyra_line_110	W-E line
		0111_20100607_120024	KingmanPalmyra_line_111	W-E line
		0112_20100607_180023	KingmanPalmyra_line_112	W-E line
159	**100608**	**0113_20100608_000020**	**KingmanPalmyra_line_113**	**W-E line**
		0114_20100608_060016	KingmanPalmyra_line_114	W-E line
		0115_20100608_120028	KingmanPalmyra_line_115	W-E line
		0116_20100608_180023	KingmanPalmyra_line_116	W-E line
160	**100609**	**0117_20100609_001225**	**KingmanPalmyra_line_117**	**E-W line**
		0118_20100609_060017	KingmanPalmyra_line_118	E-W line
		0119_20100609_120006	KingmanPalmyra_line_119	E-W line
		0120_20100609_180008	KingmanPalmyra_line_120	E-W line
161	**100610**	**0121_20100610_000011**	**KingmanPalmyra_line_121**	**E-W line**
		0122_20100610_060009	KingmanPalmyra_line_122	E-W line

JD	Data Folder	Kongsberg file name KM.all	UNH file name .all	Notes
		0123_20100610_113911	KingmanPalmyra_line_123	W-E line
		0124_20100610_180012	KingmanPalmyra_line_124	W-E line
162	**100611**	**0125_20100611_000001**	**KingmanPalmyra_line_125**	**W-E line**
		0126_20100611_060009	KingmanPalmyra_line_126	W-E line
		0127_20100611_120024	KingmanPalmyra_line_127	W-E line
		0128_20100611_180027	KingmanPalmyra_line_128	W-E line
163	**100612**	**0129_20100612_022048**	**KingmanPalmyra_line_129**	**holiday fill S Pal**
		0130_20100612_085220	KingmanPalmyra_line_130	Holiday fill S. Pal
		0131_20100612_133529	KingmanPalmyra_line_131	Holiday fill S. Pal.
		0132_20100612_181543	KingmanPalmyra_line_132	Holiday fill S. Pal.
		0133_20100612_224359	KingmanPalmyra_line_133	Holiday fill S. Pal.
164	**100613**	**0134_20100613_032421**	**KingmanPalmyra_line_134**	**Holiday fill S Pal**
		0135_20100613_083856	KingmanPalmyra_line_135	Holiday fill S Pal
		END OF MAPPING	**END OF MAPPING**	
		0136_20100613_104611	**KingmanPalmyra_line_tran136**	**Transit Honolulu**
		0137_20100613_120014	KingmanPalmyra_line_tran137	Transit Honolulu
		0138_20100613_180038	KingmanPalmyra_line_tran138	Transit Honolulu
165	**100614**	**0139_20100614_000010**	**KingmanPalmyra_line_tran139**	**Transit Honolulu**
		0139_20100614_010012	KingmanPalmyra_line_tran139a	Transit Honolulu
		0140_20100614_060018	KingmanPalmyra_line_tran140	Transit Honolulu
		0141_20100614_120025	KingmanPalmra_line_tran141	Transit Honolulu
		0142_20100614_180119	KingmanPalmra_line_tran142	Transit Honolulu
166	**100615**	**0143_20100615_000012**	**KingmanPalmra_line_tran143**	**Transit Honolulu**
		0144_20100615_061134	KingmanPalmyra_line_tran144	Transit Honolulu
		0145_20100615_120137	KingmanPalmyra_line_tran145	Transit Honolulu
		0146_20100615_180118	KingmanPalmyra_line_tran146	Transit Honolulu
167	**100616**	**0147_20100616_000008**	**KingmanPalmyra_line_tran147**	**Transit Honolulu**
		0148_20100616_060009	KingmanPalmyra_line_tran148	Transit Honolulu
		0149_20100616_120014	KingmanPalmyra_line_tran149	Transit Honolulu
		END OF CRUISE	**END OF CRUISE**	

Appendix 2. Conversion table of Knudsen-assigned .sgy file names to UNH file names by Julian Day

JD	Data Folder	Knudsen file name KP_LINE_70884_xxx.sgy	UNH file name .sgy	Notes
134	**100514**	**001**	**KingmanPalmyra_line_transit1**	**No navigation**
		002	KingmanPalmyra_line_tran2	transit to PagoPago
		003	KingmanPalmyra_line_tran3	Pago Pago to area
138	**100518**	**004**	**KingmanPalmyra_line_tran4**	**Pago Pago to area**
		005	KingmanPalmyra_line_tran5	Pago Pago to area
		006	KingmanPalmyra_line_tran6	Pago Pago to area
		007	KingmanPalmyra_line_tran7	Pago Pago to area
		007a	KingmanPalmyra_line_tran7a	Pago Pago to area
		007b	KingmanPalmyra_line_tran7b	Pago Pago to area
		007c	KingmanPalmyra_line_tran7c	Pago Pago to area
139	**100519**	**008**	**KingmanPalmyra_line_tran8**	**Pago Pago to area**
			No line tran9	Pago Pago to area
		0010	KingmanPalmyra_line_tran10	Pago Pago to area
		0011	KingmanPalmyra_line_tran11	Pago Pago to area
		0012	KingmanPalmyra_line_tran12	Pago Pago to area
140	**100520**	**0013**	**KingmanPalmyra_line_tran13**	**Pago Pago to area**
		0014	KingmanPalmyra_line_tran14	Pago Pago to area
		0015	KingmanPalmyra_line_tran15	Pago Pago to area
		0016	KingmanPalmyra_line_tran16	Pago Pago to area
		0017	KingmanPalmyra_line_tran17	Pago Pago to area
141	**100521**	**0018**	**KingmanPalmyra_line_tran18**	**Pago Pago to area**
		0019	KingmanPalmyra_line_tran19	Pago Pago to area
		0020	KingmanPalmyra_line_tran20	Pago Pago to area
		0021	KingmanPalmyra_line_tran21	Pago Pago to area
		0022	KingmanPalmyra_line_tran22	Pago Pago to area
		No line 23	No line 23	patch test site
142	**100522**	**No line 24**	**No line 24**	**patch test**
		No line 25	No line 25	patch test
		No line 26	No line 26	patch test
		No line 27	No line 27	patch test
		No line 28	No line 28	patch test
		No line 29	No line 29	patch test
		No line 30	No line 30	patch test
		No line 31	No line31	patch test
		No line 32	No line 32	patch test
		0033	KingmanPalmyra_line_33	dipline
		0034	KingmanPalmyra_line_34	dipline
143	**100523**	**0035**	**KingmanPalmyra_line_35**	**dipline**
		0036	KingmanPalmyra_line36	dipline
		0037	KingmanPalmyra_line_37	dipline
		0038	KingmanPalmyra_line_38	dipline(end)
		0039	KingmanPalmyra_line_39	traverse

JD	Data Folder	Knudsen file name KP_LINE_70884_xxx.sgy	UNH file name .sgy	Notes
144	**100524**	**0040**	**KingmanPalmyra_line_40**	**line40 40a MBES**
			No line 41	
			No line 42	
		0043	KingmanPalmyra_line_43	1st E-W line
		0044	KingmanPalmyra_line_44	1st E-W line
		0045	KingmanPalmyra_line_45	1st E-W line
		0046	KingmanPalmyra_line_46	1st E-W line
		0047	KingmanPalmyra_line_47	1st E-W line
145	**100525**	**0048**	**KingmanPalmyra_line_48**	**1st E-W line**
		0049	KingmanPalmyra_line_49	1st E-W line
		0050	KingmanPalmyra_line_50	1st W-E line
		0051	KingmanPalmyra_line_51	1st W-E line
146	**100526**	**0052**	**KingmanPalmyra_line_52_**	**1st W-E line**
		0053	KingmanPalmyra_line_53	1st W-E line
		0054	KingmanPalmyra_line_54	1st W-E line
		0055	KingmanPalmyra_line_55	1st W-E line
			No line 56	turn
147	**100527**	**0057**	**KingmanPalmyra_line_57**	**E-W line**
		0058	KingmanPalmyra_line_58	E-W line
		0059	KingmanPalmyra_line_59	E-W line
		0060	KingmanPalmyra_line_60	E-W line
148	**100528**	**0061**	**KingmanPalmyra_line_61**	**E-W Line**
		0062	KingmanPalmyra_line_62	W-E line
		0063	KingmanPalmyra_line_63	W-E line
		0064	KingmanPalmyra_line_64	W-E line
149	**100529**	**0065**	**KingmanPalmyra_line_65**	**W-E line**
		0066	KingmanPalmyra_line_66	W-E line
		0067	KingmanPalmyra_line_67	W-E line
		0068	KingmanPalmyra_line_68	W-E line (end)
		0069	KingmanPalmyra_line_69	S Palmyra E-W
150	**100530**	**0070**	KingmanPalmyra_line_70	**S Palmyra E-W**
		0071	KingmanPalmyra_line_71	S. Palmyra W-E
		0072	KingmanPalmyra_line_72	S. Palmyra W-E
		0073	KingmanPalmyra_line_73	E-W line
		0074	KingmanPalmyra_line_74	E-W line
		0075	KingmanPalmyra_line_75	E-W line
151	**100531**	**0076**	**KingmanPalmyra_line_76**	**E-W line**
		0077	KingmanPalmyra_line_77	E-W line
		0078	KingmanPalmyra_line_78	E-W line
		0079	KingmanPalmyra_line_79	E-W line
		0080	KingmanPalmyra_line_80	W-E line
152	**100601**	**0081**	**KingmanPalmyra_line_81**	**W-E line**
		0082	KingmanPalmyra_line_82	W-E line

JD	Data Folder	Knudsen file name KP_LINE_70884_xxx.sgy	UNH file name .sgy	Notes
		0083	KingmanPalmyra_line_83	W-E line
		0084	KingmanPalmyra_line_84	W-E line
153	**100602**	**0085**	**KingmanPalmyra_line_85**	**W-E line**
		0086	KingmanPalmyra_line_86	W-E line (end)
		0087	KingmanPalmyra_line_87	E-W line
		0088	KingmanPalmyra_line_88	E-W line
154	**100603**	**0089**	**KingmanPalmyra_line_89**	**E-W line**
		0090	KingmanPalmyra_line_90	E-W line
		0091	KingmanPalmyra_line_91	E-W line
		0092	KingmanPalmyra_line_92	E-W line
155	**100604**	**0093**	**KingmanPalmyra_line_93**	**E-W line**
		0094	KingmanPalmyra_line_94	W-E line
		0095	KingmanPalmyra_line_95	W-E line
		0096	KingmanPalmyra_line_96	W-E line
		0097	KingmanPalmyra_line_97	W-E line
156	**100605**	**0098**	**KingmanPalmyra_line_98**	**W-E line**
		0099	KingmanPalmyra_line_99	W-E line
		0100	KingmanPalmyra_line_100	W-E line
		0101	KingmanPalmyra_line_101	E-W line
		0102	KingmanPalmyra_line_102	E-W line
157	**100606**	**0103**	**KingmanPalmyra_line_103**	**E-W line**
		0104	KingmanPalmyra_line_104	E-W line
		0105	KingmanPalmyra_line_105	E-W line
		0106	KingmanPalmyra_line_106	E-W line
		0107	KingmanPalmyra_line_107	E-W line
158	**100607**	**0108**	**KingmanPalmyra_line_108**	**E-W line**
		0109	KingmanPalmyra_line_109	E-W line
		0110	KingmanPalmyra_line_110	W-E line
		0111	KingmanPalmyra_line_111	W-E line
		0112	KingmanPalmyra_line_112	W-E line
159	**100608**	**0113**	**KingmanPalmyra_line_113**	**W-E line**
		0114	KingmanPalmyra_line_114	W-E line
		0115	KingmanPalmyra_line_115	W-E line
		0116	KingmanPalmyra_line_116	W-E line
160	**100609**	**0117**	**KingmanPalmyra_line_117**	**E-W line**
		0118	KingmanPalmyra_line_118	E-W line
		0119	KingmanPalmyra_line_119	E-W line
		0120	KingmanPalmyra_line_120	E-W line
161	**100610**	**0121**	**KingmanPalmyra_line_121**	**E-W line**
		0122	KingmanPalmyra_line_122	E-W line
		0123	KingmanPalmyra_line_123	W-E line
		0124	KingmanPalmyra_line_124	W-E line

Appendix 2 Continued

JD	Data Folder	Knudsen file name KP_LINE_70884_xxx.sgy	UNH file name .sgy	Notes
162	**100611**	**0125**	**KingmanPalmyra_line_125**	**W-E line**
		0126	KingmanPalmyra_line_126	W-E line e
		0127	KingmanPalmyra_line_127	W-E line
		0128	KingmanPalmyra_line_128	W-E line
163	**100612**	**0129**	**KingmanPalmyra_line_129**	**holiday fill S Pal**
		0130	KingmanPalmyra_line_130	Holiday fill S. Pal.
		0131	KingmanPalmyra_line_131	Holiday fill S. Pal
		0132	KingmanPalmyra_line_132	Holiday fill S. Pal
		0133	KingmanPalmyra_line_133	Holiday fill S. Pal
164	**100613**	**0134**	**KingmanPalmyra_line_134**	**Holiday fill S Pal**
		0135	KingmanPalmyra_line_135	Holiday fill S Pal
		END OF MAPPING	**END OF MAPPING**	
		0136	KingmanPalmyra_line_tran136	Transit Honolulu
		0137	KingmanPalmyra_line_tran137	Transit Honolulu
		0138	KingmanPalmyra_line_tran138	Transit Honolulu
165	**100614**	**0139**	KingmanPalmyra_line_tran139	**Transit Honolulu**
		0139a	KingmanPalmyra_line_tran139a	Transit Honolulu
		0139b	KingmanPalmyra_line_tran139b	Transit Honolulu
		0140	KingmanPalmyra_line_tran140	Transit Honolulu
		0141	KingmanPalmyra_line_tran141	Transit Honolulu
		0142	KingmanPalmyra_line_tran142	Transit Honolulu
166	**100615**	**0143**	**KingmanPalmyra_line_tran143**	**Transit Honolulu**
		0144	KingmanPalmyra_line_tran144	Transit Honolulu
		0145	KingmanPalmyra_line_tran145	Transit Honolulu
		0146	KingmanPalmyra_line_tran146	Transit Honolulu
167	**100616**	**0147**	**KingmanPalmyra_line_tran147**	**Transit Honolulu**
		0148	KingmanPalmyra_line_tran_148	Transit Honolulu
		0149	KingmanPalmyra_line_tran_149	Transit Honolulu
		END OF CRUISE	**END OF CRUISE**	

Appendix 3. Location of XBT cast

XBT number	Latitude	Longitude	Serial Number	TYPE
TS_00544	-14.6555	-144.78500	00339828	T-5
TD_00545	-2.08872	-166.08988	01096741	Deep Blue
TD_00546	-2.12691	-166.46833	01096745	Deep Blue
TD_00547	-0.42108	-165.79057	01096740	Deep Blue
TD_00549	1.92478	-165.04593	01096744	Deep Blue
TD_00550	3.31997	-164.0798	01096748	Deep Blue
TD_00551	4.32888	-164.4148	01096739	Deep Blue
TD_00552	5.24697	-162.80627	01096743	Deep Blue
TD_00553	6.19882	-162.17635	01096747	Deep Blue
TD_00554	5.66575	-161.3442	01096738	Deep Blue
TD_00555	5.92388	-161.91927	01096742	Deep Blue
TD_00556	6.54903	-162.98413	01096746	Deep Blue
TD_00557	7.18750	-164.07237	01096938	Deep Blue
TD_00558	7.83402	-165.17702	01096939	Deep Blue
TD_00559	8.48360	-166.28770	01096940	Deep Blue
TD_00560	9.11810	-167.35802	01096941	Deep Blue
TD_00561	8.74900	-166.92350	01096937	Deep Blue
TD_00562	8.1756	-165.94232	01096936	Deep Blue
TD_00563	7.62075	-164.99383	01096935	Deep Blue
TD_00564	7.06655	-164.04795	01096934	Deep Blue
TD_00565	6.49917	-163.08083	01096930	Deep Blue
TD_00566	5.92420	-162.28315	01096933	Deep Blue
TD_00567	6.53467	-163.32263	01096932	Deep Blue
TD_00568	7.14137	-164.35743	01096931	Deep Blue
TD_00569	7.76952	-165.43100	01096775	Deep Blue
TD_00570	8.40082	-166.50988	01096774	Deep Blue
TD_00571	9.02948	-167.58703	01096778	Deep Blue
TD_00572	8.51278	-166.87710	01096776	Deep Blue
TD_00573	7.95515	-165.91910	01096777	Deep Blue
TD_00574	7.37713	-164.92733	01096779	Deep Blue
TD_00575	6.81633	-163.96645	01096781	Deep Blue
TD_00576	6.25883	-163.01240	01096780	Deep Blue
TD_00577	5.68495	-162.03140	01096785	Deep Blue
TD_00578	5.30478	-161.33190	01096782	Deep Blue
TD_00579	5 54943	-161.62155	01096783	Deep Blue
TD_00580	5.78430	-162.00612	01096784	Deep Blue
TD_00581	5.65035	-162.61712	01096950	Deep Blue
TD_00582	5.19708	-161.39500	01096942	Deep Blue
TD_00583	5.36545	-161.68247	01096943	Deep Blue
TD_00584	5.99600	-162.75990	01096944	Deep Blue

Appendix 3 continued

XBT number	Latitude N	Longitude W	Serial Number	TYPE
TD_00585	6.23747	-163.17305	01096945	Deep Blue
TD_00586	6.62645	-163.83895	01096947	Deep Blue
TD_00587	7.25677	-164.91853	01096946	Deep Blue
TD_00588	7.88565	-165.99747	01096951	Deep Blue
TD_00589	8.23798	-166.60253	01096948	Deep Blue
TD_00590	8.51802	-167.08395	01096949	Deep Blue
TD_00591	8.67108	-167.77000	01096952	Deep Blue
TD_00592	8.64462	-167.49918	01096953	Deep Blue
TD_00594	8.08733	-166.54090	01096634	Deep Blue
TD_00595	7.53315	-165.58910	01096630	Deep Blue
TD_00596	6.97233	-164.62707	01096639	Deep Blue
TD_00597	6.40820	-163.66108	01096635	Deep Blue
TD_00598	5.82427	-162.66147	01096631	Deep Blue
TD_00599	5.24745	-161.67623	01096632	Deep Blue
TD_00600	5.40175	-162.13782	01096636	Deep Blue
TD_00601	5.61450	-162.47285	01096640	Deep Blue
TD_00602	6.02825	-163.20892	01096633	Deep Blue
TD_00603	6.47067	-164.26828	01096637	Deep Blue
TD_00604	7.29233	-165.37410	01096641	Deep Blue
TD_00605	7.94320	-166.49117	01096662	Deep Blue
TD_00606	8.47118	-167.39845	01096663	Deep Blue
TD_00607	8.25362	-167.22107	01096664	Deep Blue
TD_00608	FAILED	FAILED	01096665	Deep Blue
TD_00609	7.68492	-166.24392	01096661	Deep Blue
TD_00610	7.11030	-165.25788	01096660	Deep Blue
TD_00611	6.90078	-164.89862	01096659	Deep Blue
TD_00612	6.55345	-164.30355	01096658	Deep Blue
TD_00613	5.91753	-163.21483	01096657	Deep Blue
TD_00614	5.29633	-162.15257	01096656	Deep Blue
TD_00615	5.04315	-161.91775	01096655	Deep Blue
TD_00616	5.58867	-162.90742	01096654	Deep Blue
TD_00617	6.03793	-163.61920	01096969	Deep Blue
TD_00618	6.19943	-163.89585	01096973	Deep Blue
TD_00619	6.60658	-164.59325	01096977	Deep Blue
TD_00620	6.83408	-164.98300	01096976	Deep Blue
TD_00621	7.07898	-165.40310	01096972	Deep Blue
TD_00622	7.72923	-166.51935	01096968	Deep Blue
TD_00623	8.39272	-167.66032	01096967	Deep Blue
TD_00624	8.16465	-167.46475	01096971	Deep Blue
TD_00625	7.60915	-166.50995	01096975	Deep Blue

Appendix 3 continued

XBT number	Latitude N	Longitude W	Serial Number	TYPE
TD_00626	7.31300	-166.00142	01096974	Deep Blue
TD_00627	7.04293	-165.53777	01096970	Deep Blue
TD_00628	6.87370	-165.2475	01096966	Deep Blue
TD_00629	6.80227	-165.12493	01096884	Deep Blue
TD_00630	6.47800	-164.56888	01096885	Deep Blue
TD_00631	5.96883	-163.69713	01096883	Deep Blue
TD_00632	5.31537	-162.57862	01096882	Deep Blue
TD_00633	4.88758	-161.84667	01096889	Deep Blue
TD_00634	FAILED	FAILED	FAILED	Deep Blue
TD_00635	5.29119	-162.73615	01096892	Deep Blue
TD_00636	5.77875	-163.57052	01096893	Deep Blue
TD_00637	5.96063	-163.88230	01096887	Deep Blue
TD_00638	6.50678	-164.81843	01096886	Deep Blue
TD_00639	7.06828	-165.78233	01096891	Deep Blue
TD_00640	7.79170	-167.02555	01096890	Deep Blue
TD_00641	FAILED	FAILED	01097214	Deep Blue
TD_00642	8.08033	-167.74890	01097210	Deep Blue
TD_00643	7.54562	-166.79925	01097206	Deep Blue
TD_00644	7.02168	-165.06527	01097215	Deep Blue
TD_00645	6.88473	-165.66348	01097211	Deep Blue
TD_00646	6.72197	-165.38403	01097207	Deep Blue
TD_00647	6.46675	-164.94522	01097216	Deep Blue
TD_00648	5.78772	-163.79912	01097212	Deep Blue
TD_00649	5.70285	-163.63727	01097208	Deep Blue
TD_00650	5.27027	-162.89665	01097217	Deep Blue
TD_00651	4.75618	-162.01728	01097213	Deep Blue
TD_00652	5.05927	-161.44625	01097209	Deep Blue
TD_00653	5.29580	-161.84953	01096831	Deep Blue
TD_00654	5.37697	-161.99307	01096827	Deep Blue
TD_00655	5.43525	-161.90903	01096823	Deep Blue
TD_0656	5.27022	-161.62117	01096822	Deep Blue
TD_0657	5.28588	-161.43430	01096826	Deep Blue
TD_0658	5.66693	-161.91983	01096830	Deep Blue
TD_0659	5.43872	-161.52495	01096832	Deep Blue
TD_0660	5.35733	-161.38412	01096828	Deep Blue
TD_0661	5.47392	-161.39467	01096824	Deep Blue
TD_0662	5.57037	-161.56978	01096829	Deep Blue
TD_0663	5.61732	-161.65497	01096825	Deep Blue
TD_0664	5.67178	-161.56835	01096833	Deep Blue
TD_0665	5.57395	-161.39713	01096764	Deep Blue

Appendix 3 continued

XBT number	Latitude N	Longitude W	Serial Number	TYPE
TD_0666	8.45213	-160.85767	01096765	Deep Blue
TD_0667	11.79657	-160.10010	01096763	Deep Blue
TD_0668	13.57413	-159.69468	01096768	Deep Blue
				Deep Blue
				Deep Blue

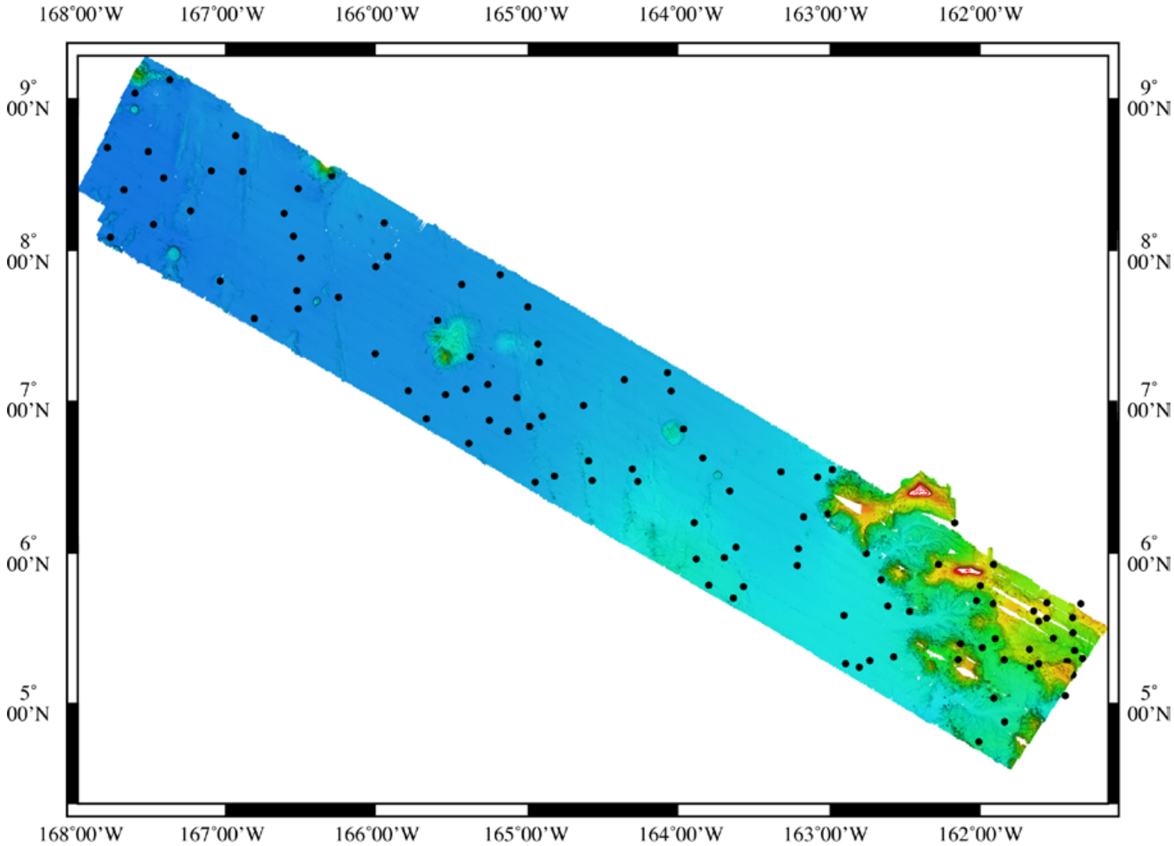


Figure 15. Map of locations of XBT (black dots). Backdrop is bathymetry acquired on this cruise. See Appendix 3 for details.

Appendix 4. Cruise Calendar

May 2010

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	3	4	5	6	7	8
9	10 engine repairs in Apia	11 engine repairs in Apia	12 engine repairs in Apia	JD133 13 engine repairs in Apia	JD134 14 engine repairs in Apia	JD135 15 began transit Apia to Pago Pago at 1600L
JD136 16 waiting to fuel in Pago Pago	JD138 17 fueled in Pago Pago. Departed 1550L	JD139 18 begin transit Pago Pago to patch test	JD140 19 transit to patch test	JD141 20 transit to patch test	JD142 21 patch test	JD143 22 mapping dipline
JD144 23 routine mapping	JD145 24 routine mapping	JD146 25 routine mapping	JD147 26 routine mapping	JD148 27 routine mapping	JD149 28 routine mapping	JD150 29 routine mapping
JD151 30 routine mapping	JD152 31 routine mapping					

June 2010

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		JD153 1 routine mapping	JD154 2 routine mapping	JD155 3 routine mapping	JD156 4 routine mapping	JD157 5 routine mapping
JD158 6 routine mapping	JD159 7 routine mapping	JD160 8 routine mapping	JD161 9 routine mapping	JD162 10 routine mapping	JD163 11 routine mapping	JD164 12 start transit to Honolulu 2200 L
JD165 13 transit to Honolulu	JD166 14 transit to Honolulu	JD167 15 transit to Honolulu	JD168 16 arrive Honolulu 1000 L	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

Appendix 5. Gravity land-tie Data

Gravity Land-Tie Report

Date:____13 May 2010_______
Base Station Code:_____________________
Port:____Apia, Western Samoa__________
Cruise: KM10-09
Gravity Base Station Location (lat/lon): no base station located

Time (UTC)	**Reading**	**Height above sea level**

Base station value (mGal)

Ship Location (Port, Pier, etc.):__Apia Port, Main pier____
Land Meter ID (Serial No.): LaCoste Romberg, s/n G-1

Location	**Time (UTC)**	**Reading**	**Height above sea level**
First pier measurement	JD 134 0000	1812.7	2.67 m (8'9")
Second pier measurement			
		From portable meter	

Comments: ship gravity meter reading 6682.02
Reading taken 6.2 m north of the second bollard from the south end on outside of pier (see Fig. 16).

Pier station location: 13˚49.636'S/171˚45.673'W

Operator: Kuhio Vellalos

Figure 16. Location of pier land-tie gravity station at Apia, Samoa dock.

Gravity Land-Tie Report

Date:____16 May 2010__local_____
Base Station Code:___AS65 ASPA FSF-1____
Port:____Pago Pago, American Samoa__________
Cruise: KM10-09
Gravity Base Station Location (lat/lon): 14˚19’32.483”S/170˚43’19.779”W

Time (UTC)	Reading	Height above sea level
2248	1830.32	14.222 m
2256	1829.89	14.222 m
2301	1829.64	14.222 m

Base station value (mGal)

Ship Location (Port, Pier, etc.):__Pago Pago fuel dock___
Land Meter ID (Serial No.): LaCoste Romberg, s/n G-1

Location	Time (UTC)	Reading	Height above sea level (m)
First pier measurement	2349	1841.13	2.5
Second pier measurement	2356	1841.01	2.5
Third pier measurement	0003	1840.87	2.5
		From portable meter	

Comments: ship gravity meter reading 6715.8
Reading taken 8.9 m south from first cleat after second bollard to the south on pier
Pier station location: 14˚16.587’S/170˚41.113’W

Operator: Kuhio Vellalos

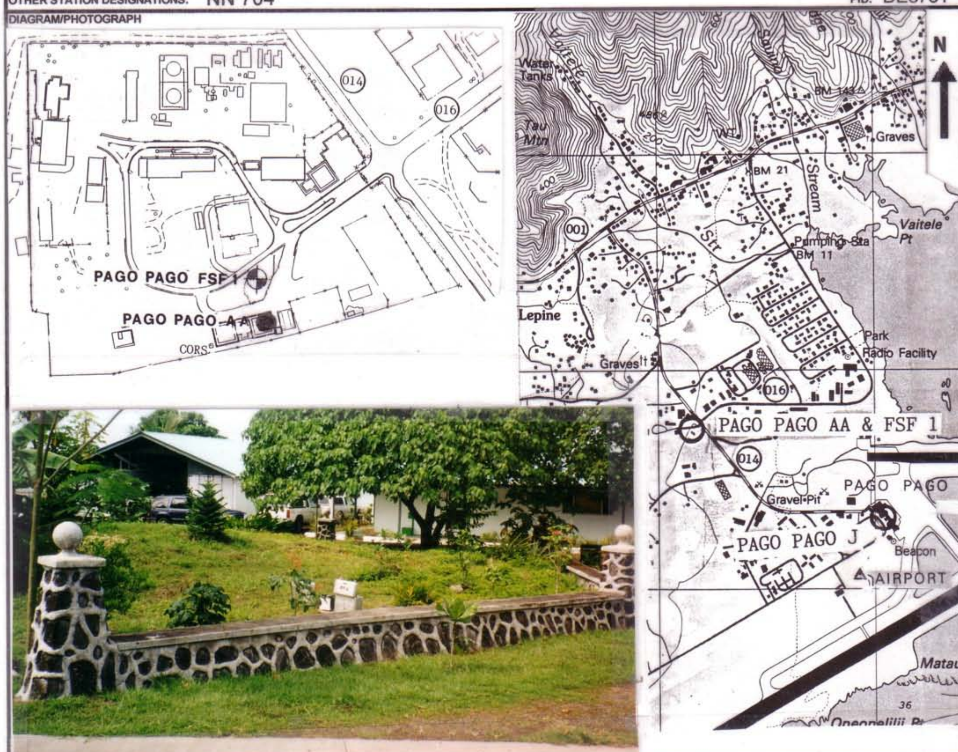
GRAVITY STATION DESCRIPTION	STATION TYPE: Absolute Excenter	STATION DESIGNATION: PAGO PAGO FSF 1
COUNTRY: United States	STATE/PROVINCE - COUNTY: American Samoa - Western district	CITY: Tafuna
LATITUTE: 14° 19' 32.483" S	LONGITUDE: 170° 43' 19.779" W	ELEVATION: 14.222 meters
GRAVITY STATION MARK: Vertical Control Disk	AGENCY: NOAA-NGS	INSCRIPTION: FSF 1 AS 65 ASPA 2002
POSITION/ELEVATION REFERENCE: Disk position/elevation	POSTION/ELEVATION SOURCE: NOAA-NGS	SOURCE DESCRIPTION: GPS/levelling
POSITION/ELEVATION REMARKS:	GRAVITY VALUE/SOURCE/DATE: g = 978 629.331 ± 0.003 mGals (NOAA-NGS, 8/2002)	

DESCRIPTION/CONTACT

The station is located in Tafuna, Tutuila Island, American Samoa, at the American Samoa Power Authority (ASPA) Wastewater Division offices, outside of Capt. Michael Dworsky Bldg. It is 4.1 mi SW of Customhouse in Fagatogo and 0.6 mi NW of Airport terminal. To access from the intersection of routes AS 001 and AS 014, go SSE on AS 014 (towards airport) for 0.63 mi to intersection with AS 016. Turn WSW (right) into ASPA compound and go 0.08 mi to bldg. and station on left in arbor traffic circle with curved rock wall. Station is 27.0 m NNW of NNW face of bldg. and 2.0 m SE of NW section of rock wall. Disk is cemented in 0.6 m by 0.6 m, basalt (lava) boulder and faces SE. Contact phone is (684) 699-1462.

OTHER STATION DESIGNATIONS: NN 704 — PID: DE8761

DIAGRAM/PHOTOGRAPH



DESCRIPTION BY: Daniel Winester	AGENCY: NOAA/NOS/NGS	DATE: 14 August 2002

Location sheet of gravity land station in Pago Pago, American Samoa.

Land gravity benchmark, Pago Pago, American Samoa.

Appendix 6. Kongsberg EM122 BIST Test Results

Bist test at Apia Harbor dock.

Saved: 2010.05.14 00:48:24
Sounder Type: 122, Serial no.: 109
Date Time Ser. No. BIST Result

2010.05.14 00:40:54.141 109 0 OK

Number of BSP67B boards: 2
BSP 1 Master 2.3 090702 4.3 070913 4.3 070913
BSP 1 Slave 2.3 090702 6.0 080902
BSP 1 RXI FPGA 3.6 080821
BSP 1 DSP FPGA A 4.0 070531
BSP 1 DSP FPGA B 4.0 070531
BSP 1 DSP FPGA C 4.0 070531
BSP 1 DSP FPGA D 4.0 070531
BSP 1 PCI TO SLAVE A1 FIFO: ok
BSP 1 PCI TO SLAVE A2 FIFO: ok
BSP 1 PCI TO SLAVE A3 FIFO: ok
BSP 1 PCI TO SLAVE B1 FIFO: ok
BSP 1 PCI TO SLAVE B2 FIFO: ok
BSP 1 PCI TO SLAVE B3 FIFO: ok
BSP 1 PCI TO SLAVE C1 FIFO: ok
BSP 1 PCI TO SLAVE C2 FIFO: ok
BSP 1 PCI TO SLAVE C3 FIFO: ok
BSP 1 PCI TO SLAVE D1 FIFO: ok
BSP 1 PCI TO SLAVE D2 FIFO: ok
BSP 1 PCI TO SLAVE D3 FIFO: ok
BSP 1 PCI TO MASTER A HPI: ok
BSP 1 PCI TO MASTER B HPI: ok
BSP 1 PCI TO MASTER C HPI: ok
BSP 1 PCI TO MASTER D HPI: ok
BSP 1 PCI TO SLAVE A0 HPI: ok
BSP 1 PCI TO SLAVE A1 HPI: ok
BSP 1 PCI TO SLAVE A2 HPI: ok
BSP 1 PCI TO SLAVE B0 HPI: ok
BSP 1 PCI TO SLAVE B1 HPI: ok
BSP 1 PCI TO SLAVE B2 HPI: ok
BSP 1 PCI TO SLAVE C0 HPI: ok
BSP 1 PCI TO SLAVE C1 HPI: ok
BSP 1 PCI TO SLAVE C2 HPI: ok
BSP 1 PCI TO SLAVE D0 HPI: ok
BSP 1 PCI TO SLAVE D1 HPI: ok
BSP 1 PCI TO SLAVE D2 HPI: ok
BSP 2 Master 2.3 090702 4.3 070913 4.3 070913
BSP 2 Slave 2.3 090702 6.0 080902
BSP 2 RXI FPGA 3.6 080821
BSP 2 DSP FPGA A 4.0 070531
BSP 2 DSP FPGA B 4.0 070531
BSP 2 DSP FPGA C 4.0 070531

BSP 2 DSP FPGA D 4.0 070531
BSP 2 PCI TO SLAVE A1 FIFO: ok
BSP 2 PCI TO SLAVE A2 FIFO: ok
BSP 2 PCI TO SLAVE A3 FIFO: ok
BSP 2 PCI TO SLAVE B1 FIFO: ok
BSP 2 PCI TO SLAVE B2 FIFO: ok
BSP 2 PCI TO SLAVE B3 FIFO: ok
BSP 2 PCI TO SLAVE C1 FIFO: ok
BSP 2 PCI TO SLAVE C2 FIFO: ok
BSP 2 PCI TO SLAVE C3 FIFO: ok
BSP 2 PCI TO SLAVE D1 FIFO: ok
BSP 2 PCI TO SLAVE D2 FIFO: ok
BSP 2 PCI TO SLAVE D3 FIFO: ok
BSP 2 PCI TO MASTER A HPI: ok
BSP 2 PCI TO MASTER B HPI: ok
BSP 2 PCI TO MASTER C HPI: ok
BSP 2 PCI TO MASTER D HPI: ok
BSP 2 PCI TO SLAVE A0 HPI: ok
BSP 2 PCI TO SLAVE A1 HPI: ok
BSP 2 PCI TO SLAVE A2 HPI: ok
BSP 2 PCI TO SLAVE B0 HPI: ok
BSP 2 PCI TO SLAVE B1 HPI: ok
BSP 2 PCI TO SLAVE B2 HPI: ok
BSP 2 PCI TO SLAVE C0 HPI: ok
BSP 2 PCI TO SLAVE C1 HPI: ok
BSP 2 PCI TO SLAVE C2 HPI: ok
BSP 2 PCI TO SLAVE D0 HPI: ok
BSP 2 PCI TO SLAVE D1 HPI: ok
BSP 2 PCI TO SLAVE D2 HPI: ok

2010.05.14 00:40:54.941 109 1 OK
High Voltage Br. 1

TX36 Spec: 108.0 - 132.0
0-1 120.9
0-2 120.9
0-3 121.3
0-4 120.9
0-5 121.7
0-6 122.1
0-7 121.7
0-8 121.7
0-9 121.3
0-10 121.3
0-11 121.7
0-12 121.7
0-13 121.3
0-14 121.7
0-15 121.7
0-16 121.3
0-17 121.7
0-18 121.3
0-19 121.3
0-20 121.7
0-21 121.3

0-22 121.3
0-23 121.3
0-24 121.3

High Voltage Br. 2

TX36   Spec: 108.0 - 132.0
0-1   120.9
0-2   120.9
0-3   120.9
0-4   121.3
0-5   121.7
0-6   121.7
0-7   121.7
0-8   121.7
0-9   120.9
0-10   121.7
0-11 122.2
0-12 121.7
0-13 120.9
0-14 121.7
0-15 120.9
0-16 120.9
0-17 120.9
0-18 122.2
0-19 121.7
0-20 122.6
0-21 121.3
0-22 121.3
0-23 121.3
0-24 121.3

Input voltage 12V

TX36   Spec: 11.0 - 13.0
0-1   11.9
0-2   11.8
0-3   11.9
0-4   11.8
0-5   11.8
0-6   11.9
0-7   11.9
0-8   11.9
0-9   11.8
0-10   11.8
0-11   11.8
0-12   11.9
0-13   11.8
0-14   11.8
0-15   11.8
0-16   11.8
0-17   11.8
0-18   11.9
0-19   11.8
0-20   11.9
0-21   11.9

0-22 11.8
0-23 11.9
0-24 11.9

Digital 3.3V

TX36 Spec: 2.8 - 3.5
0-1 3.3
0-2 3.3
0-3 3.3
0-4 3.3
0-5 3.3
0-6 3.3
0-7 3.3
0-8 3.3
0-9 3.3
0-10 3.3
0-11 3.3
0-12 3.3
0-13 3.3
0-14 3.3
0-15 3.3
0-16 3.3
0-17 3.3
0-18 3.3
0-19 3.3
0-20 3.3
0-21 3.3
0-22 3.3
0-23 3.3
0-24 3.3

Digital 2.5V

TX36 Spec: 2.4 - 2.6
0-1 2.5
0-2 2.5
0-3 2.5
0-4 2.5
0-5 2.5
0-6 2.5
0-7 2.5
0-8 2.5
0-9 2.5
0-10 2.5
0-11 2.5
0-12 2.5
0-13 2.5
0-14 2.5
0-15 2.5
0-16 2.5
0-17 2.5
0-18 2.5
0-19 2.5
0-20 2.5
0-21 2.5

0-22 2.5
0-23 2.5
0-24 2.5

Digital 1.5V

TX36 Spec: 1.4 - 1.6
0-1 1.5
0-2 1.5
0-3 1.5
0-4 1.5
0-5 1.5
0-6 1.5
0-7 1.5
0-8 1.5
0-9 1.5
0-10 1.5
0-11 1.5
0-12 1.5
0-13 1.5
0-14 1.5
0-15 1.5
0-16 1.5
0-17 1.5
0-18 1.5
0-19 1.5
0-20 1.5
0-21 1.5
0-22 1.5
0-23 1.5
0-24 1.5

Temperature

TX36 Spec: 15.0 - 75.0
0-1 28.8
0-2 28.0
0-3 28.0
0-4 27.6
0-5 28.4
0-6 28.8
0-7 28.8
0-8 27.2
0-9 29.2
0-10 28.4
0-11 27.6
0-12 26.8
0-13 27.6
0-14 28.0
0-15 27.2
0-16 26.4
0-17 28.0
0-18 28.4
0-19 27.6
0-20 28.4
0-21 28.4

0-22 27.2
0-23 28.4
0-24 28.8

Input Current 12V

TX36 Spec: 0.3 - 1.5
0-1 0.6
0-2 0.5
0-3 0.6
0-4 0.5
0-5 0.5
0-6 0.5
0-7 0.6
0-8 0.5
0-9 0.5
0-10 0.5
0-11 0.5
0-12 0.5
0-13 0.5
0-14 0.5
0-15 0.5
0-16 0.5
0-17 0.6
0-18 0.5
0-19 0.5
0-20 0.5
0-21 0.5
0-22 0.5
0-23 0.6
0-24 0.5

TX36 power test passed

IO TX MB Embedded PPC Embedded PPC Download
2.11 One CPU1.13 Reduced Performance: 1 voice/Mar 5 2007/1.07 Jun 17 2008/1.11

TX36 unique firmware test OK

2010.05.14 00:41:09.641 109 2 OK

Input voltage 12V

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7

Digital 3.3V

RX32   Spec: 2.8 - 3.5
7-1   3.3
7-2   3.3

Digital 2.5V

RX32   Spec: 2.4 - 2.6
7-1   2.5
7-2   2.5

Digital 1.5V

RX32   Spec: 1.4 - 1.6
7-1   1.5
7-2   1.5

Temperature

RX32   Spec: 15.0 - 75.0
7-1   23.0
7-2   24.0

Input Current 12V

RX32   Spec: 0.4 - 1.5
7-1   0.6
7-2   0.6

Input Current 6V

RX32   Spec: 2.4 - 3.3
7-1   2.9
7-2   2.9

RX32   power test passed

IO   RX   MB Embedded   PPC Embedded   PPC Download
1.12 Generic1.14 GenericMay 5 2006/1.06 May 5 2006/1.07 Apr 25 2008/1.11

RX32 unique firmware test OK

2010.05.14 00:41:09.708 109   3   OK

High Voltage Br. 1

TX36   Spec: 108.0 - 132.0
0-1   120.9
0-2   120.9
0-3   121.3
0-4   120.9
0-5   121.7
0-6   121.7
0-7   121.7

0-8   121.7
0-9   121.3
0-10   121.3
0-11 121.7
0-12 121.7
0-13 121.3
0-14 121.7
0-15 121.3
0-16 121.3
0-17 121.7
0-18 121.3
0-19 121.3
0-20 121.7
0-21 121.3
0-22 121.3
0-23 120.9
0-24 121.3

High Voltage Br. 2

TX36   Spec: 108.0 - 132.0
0-1   120.9
0-2   120.9
0-3   120.9
0-4   121.3
0-5   121.7
0-6   121.7
0-7   121.3
0-8   121.7
0-9   120.9
0-10   121.7
0-11 122.2
0-12 121.7
0-13 120.9
0-14 121.7
0-15 120.9
0-16 120.9
0-17 120.5
0-18 122.2
0-19 121.7
0-20 122.6
0-21 121.3
0-22 121.3
0-23 121.3
0-24 121.3

Input voltage 12V

TX36   Spec: 11.0 - 13.0
0-1   11.9
0-2   11.8
0-3   11.9
0-4   11.8
0-5   11.8
0-6   11.9
0-7   11.9

0-8 11.9
0-9 11.8
0-10 11.8
0-11 11.8
0-12 11.9
0-13 11.8
0-14 11.8
0-15 11.8
0-16 11.8
0-17 11.8
0-18 11.9
0-19 11.8
0-20 11.9
0-21 11.9
0-22 11.8
0-23 11.9
0-24 11.9

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7

TRU power test passed

2010.05.14 00:41:09.825 109 4 OK

EM 122 High Voltage Ramp Test
Test Voltage:20.00 Measured Voltage: 18.00 PASSED
Test Voltage:60.00 Measured Voltage: 59.00 PASSED
Test Voltage:100.00 Measured Voltage: 100.00 PASSED
Test Voltage:120.00 Measured Voltage: 121.00 PASSED
Test Voltage:80.00 Measured Voltage: 85.00 PASSED
Test Voltage:40.00 Measured Voltage: 45.00 PASSED

6 of 6 tests OK

2010.05.14 00:43:33.914 109 5 OK

BSP 1 RXI TO RAW FIFO: ok
BSP 2 RXI TO RAW FIFO: ok

2010.05.14 00:43:38.081 109 6 OK
Receiver impedance limits [350.0 700.0] ohm
Board 1 2 3 4

1:	517.3	579.3
2:	602.1	584.7
3:	558.4	581.5
4:	583.6	581.4
5:	541.3	587.2
6:	575.4	559.1
7:	568.1	574.7
8:	586.4	585.6
9:	558.9	540.6
10:	561.3	552.0
11:	553.9	587.4
12:	573.8	576.5
13:	612.1	549.8
14:	591.0	604.2
15:	577.2	534.1
16:	602.8	572.0
17:	613.5	524.7
18:	591.8	525.1
19:	576.4	586.7
20:	509.4	589.9
21:	599.5	589.9
22:	603.9	537.6
23:	593.6	584.4
24:	593.1	582.6
25:	592.1	553.6
26:	581.1	600.6
27:	564.7	591.4
28:	593.2	569.8
29:	547.0	579.8
30:	589.6	519.1
31:	572.6	564.6
32:	567.6	566.3

Receiver Phase limits [-20.0 20.0] deg

Board	1	2	3	4
1:	5.0	-0.9		
2:	-1.6	-1.7		
3:	1.8	-1.6		
4:	-0.6	-1.2		
5:	2.9	-0.9		
6:	-0.5	0.3		
7:	0.4	-0.7		
8:	-0.7	-1.4		
9:	1.4	2.2		
10:	0.7	0.9		
11:	1.6	-1.3		
12:	0.0	-0.3		
13:	-2.1	1.9		
14:	-1.2	-2.7		
15:	0.1	3.4		
16:	-1.8	-0.6		
17:	-2.5	4.5		
18:	-1.0	4.0		
19:	0.2	-1.4		
20:	5.4	-2.0		
21:	-1.9	-1.9		

22: -2.5   2.9
23: -2.0   -1.1
24: -1.7   -1.4
25: -1.0   1.6
26: -0.3   -2.6
27:   1.8   -1.2
28: -2.1   -0.2
29:   2.8   -1.0
30: -1.5   3.9
31:   0.3   0.8
32:   0.8   -0.3
Rx Channels test passed

2010.05.14 00:44:09.316 109 7 OK

Tx Channels test passed

2010.05.14 00:46:49.956 109 8 OK

RX NOISE LEVEL

Board No: 1 2

0:	63.4	61.7	dB
1:	64.6	61.1	dB
2:	64.1	61.0	dB
3:	63.9	61.5	dB
4:	54.4	61.5	dB
5:	63.5	59.7	dB
6:	63.1	61.5	dB
7:	59.5	63.3	dB
8:	60.3	63.1	dB
9:	62.3	59.6	dB
10:	62.3	52.4	dB
11:	62.1	61.9	dB
12:	63.3	61.7	dB
13:	61.8	58.6	dB
14:	62.7	62.8	dB
15:	54.3	61.6	dB
16:	61.4	61.6	dB
17:	61.5	48.9	dB
18:	63.5	50.3	dB
19:	63.6	52.9	dB
20:	63.8	57.5	dB
21:	62.0	51.4	dB
22:	63.0	59.6	dB
23:	59.8	61.6	dB
24:	61.1	57.9	dB
25:	63.3	61.0	dB
26:	62.9	61.3	dB
27:	62.9	60.2	dB
28:	59.2	60.5	dB

29:	54.0	59.4	dB
30:	62.3	57.1	dB
31:	60.5	60.3	dB

Maximum noise at Board 1 Channel 1 Level: 64.6 dB

Broadband noise test

Average noise at Board 1 62.2 dB OK

2010.05.14 00:46:55.606 109 9 OK

RX NOISE SPECTRUM

Board No:	1	2	
10.0 kHz:	59.7	58.3	dB
10.2 kHz:	60.6	59.4	dB
10.3 kHz:	61.9	60.7	dB
10.4 kHz:	61.9	61.8	dB
10.6 kHz:	63.1	61.6	dB
10.7 kHz:	63.3	62.8	dB
10.9 kHz:	63.8	62.4	dB
11.0 kHz:	63.5	62.3	dB
11.2 kHz:	63.8	62.9	dB
11.3 kHz:	63.9	62.2	dB
11.4 kHz:	63.8	62.8	dB
11.6 kHz:	63.8	62.5	dB
11.7 kHz:	63.0	62.6	dB
11.9 kHz:	63.4	61.9	dB
12.0 kHz:	63.0	62.0	dB
12.1 kHz:	63.2	62.2	dB
12.3 kHz:	62.0	61.8	dB
12.4 kHz:	61.9	61.5	dB
12.6 kHz:	61.7	60.7	dB
12.7 kHz:	60.9	60.3	dB
12.9 kHz:	60.9	59.5	dB
13.0 kHz:	60.2	59.1	dB

Maximum noise at Board 1 Frequency 11.3 kHz Level: 63.9 dB

Spectral noise test

Average noise at Board 1 62.6 dB OK
Average noise at Board 2 61.6 dB OK

2010.05.14 00:47:01.257 109 10 OK

CPU: KOM CP6011
Clock 1795 MHz
Die 38 oC (peak: 40 oC @ 2010-05-14 - 00:43:38)
Board 38 oC (peak: 39 oC @ 2010-05-14 - 00:46:56)

Core 1.30 V
3V3 3.28 V
12V 11.91 V
-12V -12.04 V
BATT 3.49 V
Primary network: 157.237.14.60:0xffff0000
Secondary network: 192.168.1.122:0xffffff00

2010.05.14 00:47:01.290 109 15 OK

EM 122

BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.1.5 091110
DDS: 3.4.9 070328
RX32 version : Apr 25 2008 Rev 1.11
TX36 LC version : Jun 17 2008 Rev 1.11
VxWorks 5.5.1 Build 1.2/2-IX0100 May 16 2007, 11:31:17

- -

End of Apia Harbor pier BIST Test

BIST test during transit at 11 knts

Saved: 2010.05.19 06:07:52
Sounder Type: 122, Serial no.: 109
Date Time Ser. No. BIST Result

2010.05.19 06:01:12.242 109 0 OK
Number of BSP67B boards: 2
BSP 1 Master 2.3 090702 4.3 070913 4.3 070913
BSP 1 Slave 2.3 090702 6.0 080902
BSP 1 RXI FPGA 3.6 080821
BSP 1 DSP FPGA A 4.0 070531
BSP 1 DSP FPGA B 4.0 070531
BSP 1 DSP FPGA C 4.0 070531
BSP 1 DSP FPGA D 4.0 070531
BSP 1 PCI TO SLAVE A1 FIFO: ok
BSP 1 PCI TO SLAVE A2 FIFO: ok
BSP 1 PCI TO SLAVE A3 FIFO: ok
BSP 1 PCI TO SLAVE B1 FIFO: ok
BSP 1 PCI TO SLAVE B2 FIFO: ok
BSP 1 PCI TO SLAVE B3 FIFO: ok
BSP 1 PCI TO SLAVE C1 FIFO: ok
BSP 1 PCI TO SLAVE C2 FIFO: ok
BSP 1 PCI TO SLAVE C3 FIFO: ok
BSP 1 PCI TO SLAVE D1 FIFO: ok
BSP 1 PCI TO SLAVE D2 FIFO: ok
BSP 1 PCI TO SLAVE D3 FIFO: ok
BSP 1 PCI TO MASTER A HPI: ok
BSP 1 PCI TO MASTER B HPI: ok
BSP 1 PCI TO MASTER C HPI: ok

BSP 1 PCI TO MASTER D HPI: ok
BSP 1 PCI TO SLAVE A0 HPI: ok
BSP 1 PCI TO SLAVE A1 HPI: ok
BSP 1 PCI TO SLAVE A2 HPI: ok
BSP 1 PCI TO SLAVE B0 HPI: ok
BSP 1 PCI TO SLAVE B1 HPI: ok
BSP 1 PCI TO SLAVE B2 HPI: ok
BSP 1 PCI TO SLAVE C0 HPI: ok
BSP 1 PCI TO SLAVE C1 HPI: ok
BSP 1 PCI TO SLAVE C2 HPI: ok
BSP 1 PCI TO SLAVE D0 HPI: ok
BSP 1 PCI TO SLAVE D1 HPI: ok
BSP 1 PCI TO SLAVE D2 HPI: ok
BSP 2 Master 2.3 090702 4.3 070913 4.3 070913
BSP 2 Slave 2.3 090702 6.0 080902
BSP 2 RXI FPGA 3.6 080821
BSP 2 DSP FPGA A 4.0 070531
BSP 2 DSP FPGA B 4.0 070531
BSP 2 DSP FPGA C 4.0 070531
BSP 2 DSP FPGA D 4.0 070531
BSP 2 PCI TO SLAVE A1 FIFO: ok
BSP 2 PCI TO SLAVE A2 FIFO: ok
BSP 2 PCI TO SLAVE A3 FIFO: ok
BSP 2 PCI TO SLAVE B1 FIFO: ok
BSP 2 PCI TO SLAVE B2 FIFO: ok
BSP 2 PCI TO SLAVE B3 FIFO: ok
BSP 2 PCI TO SLAVE C1 FIFO: ok
BSP 2 PCI TO SLAVE C2 FIFO: ok
BSP 2 PCI TO SLAVE C3 FIFO: ok
BSP 2 PCI TO SLAVE D1 FIFO: ok
BSP 2 PCI TO SLAVE D2 FIFO: ok
BSP 2 PCI TO SLAVE D3 FIFO: ok
BSP 2 PCI TO MASTER A HPI: ok
BSP 2 PCI TO MASTER B HPI: ok
BSP 2 PCI TO MASTER C HPI: ok
BSP 2 PCI TO MASTER D HPI: ok
BSP 2 PCI TO SLAVE A0 HPI: ok
BSP 2 PCI TO SLAVE A1 HPI: ok
BSP 2 PCI TO SLAVE A2 HPI: ok

BSP 2 PCI TO SLAVE B0 HPI: ok
BSP 2 PCI TO SLAVE B1 HPI: ok
BSP 2 PCI TO SLAVE B2 HPI: ok
BSP 2 PCI TO SLAVE C0 HPI: ok
BSP 2 PCI TO SLAVE C1 HPI: ok
BSP 2 PCI TO SLAVE C2 HPI: ok
BSP 2 PCI TO SLAVE D0 HPI: ok
BSP 2 PCI TO SLAVE D1 HPI: ok
BSP 2 PCI TO SLAVE D2 HPI: ok

2010.05.19 06:01:13.042 109   1   OK
High Voltage Br. 1

TX36   Spec: 108.0 - 132.0
0-1   120.5
0-2   120.5

0-3   120.9
0-4   120.5
0-5   121.3
0-6   121.3
0-7   121.3
0-8   120.9
0-9   120.5
0-10   120.9
0-11 121.3
0-12 121.3
0-13 120.9
0-14 121.3
0-15 120.9
0-16 120.9
0-17 120.9
0-18 120.9
0-19 120.5
0-20 121.3
0-21 120.9
0-22 120.5
0-23 120.5
0-24 120.9
High Voltage Br. 2

TX36   Spec: 108.0 - 132.0
0-1   120.1
0-2   120.5
0-3   120.5
0-4   120.9
0-5   121.3
0-6   121.3
0-7   120.9
0-8   121.3
0-9   120.5
0-10   120.9
0-11 121.7
0-12 121.3
0-13 120.5
0-14 121.3
0-15 120.5
0-16 120.5
0-17 120.1
0-18 121.7
0-19 120.9
0-20 122.2
0-21 120.9
0-22 120.9
0-23 120.9
0-24 120.9
Input voltage 12V

TX36   Spec: 11.0 - 13.0
0-1   11.9
0-2   11.8
0-3   11.9

0-4 11.8
0-5 11.8
0-6 11.9
0-7 11.9
0-8 11.9
0-9 11.8
0-10 11.8
0-11 11.8
0-12 11.9
0-13 11.8
0-14 11.8
0-15 11.8
0-16 11.7
0-17 11.8
0-18 11.9
0-19 11.8
0-20 11.9
0-21 11.8
0-22 11.8
0-23 11.9
0-24 11.9
Digital 3.3V

TX36 Spec: 2.8 - 3.5
0-1 3.3
0-2 3.3
0-3 3.3
0-4 3.3
0-5 3.3
0-6 3.3
0-7 3.3
0-8 3.3
0-9 3.3
0-10 3.3

0-11 3.3
0-12 3.3
0-13 3.3
0-14 3.3
0-15 3.3
0-16 3.3
0-17 3.3
0-18 3.3
0-19 3.3
0-20 3.3
0-21 3.3
0-22 3.3
0-23 3.3
0-24 3.3
Digital 2.5V

TX36 Spec: 2.4 - 2.6
0-1 2.5
0-2 2.5
0-3 2.5
0-4 2.5

0-5 2.5
0-6 2.5
0-7 2.5
0-8 2.5
0-9 2.5
0-10 2.5
0-11 2.5
0-12 2.5
0-13 2.5
0-14 2.5
0-15 2.5
0-16 2.5
0-17 2.5
0-18 2.5
0-19 2.5
0-20 2.5
0-21 2.5
0-22 2.5
0-23 2.5
0-24 2.5
Digital 1.5V

TX36 Spec: 1.4 - 1.6
0-1 1.5
0-2 1.5
0-3 1.5
0-4 1.5
0-5 1.5
0-6 1.5
0-7 1.5
0-8 1.5
0-9 1.5
0-10 1.5
0-11 1.5
0-12 1.5
0-13 1.5
0-14 1.5
0-15 1.5
0-16 1.5
0-17 1.5
0-18 1.5
0-19 1.5
0-20 1.5
0-21 1.5
0-22 1.5
0-23 1.5
0-24 1.5
Temperature

TX36 Spec: 15.0 - 75.0
0-1 39.2
0-2 38.8
0-3 38.4
0-4 37.2
0-5 38.4
0-6 38.4

0-7 38.0
0-8 36.4
0-9 38.4
0-10 37.2
0-11 36.4
0-12 36.0
0-13 37.2
0-14 38.0
0-15 37.6
0-16 37.2
0-17 39.2
0-18 40.0
0-19 39.2
0-20 39.6
0-21 39.6
0-22 38.4
0-23 39.6
0-24 39.6
Input Current 12V

TX36 Spec: 0.3 - 1.5
0-1 0.6
0-2 0.5
0-3 0.6
0-4 0.5
0-5 0.5
0-6 0.5
0-7 0.6
0-8 0.6
0-9 0.5
0-10 0.5
0-11 0.5
0-12 0.5
0-13 0.5
0-14 0.6
0-15 0.5
0-16 0.5
0-17 0.6
0-18 0.5
0-19 0.6
0-20 0.5
0-21 0.6
0-22 0.6
0-24 0.5
TX36 power test passed
IO TX MB Embedded PPC Embedded PPC Download
2.11 One CPU1.13 Reduced Performance: 1 voice/Mar 5 2007/1.07 Jun 17 2008/1.11
TX36 unique firmware test OK

2010.05.19 06:01:13.159 109 2 OK
Input voltage 12V

RX32 Spec: 11.0 - 13.0
7-1 11.8
7-2 11.8
Input voltage 6V

RX32   Spec: 5.0 - 7.0
7-1   5.7
7-2   5.7
Digital 3.3V

RX32   Spec: 2.8 - 3.5
7-1   3.3
7-2   3.3
Digital 2.5V

RX32   Spec: 2.4 - 2.6
7-1   2.5
7-2   2.5
Digital 1.5V

RX32   Spec: 1.4 - 1.6
7-1   1.5
7-2   1.5
Temperature

RX32   Spec: 15.0 - 75.0
7-1   39.0
7-2   39.0
Input Current 12V

RX32   Spec: 0.4 - 1.5
7-1   0.6
7-2   0.6
Input Current 6V

RX32   Spec: 2.4 - 3.3
7-1   2.8
7-2   2.9
RX32   power test passed
IO   RX   MB Embedded   PPC Embedded   PPC Download
1.12 Generic1.14 GenericMay 5 2006/1.06 May 5 2006/1.07 Apr 25 2008/1.11
RX32 unique firmware test OK

2010.05.19 06:01:13.225 109   3   OK
High Voltage Br. 1

TX36   Spec: 108.0 - 132.0
0-1   120.5
0-2   120.5
0-3   120.9
0-4   120.5
0-5   121.3
0-6   121.3
0-7   121.3
0-8   121.3
0-9   120.5
0-10   120.9
0-11 121.3
0-12 121.3
0-13 120.9

0-14 121.3
0-15 120.9
0-16 120.9
0-17 121.3
0-18 120.5
0-19 120.9
0-20 121.3
0-21 120.5
0-22 120.9
0-23 120.9
0-24 120.9
High Voltage Br. 2

TX36   Spec: 108.0 - 132.0
0-1   120.5
0-2   120.5
0-3   120.5
0-4   120.9
0-5   121.3
0-6   121.3
0-7   120.9
0-8   121.3
0-9   120.5
0-10   120.9
0-11 121.7
0-12 120.9
0-13 120.1
0-14 121.3
0-15 120.5
0-16 120.5
0-17 120.1
0-18 121.3
0-19 120.9
0-20 122.2
0-21 120.9
0-22 120.9
0-23 120.9
0-24 120.9
Input voltage 12V

TX36   Spec: 11.0 - 13.0
0-1   11.8
0-2   11.8
0-3   11.9
0-4   11.8
0-5   11.8
0-6   11.9
0-7   11.9
0-8   11.9
0-9   11.8
0-10   11.8
0-11   11.8
0-12   11.9
0-13   11.8
0-14   11.8
0-15   11.8

0-16   11.7
0-17   11.8
0-18   11.9
0-19   11.8
0-20   11.9
0-21   11.9
0-22   11.8
0-23   11.9
0-24   11.8
RX32   Spec: 11.0 - 13.0
7-1   11.8
7-2   11.8
Input voltage 6V

RX32   Spec: 5.0 - 7.0
7-1   5.7
7-2   5.7
TRU power test passed

2010.05.19 06:01:13.342 109   4   OK
EM 122 High Voltage Ramp Test
Test Voltage:20.00 Measured Voltage: 19.00 PASSED
Test Voltage:60.00 Measured Voltage: 59.00 PASSED
Test Voltage:100.00 Measured Voltage: 100.00 PASSED
Test Voltage:120.00 Measured Voltage: 121.00 PASSED
Test Voltage:80.00 Measured Voltage: 85.00 PASSED
Test Voltage:40.00 Measured Voltage: 45.00 PASSED
6 of 6 tests OK

2010.05.19 06:03:37.415 109   5   OK
BSP 1 RXI TO RAW FIFO: ok
BSP 2 RXI TO RAW FIFO: ok

2010.05.19 06:03:41.598 109   6   OK
Receiver impedance limits [350.0 700.0] ohm
Board 1   2   3   4
1: 503.7 559.6
2: 581.9 561.4
3: 545.4 559.5
4: 564.1 561.3
5: 522.5 567.2
6: 557.1 540.4
7: 548.8 553.6
8: 563.0 567.2
9: 534.7 525.7
10: 543.1 533.4
11: 534.1 560.9
12: 552.5 553.9
13: 585.7 531.5
14: 569.2 578.3
15: 556.7 520.6
16: 575.0 554.1
17: 593.3 511.6
18: 570.6 510.4
19: 559.1 562.8
20: 499.8 566.6

21: 579.4 566.7
22: 584.3 522.9
23: 575.5 565.4
24: 571.2 565.0
25: 570.1 538.0
26: 562.5 575.4
27: 548.7 568.7
28: 569.3 548.4
29: 532.3 558.1
30: 565.7 506.2
31: 554.5 545.6
32: 549.4 554.4
Receiver Phase limits [-20.0 20.0] deg
Board 1   2   3   4
1:   4.4   -0.8
2: -1.4   -1.3
3:   1.2   -1.3
4: -0.6   -1.2
5:   2.8   -0.9
6: -0.6   0.2
7:   0.4   -0.5
8: -0.3   -1.4
9:   1.7   1.8
10:   0.6   0.8
11:   1.6   -0.7
12:   0.1   -0.1
13: -1.6   1.7
14: -1.0   -2.1
15:   0.2   2.8
16: -1.1   -0.7
17: -2.4   3.9
18: -0.9   3.6
19: -0.1   -1.0
20:   4.5   -1.6
21: -1.9   -1.5
22: -2.5   2.4
23: -2.1   -1.1
24: -1.5   -1.6
25: -0.8   1.2
26: -0.4   -2.0
27:   1.4   -0.9
28: -1.7   0.0
29:   2.2   -0.7
30: -1.1   3.3
31:   0.1   0.7
32:   0.6   -1.0
Rx Channels test passed

2010.05.19 06:04:12.833 109   7   OK
Tx Channels test passed

2010.05.19 06:06:53.473 109   8   OK
RX NOISE LEVEL
Board No: 1   2
0:        63.1   51.0   dB
1:        60.8   50.4   dB

2:	60.3	51.4	dB
3:	58.7	50.8	dB
4:	50.0	50.4	dB
5:	57.0	49.2	dB
6:	55.9	51.3	dB
7:	55.9	56.5	dB
8:	55.5	61.0	dB
9:	53.8	50.3	dB
10:	54.6	43.1	dB
11:	53.8	52.4	dB
12:	54.8	51.4	dB
13:	53.1	48.6	dB
14:	52.6	53.4	dB
15:	50.2	53.1	dB
16:	56.3	53.2	dB
17:	50.9	42.0	dB
18:	52.4	43.6	dB
19:	53.4	45.4	dB
20:	52.7	49.9	dB
21:	52.2	45.8	dB
22:	51.7	53.2	dB
23:	56.5	55.9	dB
24:	53.5	52.8	dB
25:	51.7	56.4	dB
26:	52.5	58.4	dB
27:	52.3	58.0	dB
28:	50.7	59.2	dB
29:	46.5	59.8	dB
30:	52.7	58.8	dB
31:	52.0	67.8	dB

Maximum noise at Board 2 Channel 31 Level: 67.8 dB
Broadband noise test

Average noise at Board 1 55.6 dB OK
Average noise at Board 2 56.7 dB OK

2010.05.19 06:06:59.140 109 9 OK
RX NOISE SPECTRUM

Board No:	1	2	
10.0 kHz:	49.1	49.6	dB
10.2 kHz:	50.5	51.8	dB
10.3 kHz:	51.9	52.0	dB
10.4 kHz:	53.2	53.4	dB
10.6 kHz:	54.6	54.7	dB
10.7 kHz:	56.5	56.5	dB
10.9 kHz:	54.9	55.2	dB
11.0 kHz:	53.8	56.4	dB
11.2 kHz:	52.6	55.4	dB
11.3 kHz:	52.1	53.1	dB
11.4 kHz:	52.4	53.9	dB
11.6 kHz:	52.3	54.1	dB
11.7 kHz:	52.1	53.6	dB
11.9 kHz:	52.3	53.8	dB
12.0 kHz:	53.0	54.6	dB
12.1 kHz:	54.3	54.3	dB
12.3 kHz:	53.9	53.2	dB

12.4 kHz: 50.8   51.6   dB
12.6 kHz: 50.3   52.0   dB
12.7 kHz: 49.6   51.9   dB
12.9 kHz: 48.0   49.5   dB
13.0 kHz: 48.7   48.2   dB
Maximum noise at Board 1 Frequency 10.7 kHz Level: 56.5 dB
Spectral noise test

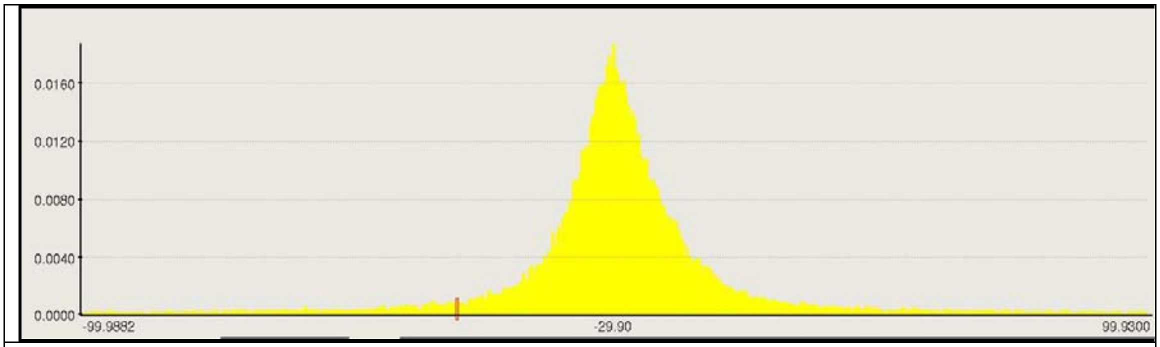
Average noise at Board 1   52.6 dB   OK
Average noise at Board 2   53.6 dB   OK

2010.05.19 06:07:04.807 109   10   OK
CPU: KOM CP6011
Clock 1795 MHz
Die   47 oC (peak: 56 oC @ 2010-05-19 - 01:26:49)
Board 51 oC (peak: 52 oC @ 2010-05-19 - 05:32:50)
Core 1.31 V
3V3   3.28 V
12V   11.91 V
-12V -12.04 V
BATT 3.50 V
Primary network: 157.237.14.60:0xffff0000
Secondary network: 192.168.1.122:0xffffff00

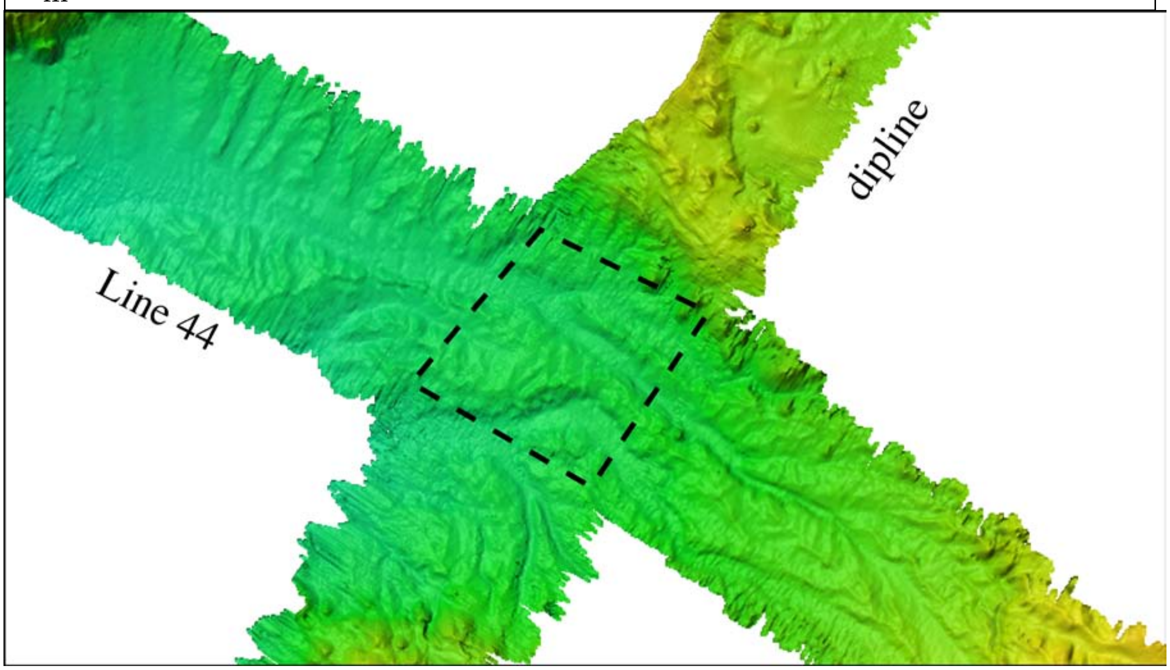
2010.05.19 06:07:04.841 109   15   OK
EM 122
BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.1.5 091110
DDS: 3.4.9 070328
RX32 version : Apr 25 2008 Rev 1.11
TX36 LC version : Jun 17 2008 Rev 1.11
VxWorks 5.5.1 Build 1.2/2-IX0100 May 16 2007, 11:31:17

End of transit BIST Test

Appendix 7. Cross-check analyses

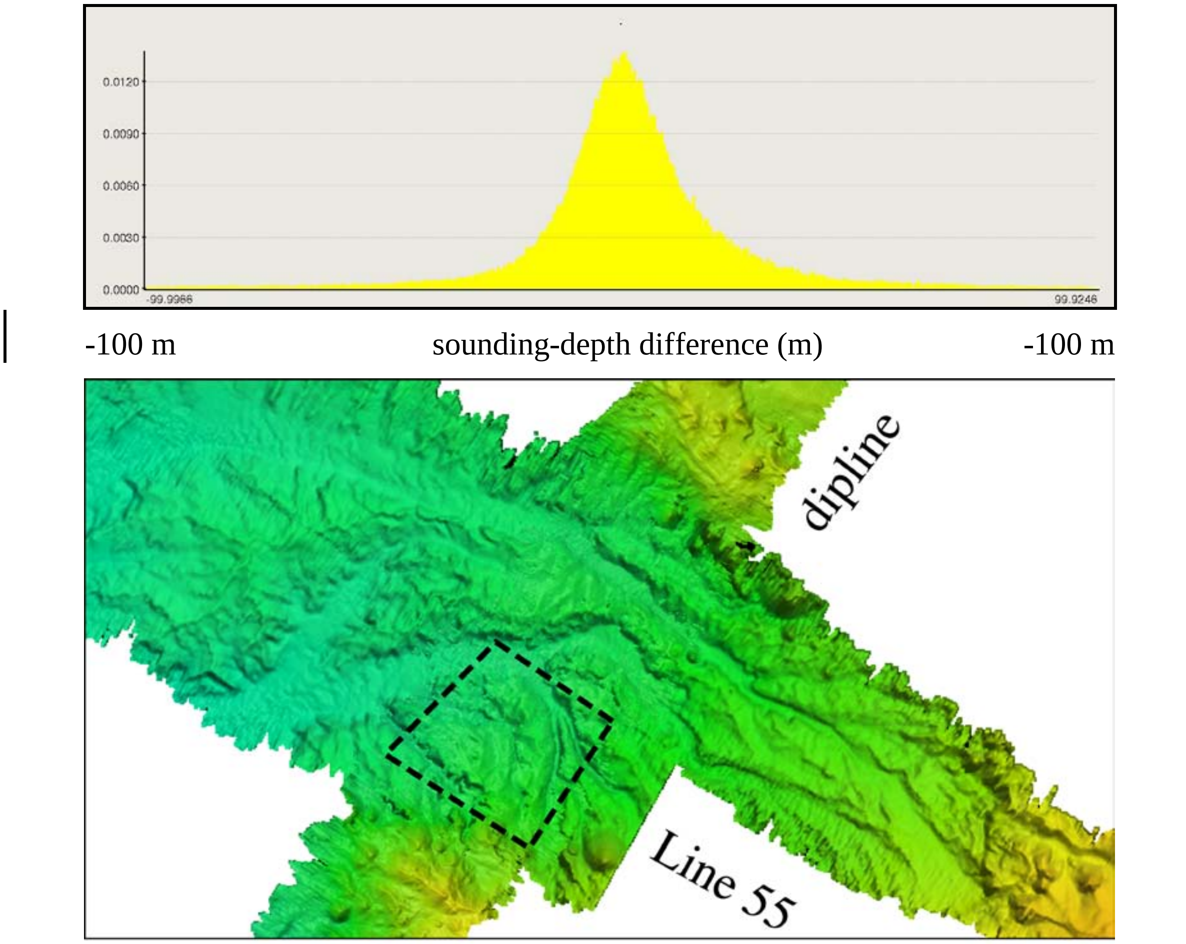


-100 m sounding-depth difference +100 m



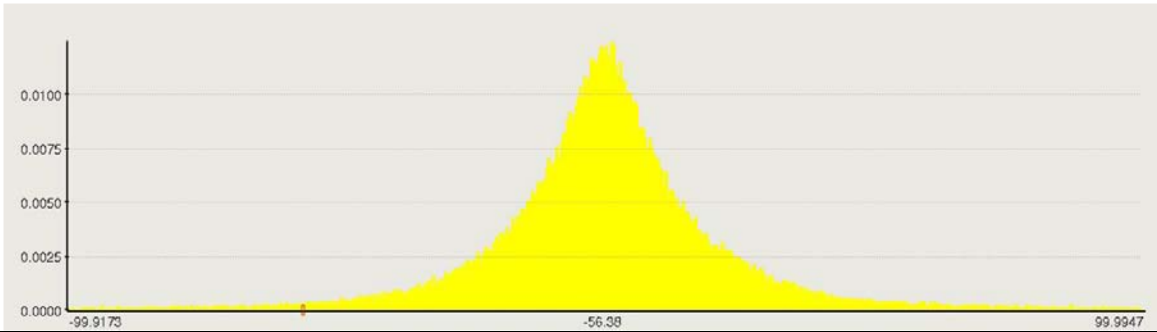
(upper) Histogram of sounding-depth differences from cross-line check of Line 44 and dipline. (lower) DTM showing area of cross-line check (dashed polygon).

Line 44 vs dipliine	Mean water depth	4000 m
	Mean Z difference	1.6 m
	Standard deviation	18.25 m
	Number of samples	995,906
	Percent of water depth	1.0% at 2σ

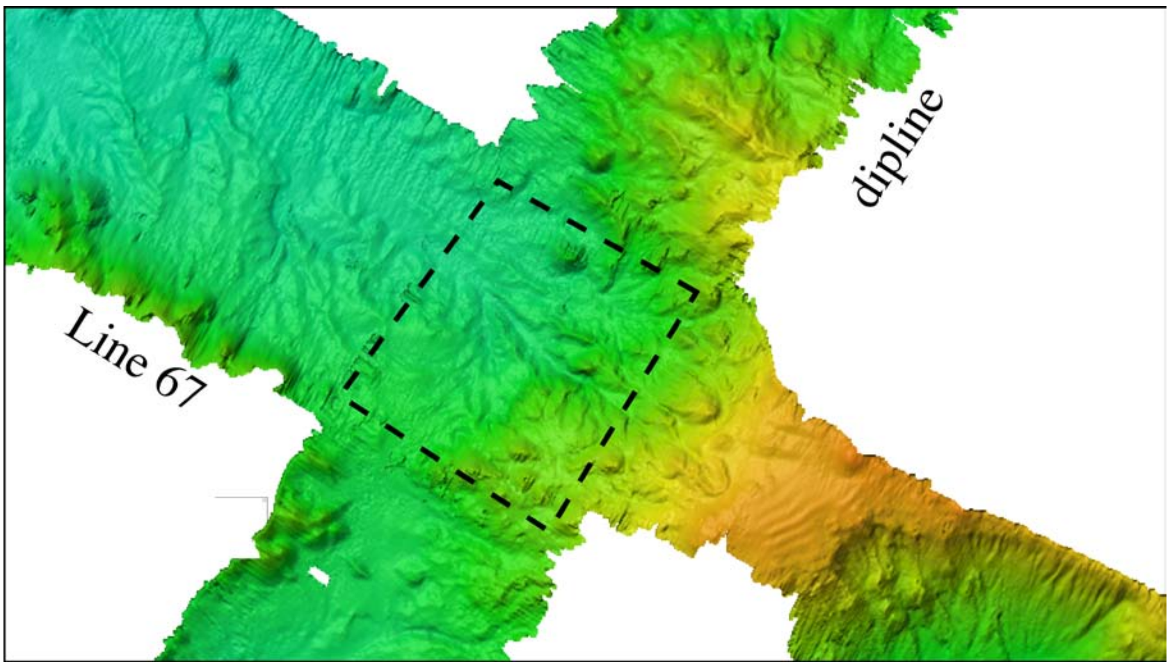


(upper) Histogram of sounding-depth differences from cross-line check of Line 55 and dipline. (lower) DTM showing area of cross-line check (dashed polygon).

Line 55 vs dipliine	Mean water depth	3567
	Mean Z difference	2.2 m
	Standard deviation	34.0 m
	Number of samples	101,998
	Percent of water depth	1.9% at 2σ

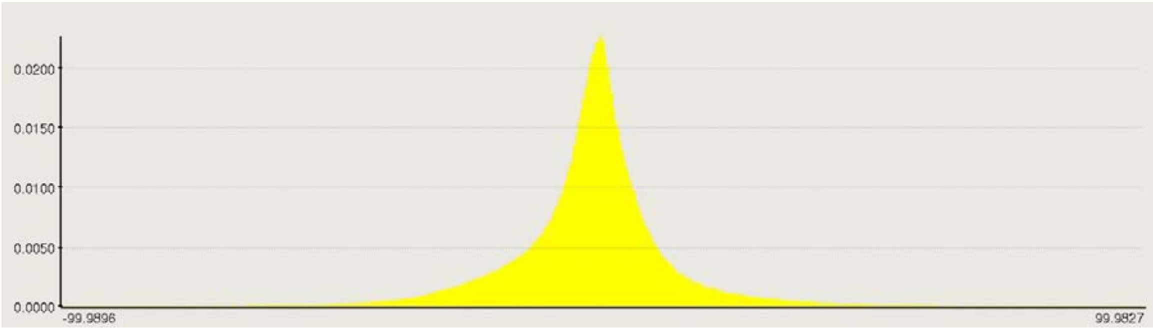


-100 m sounding-depth difference (m) -100 m

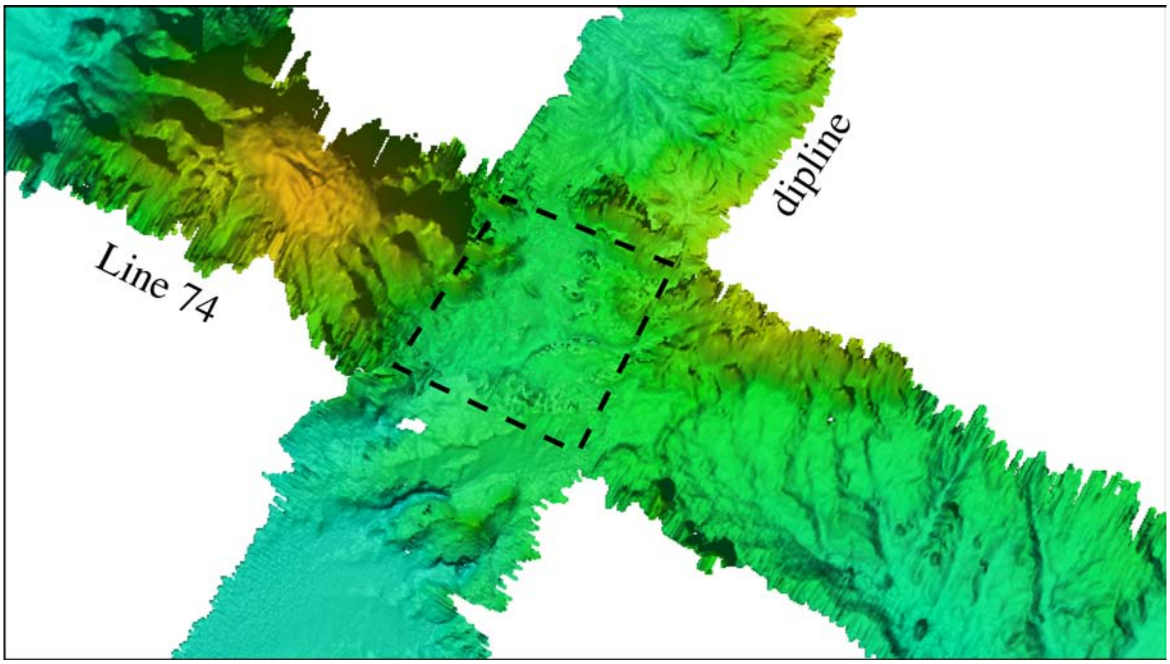


(upper) Histogram of sounding-depth differences from cross-line check of Line 67 and dipline. (lower) DTM showing area of cross-line check (dashed polygon).

Line 67 vs dipliine	Mean water depth	3357 m
	Mean Z difference	0.1 m
	Standard deviation	23.1 m
	Number of samples	81,691
	Percent of water depth	1.3% at 2σ

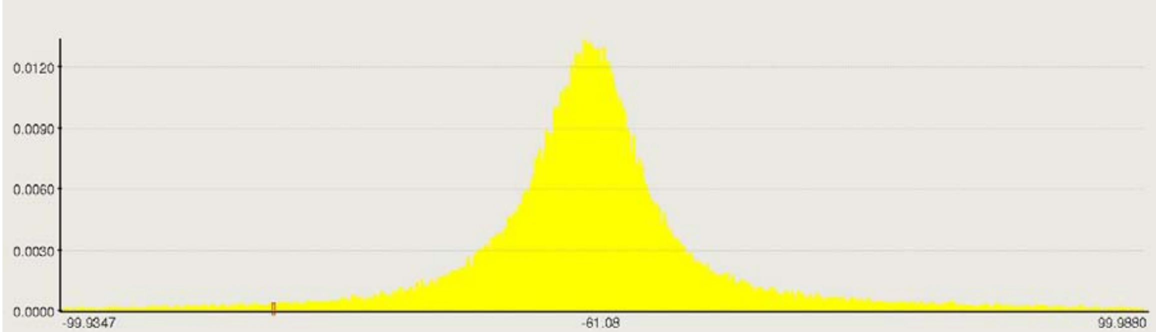


-100 m sounding-depth difference (m) -100 m

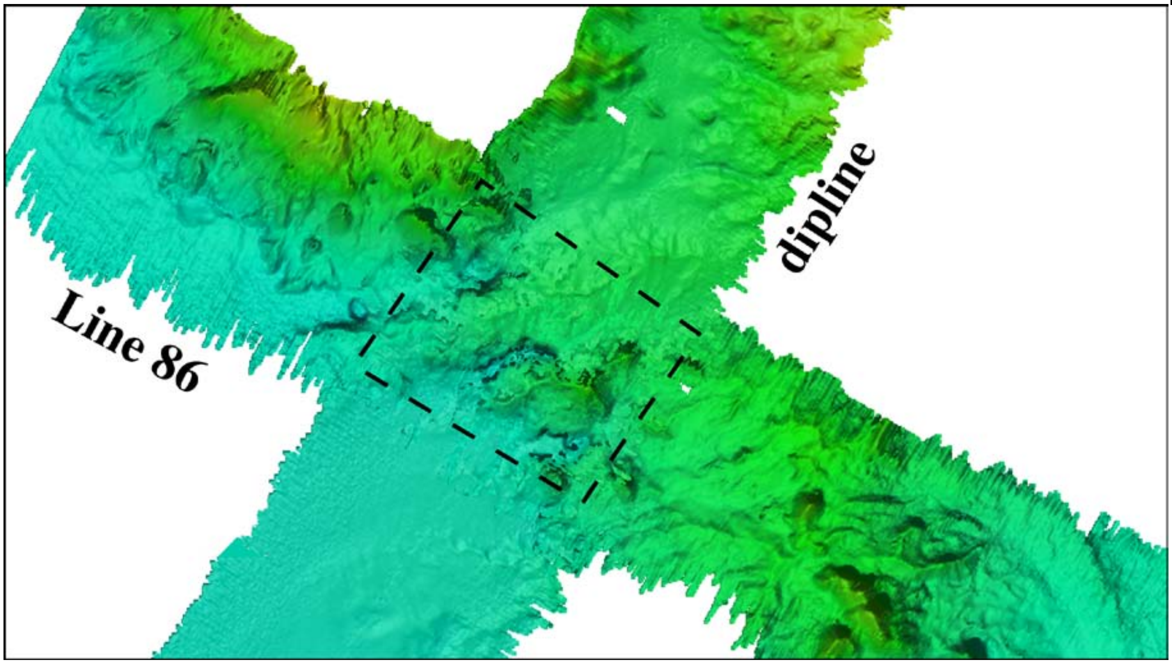


(upper) Histogram of sounding-depth differences from cross-line check of Line 74 and dipline. (lower) DTM showing area of cross-line check (dashed polygon).

Line 74 vs dipliine	Mean water depth	3085 m
	Mean Z difference	2.14
	Standard deviation	15.9 m
	Number of samples	1,049,057
	Percent of water depth	1.0% at 2σ

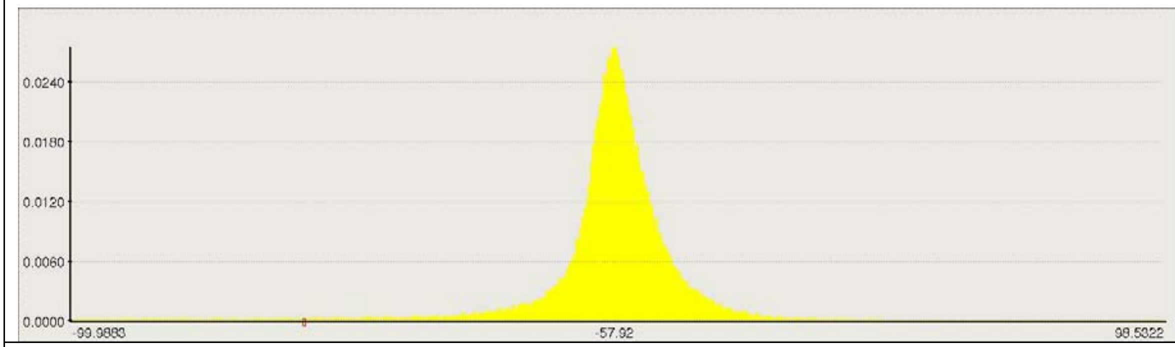


-100 m sounding-depth difference (m) -100 m

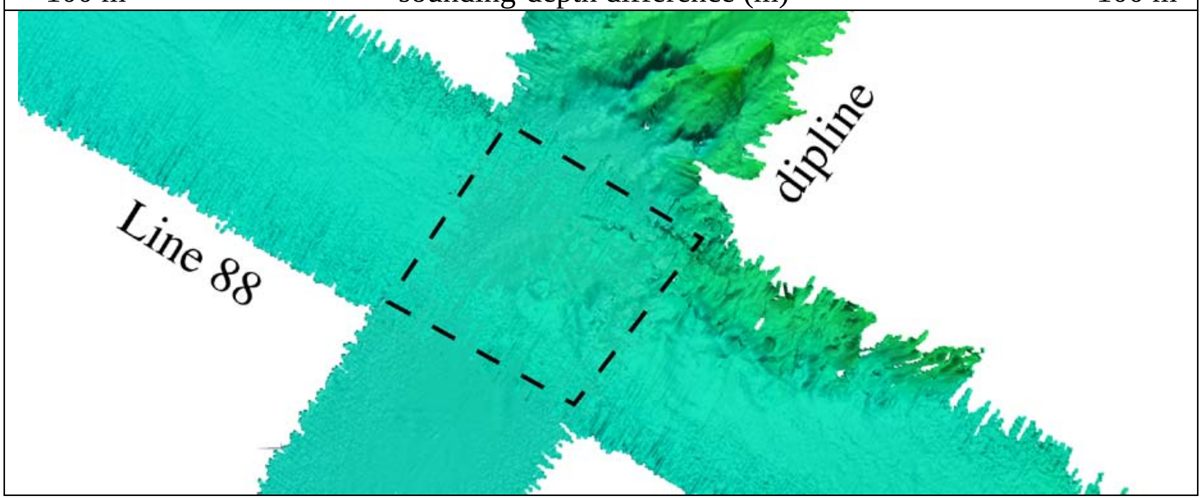


(upper) Histogram of sounding-depth differences from cross-line check of Line 86 and dipline. (lower) DTM showing area of cross-line check (dashed polygon).

Line 86 vs dipliine	Mean water depth	3863 m
	Mean Z difference	2.28 m
	Standard deviation	24.2 m
	Number of samples	89,252
	Percent of water depth	1.2% at 2σ

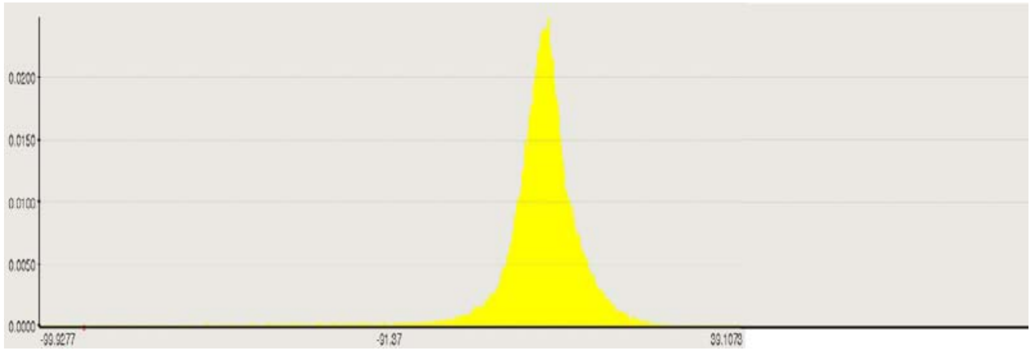


-100 m	sounding-depth difference (m)	-100 m

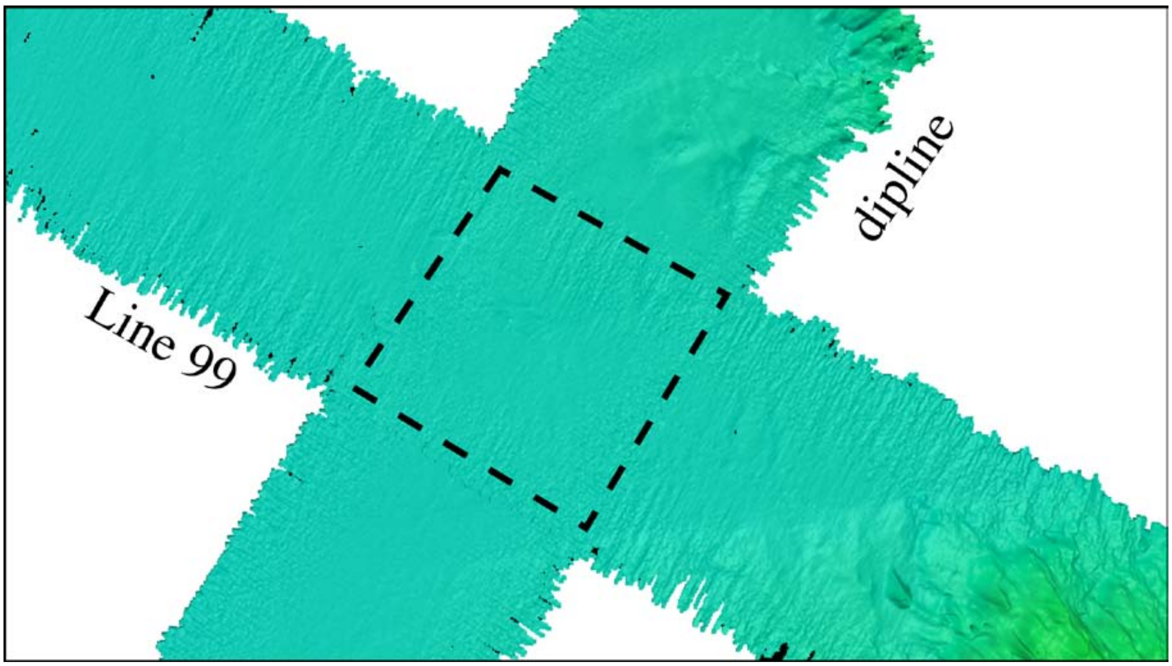


(upper) Histogram of sounding-depth differences from cross-line check of Line 88 and dipline. (lower) DTM showing area of cross-line check (dashed polygon).

Line 88 vs dipliine	Mean water depth	4276 m
	Mean Z difference	2.28 m
	Standard deviation	15.9 m
	Number of samples	66,566
	Percent of water depth	0.7% at 2σ

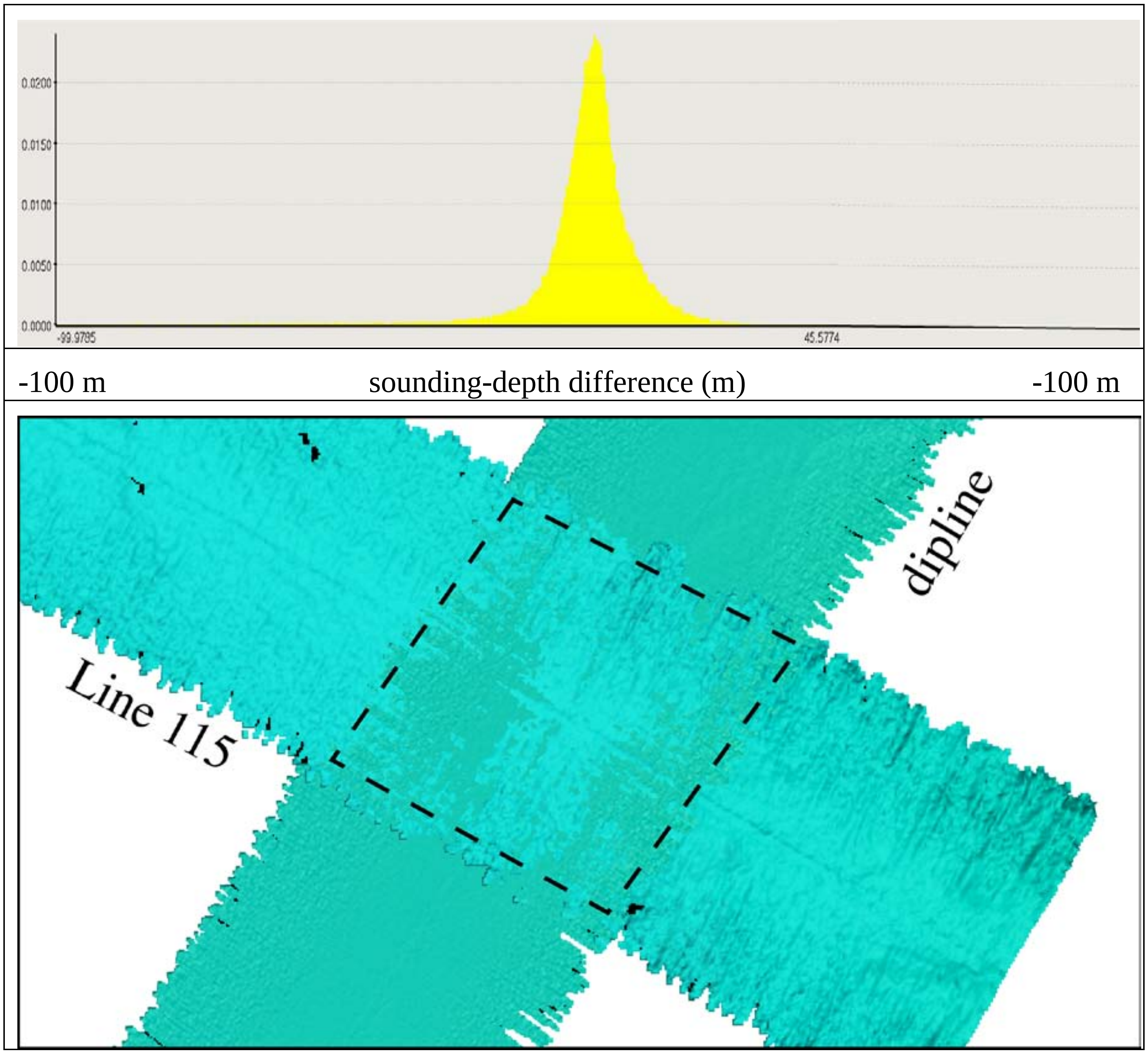


-100 m sounding-depth difference (m) -100 m



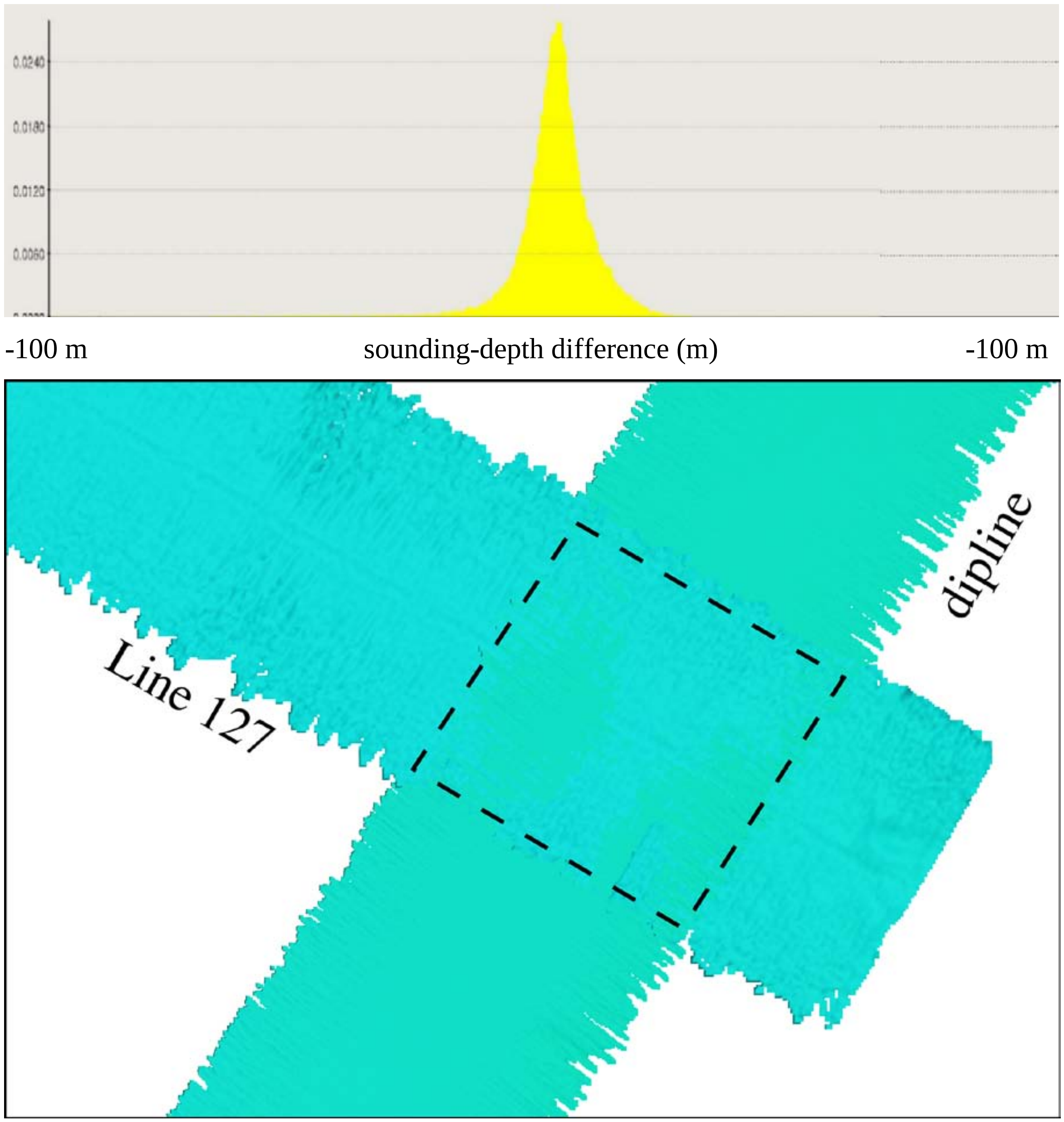
(upper) Histogram of sounding-depth differences from cross-line check of Line 99 and dipline. (lower) DTM showing area of cross-line check (dashed polygon).

Line 99 vs dipliine	Mean water depth	4357 m
	Mean Z difference	1.79 m
	Standard deviation	10.0 m
	Number of samples	88546
	Percent of water depth	0.4% at 2σ



(upper) Histogram of sounding-depth differences from cross-line check of Line 115 and dipline. (lower) DTM showing area of cross-line check (dashed polygon).

Line 115 vs dipliine	Mean water depth	4394 m
	Mean Z difference	1.29 m
	Standard deviation	11.4 m
	Number of samples	91966
	Percent of water depth	0.5% at 2σ



(upper) Histogram of sounding-depth differences from cross-line check of Line 127 and dipline. (lower) DTM showing area of cross-line check (dashed polygon).

Line 99 vs dipliine	Mean water depth	4419 m
	Mean Z difference	1.03 m
	Standard deviation	10.1 m
	Number of samples	94,360
	Percent of water depth	0.4% at 2σ

Appendix 8. Calibration Report for the CTD

Instrument configuration file: C:\CTD Data\km1009\KM1009_Cast1.con
Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 1
Voltage words suppressed : 0
Computer interface : RS-232C
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : No
NMEA device connected to : PC
Surface PAR voltage added : No
Scan time added : No
1) Frequency 0, Temperature
Serial number : 2013
Calibrated on : 17-Jun-2009
G : 4.16201029e-003
H : 6.36694282e-004
I : 2.22326267e-005
J : 2.39459894e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000
2) Frequency 1, Conductivity
Serial number : 3326
Calibrated on : 04-Feb-2010
G : -9.97924129e+000
H : 1.40987260e+000
I : 3.87272340e-004
J : 3.94652581e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000
3) Frequency 2, Pressure, Digiquartz with TC
Serial number : 92859
Calibrated on : 02-Feb-2009
C1 : -3.925976e+004
C2 : 5.521649e-001
C3 : 1.316830e-002
D1 : 3.870500e-002
D2 : 0.000000e+000
T1 : 3.023695e+001
T2 : -1.084036e-004
T3 : 4.196690e-006

T4 : 3.738330e-009
T5 : 0.000000e+000
Slope : 0.99987000
Offset : -1.39060
AD590M : 1.135000e-002
AD590B : -8.802100e+000
4) Frequency 3, Temperature, 2
Serial number : 2700
Calibrated on : 17-Jun-2009
G : 4.36277174e-003
H : 6.49451878e-004
I : 2.45256373e-005
J : 2.43273063e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000
5) A/D voltage 0, Oxygen, SBE 43
Serial number : 0310
Calibrated on : 05-Jul-2009p
Equation : Murphy-Larson
Coefficients for Owens-Millard:
Soc : 0.0000e+000
Boc : 0.0000
Offset : 0.0000
Tcor : 0.0000
Pcor : 0.00e+000
Tau : 0.0
Coefficients for Murphy-Larson:
Soc : 4.10200e-001
Offset : -4.56000e-001
A : -1.50030e-003
B : 1.30820e-004
C : -1.81360e-006
E : 3.60000e-002
Tau : 1.04000e+000
6) A/D voltage 1, Oxygen, SBE 43, 2
Serial number : 0325
Calibrated on : 30Jan-10p
Equation : Murphy-Larson
Coefficients for Owens-Millard:
Soc : 0.0000e+000
Boc : 0.0000
Offset : 0.0000
Tcor : 0.0000
Pcor : 0.00e+000
Tau : 0.0
Coefficients for Murphy-Larson:

Soc : 4.36900e-001
Offset : -4.96600e-001
A : -1.23730e-003
B : 1.49940e-004
C : -2.72380e-006
E : 3.60000e-002
Tau : 1.41000e+000
7) A/D voltage 2, Free
8) A/D voltage 3, Free
9) A/D voltage 4, Free
10) A/D voltage 5, Free
11) A/D voltage 6, Free
12) A/D voltage 7, Free

Appendix 9. Color shaded-relief bathymetry and acoustic backscatter maps of eastern section of Kingman Palmyra area.