CRUISE REPORT

RV *Atlantis* (AGOR-25)

U.S. Extended Continental Shelf Cruise to Map Sections of the Mendocino Ridge

CCOM-JHC CRUISE AT26-21

September 23 to October 11, 2014

Astoria, Oregon to San Francisco, California

Andrew A. Armstrong and

Giuseppe Masetti

NOAA/UNH Joint Hydrographic Center
UNH Center For Coastal and Ocean Mapping
University of New Hampshire
Durham, NH 03824

October 12, 2014
UNH-CCOM/JHC Technical Report 14-002

Table of Contents

Introduction 8
Survey Area – Mendocino Ridge 10
Mapping Sensors 11
Multibeam Echo Sounder – Kongsberg EM 122 11
Positioning – C&C C-Nav 3050 RT GYPSY 15
Attitude and Motion Sensing – IXSEA PHINS III 15
Surface Sound Speed Measurement – Seabird SBE48 and SBE45 15
Sound Speed Profiling – Lockheed Martin Sippican Win MK21 15
Sub-bottom Profiling System (SBP) – Knudsen 320 B/R 16
Data Acquisition 16
MBES 16
SBP 18
Navigation 20
Ancillary Data 20
Daily Acquisition Summary 21
Data Processing 30
Bathymetry 30
Seafloor Imagery 32
Sub Bottom Profiles 34
References Cited 35
Appendices
Appendix A – Cruise Personnel
Appendix B – Sound Speed and XCTD/XBT Cast Information
Appendix C – Calibration Reports for Atlantis sound speed sensors
Appendix D – BIST Test no. 1 Results
Appendix E – Cross-check Analyses
Appendix F – Information about the acquired MBES lines.
Appendix G – Conversion table of Kongsberg .all file names to UNH .all file names.

Table of Figures

Figure 1 – Outline of Mendocino Ridge survey area. Existing bathymetric data coverage from 2009 surveys by *NOAA Ship Okeanos Explorer*. Background from NGDC's ETOPO1. 8

Figure 2 – *RV Atlantis* (AGOR-25). Photo Woods Hole Oceanographic Institution. 9

Figure 3 – Northern volcanic spur region. 11

Figure 4 – *RV Atlantis* EM122 transducer gondola. Photo: WHOI. 11

Figure 5 – Patch test results: a) navigation time latency based on lines *0021_20140925_111524_Atlantis* and *0025_20140925_122145_Atlantis*; b) pitch based on lines *0021_20140925_111524_Atlantis* and *0023_20140925_114003_Atlantis*; c) roll based on lines *0023_20140925_114003_Atlantis* and *0025_20140925_122145_Atlantis*; d) yaw based on lines *0021_20140925_111524_Atlantis* and *0027_20140925_133731_Atlantis*. Intersection area (in white) provided in the insertions. ..13

Figure 6 – Sensor linear offsets from Kongsberg SIS. 14

Figure 7 – Sensor angular offsets from Kongsberg SIS. 14

Figure 8 – Port settings and time source in use from Kongsberg SIS. 14

Figure 9 – Screenshot of Kongsberg SIS runtime parameters in normal operations. 17

Figure 10 – Screenshot of Kongsberg SIS filters in normal operations. 17

Figure 11 – The SIS Stave Display showing the stave #17 issue. 18

Figure 12 – Screenshot of SounderSuite EchoControl file naming and formats. 18

Figure 13 – Screenshot of SounderSuite EchoControl runtime settings in normal operations. ..19

Figure 14 – Screenshot showing the effects of the missing synchronization between the Kongsberg EM122 MBES and Knudsen 320 B/R SBP. 19

Figure 15 – Screenshot after the synchronization between the Kongsberg EM122 MBES and Knudsen 320 B/R SBP. 20

Figure 16 – Multibeam data over Blanco Fracture zone, showing effects of 6 - 8 m seas. 21

Figure 17 – Patch test site. Small, narrow ridge feature east of main spur is shown in center of image. The ridge is approximately 7000 m long and 900 m across. (Motion artifacts seen in image are in data from another cruise. 22

Figure 18 – Northern spur region with flat top volcanic features. 24

Figure 19 – Water column display showing parallel bands of echo return in upper portion of water column. 24

Figure 20 – Primary fracture zone axis (A), main volcanic lobe (B), and small parallel ridge feature (C) at western end of project area. 26

Figure 21 – Seaward end of Mendocino Ridge project area, showing large lobe of volcanic material south of the fracture zone and the J-structures north of the fracture zone. 26

Figure 22 – SIS screenshot showing the effects of a temporary malfunctioning. 28

Figure 23 – Boutelle Seamount and surrounding features; view from the north. 29

Figure 24 - Eastern end of Pioneer Ridge/Pioneer Fracture Zone. 30

Figure 25 – Resulting bathymetry for the project area (depth in meters). 31

Figure 26 – Bathymetric data compilation between the acquired data and existing surveys (Ex903 and Ex905). 32

Figure 27 – Resulting mosaic for the project area (backscatter intensity in dB). 33

Figure 28 – Location of XBT casts (white squares). IV

Figure 29 – Average sound speed profile (blue) and 2 standard deviation range (red). Sound speed derived from XBT with surface salinity and World Ocean Atlas (2009) salinity tables. IV

Figure 30 – SBE 48 S/N 480040 'As Received' Calibration Report. .....

Figure 31 – SBE 48 S/N 480040 'As Received' Calibration Coefficients. I

Figure 32 – SBE 45 S/N 4540841-0063 'After Repair' Temperature Calibration Report. II

Figure 33 – SBE 45 S/N 4540841-0063 'After Repair' Temperature Calibration Coefficients. III

Figure 34 – SBE 45 S/N 4540841-0063 'After Repair' Conductivity Calibration Report. IV

Figure 35 – SBE 45 S/N 4540841-0063 'After Repair' Conductivity Calibration Coefficients. . V

Figure 36 – Surveylines selected for internal cross-check analyses. .....

Figure 37– Sounding depth difference (m) between line number 101 and the remaining survey data. I

Figure 38– Sounding depth difference (m) between line number 117 and the remaining survey data. I

Figure 39– Sounding depth difference (m) between line number 181 and the remaining survey data. I

Figure 40 – Overlapping areas with previous surveys: Ex903 (red) and Ex905 (magenta). II

Figure 41 – Sounding depth difference (m) between acquired data and survey Ex903 (west area). III

Figure 42 – Sounding depth difference (m) between acquired data and survey Ex903 (east area). III

Figure 43 – Sounding depth difference (m) between acquired data and survey Ex905. III

Tables

Table 1 – Cruise Statistics.....10
Table 2 – Kongsberg Maritime EM 122 system modules/versions.....12
Table 3 – MK 21 XBT System Information.....16
Table 4 – SounderSuite EchoControl versions.....16
Table 5 – Science Party.....II
Table 6 – WHOI Scientific Ship Support Group.....II
Table 7 – RV *Atlantis* II
Table 8 – XCTD/XBT Casts Information.....IV
Table 9 – Results of the surface comparison with previous surveys. .....
Table 10 – Results of the surface comparison with previous surveys.....II
Table 11 – Information about surveylines during transit from Astoria, OR.....IV
Table 12 – Information about surveylines in the project area. XI
Table 13 – Information about surveylines during transit to San Francisco, CA.....XII
Table 14 – Conversion table of Kongsberg .all file names to UNH .all file names. VIII

Introduction

This report describes a 19-day Extended Continental Shelf-related bathymetry cruise to the Mendocino Ridge, off the coast of California. The mapping area on this cruise, shown in Figure 1, will junction with bathymetry acquired on Okeanos Explorer Cruises EX 0903-0905 in 2009 (Gardner and Malik, 2009, NOAA Ocean Exploration, 2009).

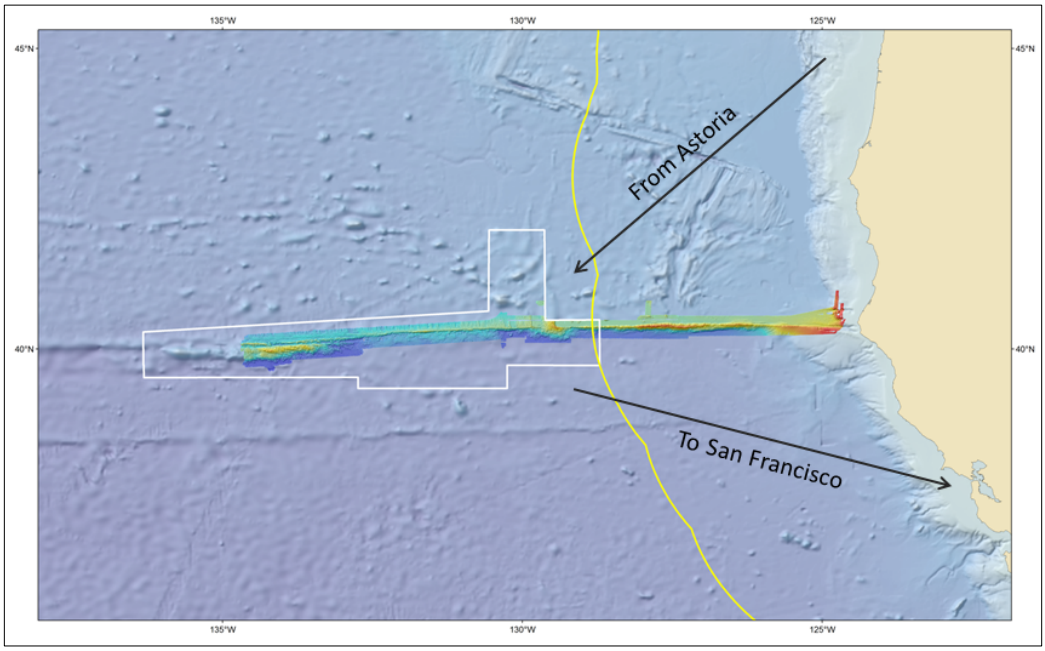


Figure 1. Outline of Mendocino Ridge survey area. Existing bathymetric data coverage from 2009 surveys by NOAA Ship *Okeanos Explorer*. Background from NGDC's ETOPO1; U.S. EEZ limits in yellow.

A study of the U.S. data holdings pertinent to the formulation of U.S. potential definition of an Extended Continental Shelf (ECS) under the United Nations Convention of the Law of the Sea (UNCLOS) identified areas where new bathymetric surveys are needed (Mayer, et al., 2002). Although the Mendocino Ridge was added as a potential ECS by the ECS Task Force area after that report, the report recommended that multibeam echo sounder (MBES) data are needed to rigorously define (1) the foot of the slope (FoS), a parameter of the two UNCLOS-stipulated formula lines, and (2) the 2500-m isobath, a parameter of one of the UNCLOS-stipulated cutoff lines. Both of these parameters, the first a precise geodetically located isobath and second a geomorphic zone, are used to define an extended continental shelf. The Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) at the University of New Hampshire (UNH) was funded by the National Oceanic and Atmospheric Administration (NOAA) to conduct research including new surveys and archive the resultant data.

With this funding from NOAA, UNH entered into an agreement with the Woods Hole Oceanographic Institution (WHOI), who provided the 84-m, 3510-ton Research Vessel

Atlantis (Figure 2**Error! Reference source not found.**) with a gondola-mounted Kongsberg Maritime EM122 MBES and a Knudsen 320 B/R chirp sub-bottom profiler. The 19-day cruise began in Astoria, Oregon, and ended in San Francisco, California.

Figure 2. RV *Atlantis* (AGOR-25). Photo Woods Hole Oceanographic Institution.

In addition to the ship and associated sensors, WHOI provided three SSSG science technicians for technical support of the cruise. Under the guidance of the Chief Scientist, NOAA and UNH provided the science party who carried out the data acquisition and onboard data processing for both the EM122 and the 320 B/R.

The cruise began with a 1.5-day transit to the southwest from Astoria to a calibration site just east of the project area. An XCTD cast was performed at this site to ensure a reliable profile for sound speed corrections for the patch test. The patch test confirmed that no adjustments to the existing ship calibration table was necessary (Figure 5).

The cruise mapped the project area in 15.5 mapping days for a total of 93,086.5 km^2 and collected 7935 line km of MBES with an average speed of approximately 11.5 kt. Junctioning with *Okeanos Explorer* data from 2009, this cruise completed the full mapping of the Mendocino Ridge from 225 nautical miles (nmi) offshore to 550 nmi offshore. This completes mapping to the end of the westernmost main lobe of volcanic material and the seaward-most significant instance of the 2500-m depth contour. Additional mapping was completed over Boutelle Seamount and along the Pioneer Fracture Zone. Summary statistics for the cruise are given in Table 1, and a sketch of the survey area is provided in Figure 1.

Julian days	JD 266 to JD 293
Dates	September 23 to October 11, 2014
Total time *- Weather delay* *- Other delays* *- Transit* *- Mapping in project area*	19.5 days *none* *none* *4 days* *15.5 days*
Total mapped area *- Transit from Astoria* *- Project area* *- Transit from Astoria*	103074.36 km^2 (30051.7 nmi^2) *5009.5 km^2 (1,460.5 nmi^2)* *93,086.5 km^2 (27,139.7 nmi^2)* *4978.3 km^2 (1451.4 nmi^2)*
Total linear kilometers *- Transit from Astoria* *- Project area* *- Transit from Astoria*	8,778.010 km (4,739.75 nmi) *566.361 km (305.81 nmi)* *7,935.398 km (4,284.77 nmi)* *276.251 km (149,16 nmi)*
Average survey speed	11.4 kt

Table 1. Cruise Statistics.

Survey Area – Mendocino Ridge

Mendocino Ridge is a narrow bathymetric high associated with the Mendocino Fracture Zone. The Mendocino Ridge strikes westward from North America and in places stands more than 1 km above the ocean basin floor. This mapping project focuses on the prominent section of the ridge from about 200 nmi offshore to 550 nmi offshore (Figure 1).

Two large lobes of overlapping subsea volcanic extrusions from the south side of the fracture characterize the mapped section of the Mendocino Ridge. Another province of extensive subsea volcanic features extend northward as a spur from the Mendocino Ridge in an oversized J-structure. This volcanic spur area, shown in Figure 3 includes large ridge-like features and numerous isolated volcanic seamounts and knolls.

Additional geologic information about the survey area can be found in the cruise report for EX0903, UNH-CCOM/JHC Technical Report 09-001 (Gardner and Malik, 2009).

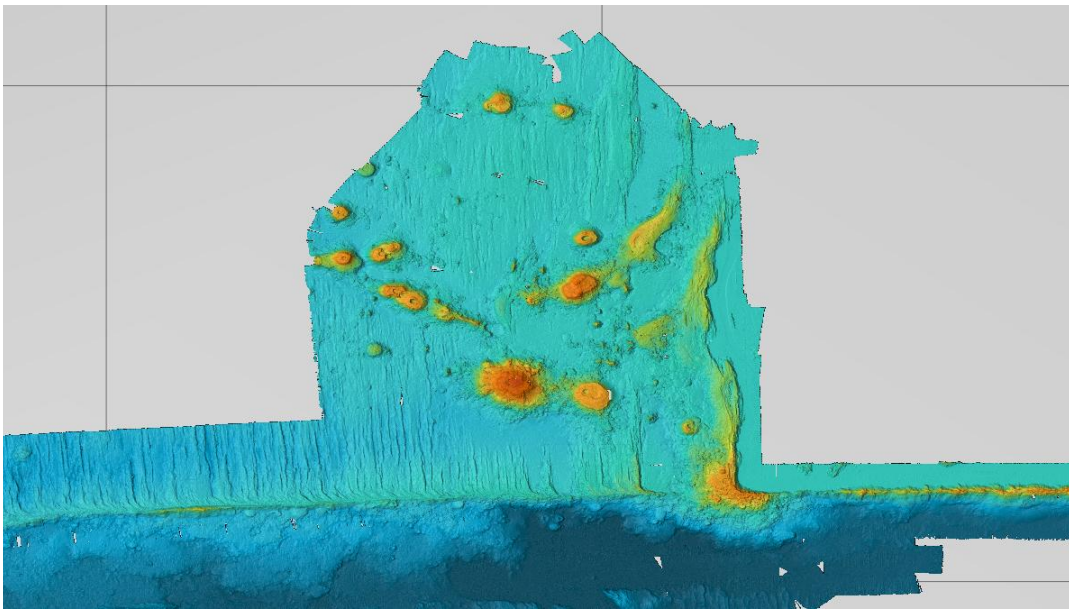


Figure 3. Northern volcanic spur region.

Mapping Sensors

Multibeam Echosounder – Kongsberg EM122

The Kongsberg Maritime EM122 MBES (s/n 118) system aboard RV *Atlantis* is a full-ocean-depth capable 12-kHz MBES with a 1° beam width in both transmit and receive. The EM 122 transducers are linear arrays in a Mills cross configuration with separate units for transmit and receive. The transducers on *Atlantis* are mounted on a gondola, shown in Figure 4, set off the hull to reduce noise from bubbles sweeping down the hull. The system produces 576 beams per ping in dual swath mode giving 864 soundings per ping in High Density mode.

Figure 4. *RV Atlantis* EM122 transducer gondola. Photo: WHOI.

The system is For this survey, the system was operated with 1° forward steering.

The EM122 transmits both continuous wave (CW) and frequency modulation (FM) pulses when set, as in this survey, in Deep Mode with FM enabled. The Kongsberg Maritime *EM122 Product Description* should be consulted for the full details of the MBES system.

Table 2 provides the version documentation published in the EM122 Release 1.1.3. These are the installed versions for the *Atlantis* EM 122 system.

Unit	Module	Version	Date
OS	SIS	3.8.3	March 2011
TRU	CPU	1.2.3	March 11, 2011
TRU	DDS	3.5.2	October 13, 2010
TRU	BSP	2.2.3	July 02, 2009
TRU	RX 32	1.11	February 18, 2010
TRU	TX 36	1.11	July 21, 2008
TRU	TX 36 LC	1.11	June 17, 2008
BSP	Master / INFIFO	4.3	September 13, 2008
BSP	Slave / INFIFO	6.0	September 2, 2008

Table 2. Kongsberg Maritime EM 122 system modules/versions.

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.

A BIST test (refer to Appendix D), was run pier side in Astoria the afternoon (Local time) of September 22. All sections of the test passed. Additional BIST tests were run during the cruise—all sections passed each time.

A full patch test was conducted on Thursday September 25, 2014 to ensure that sensor offsets were correct. The patch test was conducted over a long, narrow ridge-like feature at Latitude 41° 03.41’ N, Longitude 129° 28.35’ W. The patch test confirmed the existing offsets in the system with no modifications required (Figure 5).

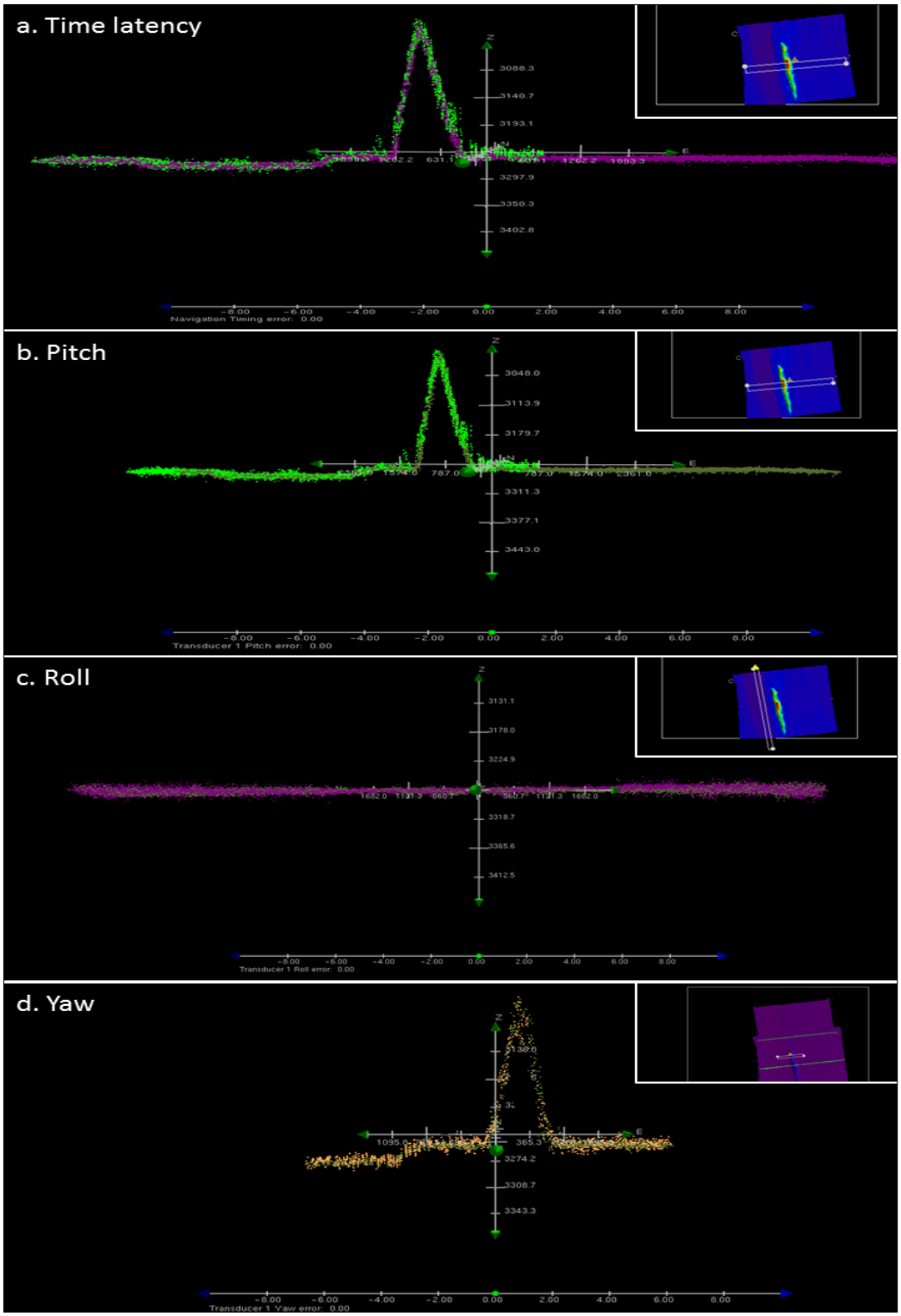


Figure 5. Patch test results: a) navigation time latency based on lines *Mendocino_line_221patch* and *Mendocino_line_225patch*; b) pitch based on lines *Mendocino_line_221patch* and *Mendocino_line_223patch*; c) roll based on lines *Mendocino_line_223patch* and *Mendocino_line_225patch*; d) yaw based on lines *Mendocino_line_221patch* and *Mendocino_line_227patch*. Intersection area (in white) provided in the insertions.

Figure 6 provides a screen dump for the linear offsets in use on Kongsberg SIS. Figure 7 shows the sensor angular offsets. Figure 8 shows the port settings. All these settings remained as shown throughout the whole survey.

Location offset (m)

	Forward (X)	Starboard (Y)	Downward (Z)
Pos, COM1:	-37.410	-2.956	-30.323
Pos, COM3:	0.00	0.00	0.00
Pos, COM4/UDP2:	0.00	0.00	0.00
TX Transducer:	-30.18129	-0.39007	0.42354
RX Transducer:	-25.71581	-0.01110	0.50488
Attitude 1, COM2:	-27.26953	0.45374	-2.85523
Attitude 2, COM3:	0.00	0.00	0.00
Waterline:			-5.270

Figure 6. Sensor linear offsets from Kongsberg SIS.

Offset angles (deg.)

	Roll	Pitch	Heading
TX Transducer:	-0.1469	0.0581	0.00568
RX Transducer:	-0.088	0.0277	359.86199
Attitude 1, COM2:	-0.11	-0.30	0.00
Attitude 2, COM3:	0.00	0.00	0
Stand-alone Heading:			0.60

Figure 7. Sensor angular offsets from Kongsberg SIS.

Positioning System Settings

Positioning System Ports: COM1

Time to use

Datagram System

Enable position motion correction

Position delay (sec.): 0.00

Datum: WGS84

Motion Sensor Settings

Motion Sensor Ports: COM2

Roll reference plane

Horizontal (DMS) Rotation (POSMV/MRU)

Motion Delay (msec.): 0

Active Sensors

Position: COM1

Motion: COM2

Heading: COM2

Figure 8. Port settings and time source in use from Kongsberg SIS.

Positioning – C&C C-Nav 3050 RT GYPSY

Positioning for the survey systems is from a C&C Technologies C-Nav Model 3050 Real-time GYPSY differential global navigation satellite system receiver:

- S/N: CNAV 14959
- Model: 3050
- Antenna S/N: 8253
- Calibration Date: N/A
- Installation: CNAV (April 2013)

Attitude and Motion Sensing – IXSEA PHINS III

A GPS-aided IXSEA PHINS III provides motion and attitude corrections to the EM122:

- FrmWCINT_INS 4.98
- FrmWDSP4_INS 2.34
- iXRepeater 8.1
- Web_PHINS_2.38a-1.38

The PHINS III system specifications for heading, roll, and pitch uncertainty are 0.01° (RMS), and for heave, surge, and sway are 5 cm or 5%, whichever is greater.

All horizontal positions were geo-referenced to the WGS84 ellipsoid and vertical referencing was to instantaneous sea level. The departure draft (in brackish water) was 15□ 10□ forward and 17□ 06□ aft. The trim and draft varied slightly during the cruise as fuel and water were used and shifted between tanks and ballast added as part of normal shipboard routine. The change in transducer depth during the cruise was negligible for this survey.

Surface Sound Speed Measurement – Seabird SBE48 and SBE45

Sound Speed at the transducer is calculated using "sea surface temperature" (actually at transducer depth) from the SBE48 and salinity from the SBE45 in the uncontaminated salt water system.

The SBE 45 also has a temperature sensor, which can be used to check the values from the SBE 48. See Appendix C for sensor and calibration information. Sound speed is computed using the UNESCO equation by Chen and Millero. Statement from *Atlantis* metadata files: *"Sound Velocity is calculated using SST from the SBE48 and Salinity from the SBE45. It is calculated using the http://search.cpan.org/~troxel/Physics-Water-SoundSpeed-0.92/lib/Physics/Water/SoundSpeed.pm"*

Sound Speed Profiling – Lockheed Martin Sippican Win MK21

Sound speed through the water column for this survey was determined by Tsurumi-Seiki XCTD-1 and Lockheed Martin Sippican Deep Blue XBT probes controlled with the Lockheed Martin Sippican Win MK21 system (Table 3).

WinMK21	v 2.4.1
MK21 COEF	v 2.6.1
MK21 AL	v 2.9.1
ARS USB Driver	v 1.6.1

Table 3. MK 21 XBT System Information.

Deep Blue XBTs have a 760-m maximum depth of measurement at speeds up to 20 knots. XCTD-1s have a 1000-m maximum depth at 12 knots.

Sub-bottom Profiling System (SBP) – Knudsen 320 B/R

In addition to the MBES, the ship is equipped with a Knudsen 320 B/R high-resolution sub-bottom profiler (D90-02080-Rev8, s/n K2K-01-0444). The Knudsen was run throughout the cruise.

Table 2 provides the version of the SounderSuite EchoControl installed for the *Atlantis* Knudsen 320 B/R system.

Part #	Ver. #
D409-03167/D409-03383	1.73

Table 4 – SounderSuite EchoControl versions.

The systems were synchronized for simultaneous transmission beginning September 25, with the EM122 controlling both sounders.

Data Acquisition

MBES

During the survey the system was operated in High Density Equidistant mode. In this mode, the swath width can be varied by the operator for sounding density and swath coverage. The system was normally operated for a swath angle of 65° or 70° on both port and starboard sides (Figure 9). These settings provided the best trade-off among data density, data quality, and swath coverage. The maximum swath width was opened to 75° port and starboard on occasions to maximize swath width, but this setting seldom produced additional coverage. Figure 10 shows the adopted settings for filtering.

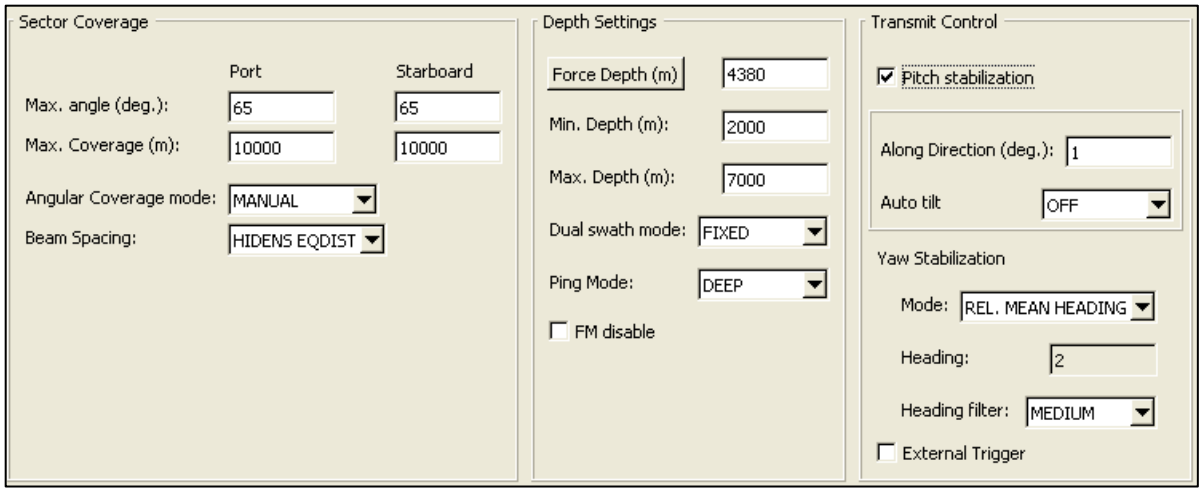


Figure 9 – Screenshot of Kongsberg SIS runtime parameters in normal operations.

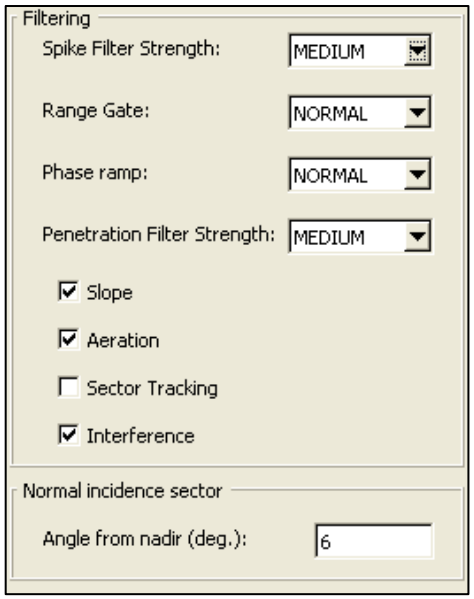


Figure 10 – Screenshot of Kongsberg SIS filters in normal operations.

Each EM122 .all file was written by the onboard Kongsberg SIS data-acquisition system to an *Atlantis*-SSSG server and the file was then copied to the UNH laptop computers and stored independently on two different UNH RAIDs.

During the acquisition, the SIS Stave Display was also monitored. Stave 17 showed a constant irregular functioning that did not influence the quality of the acquired data (Figure 11).

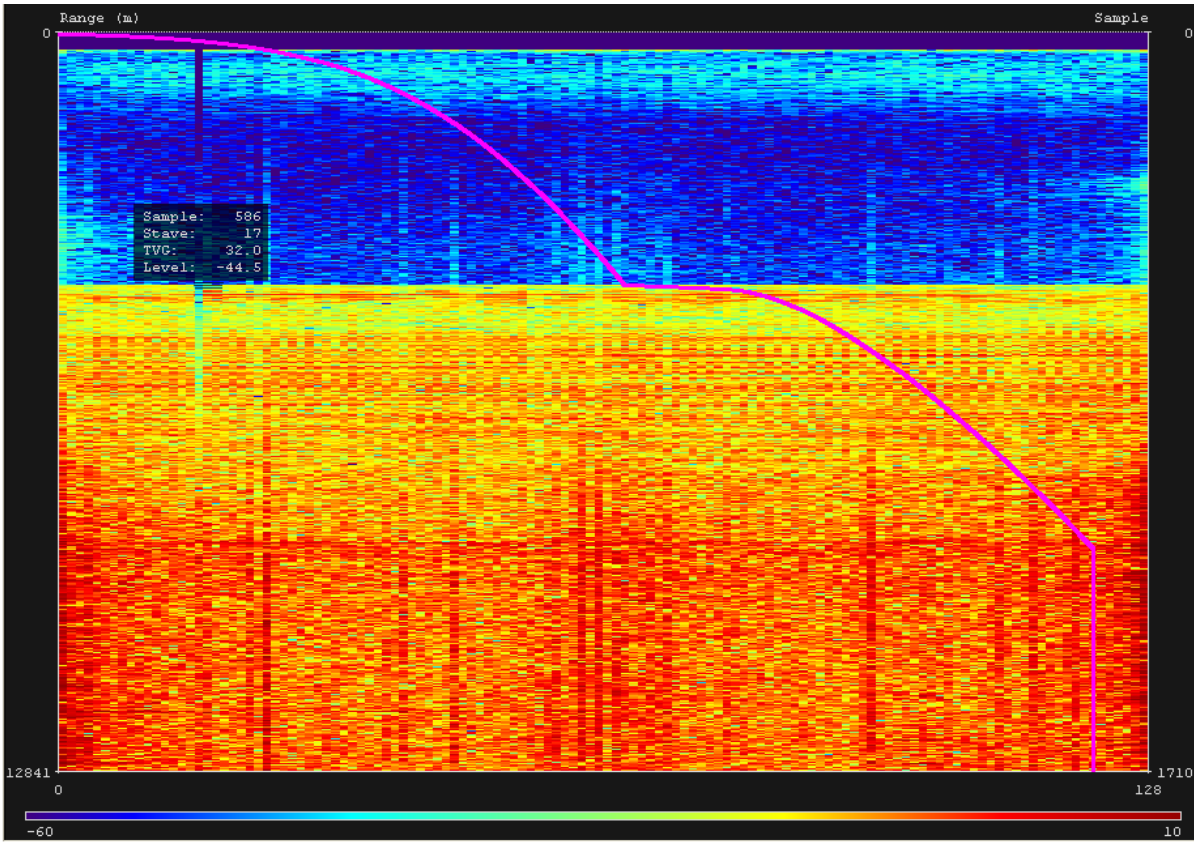


Figure 11 – The SIS Stave Display showing the stave #17 issue.

Sub-bottom Profiler

The sub-bottom profiler was set to record and save both SEG-Y and Knudsen's KEB formats (Figure 12).

The range, phase, gain, power, sensitivity, processing gain, and contrast were set and adjusted by the watch to maintain seafloor tracking and suitable image quality. The sub-bottom profiler was set to operate with an assumed 1500 m/s speed of sound. The system was normally operated using the settings showed in Figure 13.

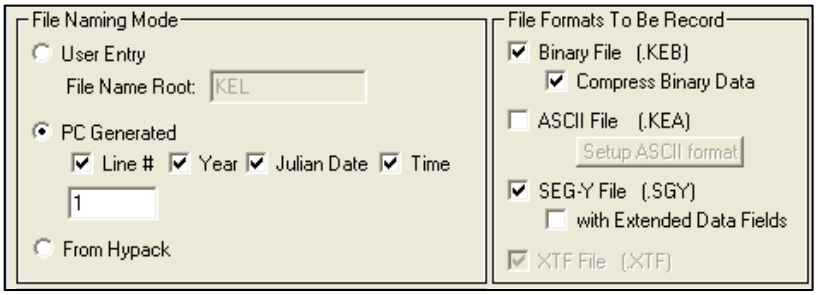


Figure 12 – Screenshot of SounderSuite EchoControl file naming and formats.

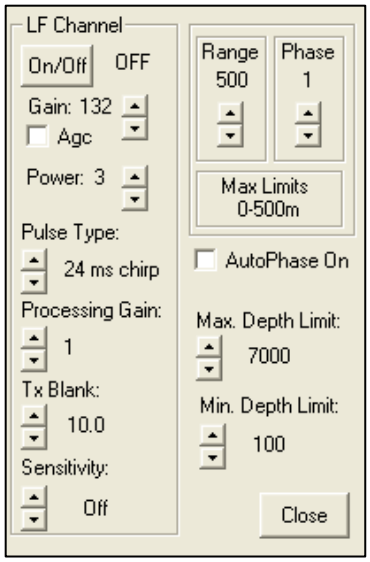


Figure 13 – Screenshot of SounderSuite EchoControl runtime settings in normal operations.

Data collection began with the Kongsberg EM122 and Knudsen 320 B/R unsynchronized. This configuration provided variable level of interference mainly in the SBP data (Figure 14). After the synchronization, the interferences disappeared (Figure 15).

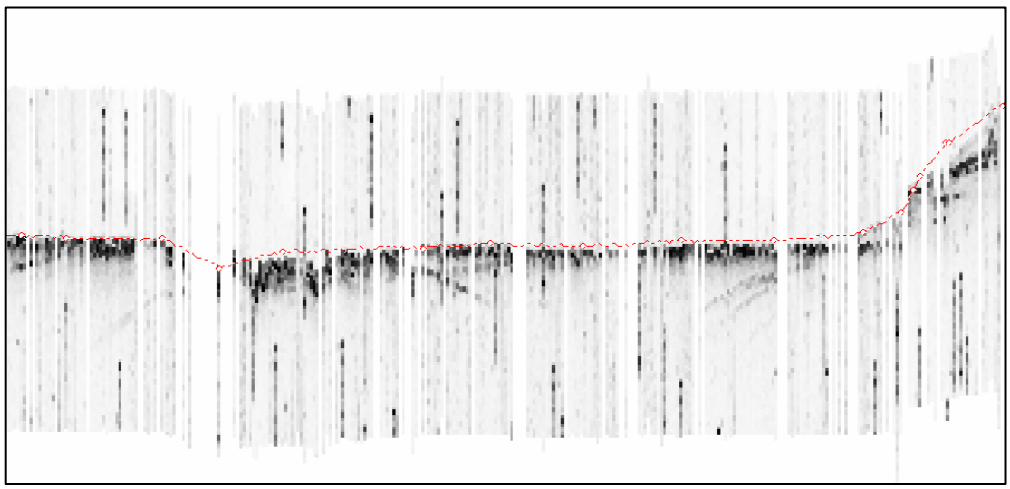


Figure 14 – Screenshot showing the effects of the missing synchronization between the Kongsberg EM122 MBES and Knudsen 320 B/R SBP.

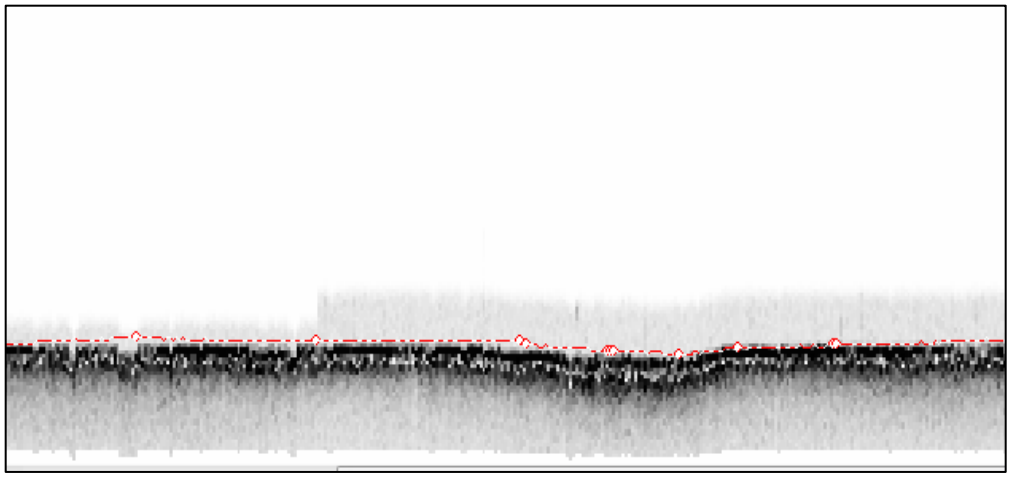


Figure 15 – Screenshot after the synchronization between the Kongsberg EM122 MBES and Knudsen 320 B/R SBP.

Navigation

The survey navigation was accomplished using the Kongsberg SIS Navigation Display in the computer lab and the *Atlantis*' MaxSea navigation software on the bridge.

In addition, QPS QINSy (v. 8.10) was interfaced to the vessel positioning and heading, and used both as additional source of information and for survey line planning and visualization.

Ancillary Data

Over the course of the survey, the science party collected 103 sound speed profiles: 101 based on XBT Deep Blue probes, 2 from XTCD-1. After the initial XCTD cast at the patch test site, Deep Blue expendable bathythermographs (XBTs) were used to measure temperature in the water column.

Temperature profiles were converted to sound speed profiles using the UNOLS Multibeam Advisory Committee SVP Editor software (version 1.02). This software imports the surface sound speed value from the ship's sensors and the National Oceanographic Data Center World Ocean Atlas seasonal salinity profile values for the location of the cast to create a locality-based sound speed profile. The software extrapolates the profiles to 12,000 m as required by the EM122 and SIS, and transmits the new sound speed profile to SIS for immediate application.

XBTs and derived water column sound-speed profiles were generally collected every 6 hours during the cruise as well as anytime the sound speed measured at the transducers differed steadily by more than 1.0 m/s from the transducer depth value of the previous cast.

Early in the cruise the SIS was set to increment the line count whenever a new sound speed profile was entered. On September 29, SIS was restarted and set so that a new cast does not increment the line count. XCTD/XBT sites are tabulated and shown in Appendix B.

Daily Acquisition Summary

- **<u>JD 266 (Tuesday September 23, 2014)</u>**

RV *Atlantis* got underway in light rain and overcast weather from the fish processing pier in Astoria, Oregon, USA at **1530Z** (0830L). The ship crossed the bar, disembarked the pilot, and began the transit to the project area. Seas from a storm offshore steadily increased throughout the day to about 5 – 6 m.

After completion of shipboard safety briefings and drills, the science watch began logging multibeam and sub-bottom profile data at 2012Z. The EM122 and the Knudsen 320 B/R are each pinging independently, and we suspect there may be noise in both systems as a result.

2130Z Deployed XBT 01 and applied new sound speed profile with salinity from World Ocean Atlas using UNOLS Multibeam Advisory Committee software SVP editor.

2320Z Shut down EM122 and the SIS, to check pin wire connections on output cable that will be modified to drive an external trigger for the Knudsen. The EM122 would not restart normally.

- **<u>JD 267 (Wednesday September 24, 2014)</u>**

0313Z After considerable, but inconclusive, trouble-shooting by SSSG technicians, the SIS was restarted, but further work on the Knudsen external trigger was deferred until additional information is available.

1730Z We are crossing the Blanco Fracture Zone, part of the boundary between the Gorda Plate and Pacific Plate (see Figure 16). Data over the feature is ragged in ~6 – 8 m seas.

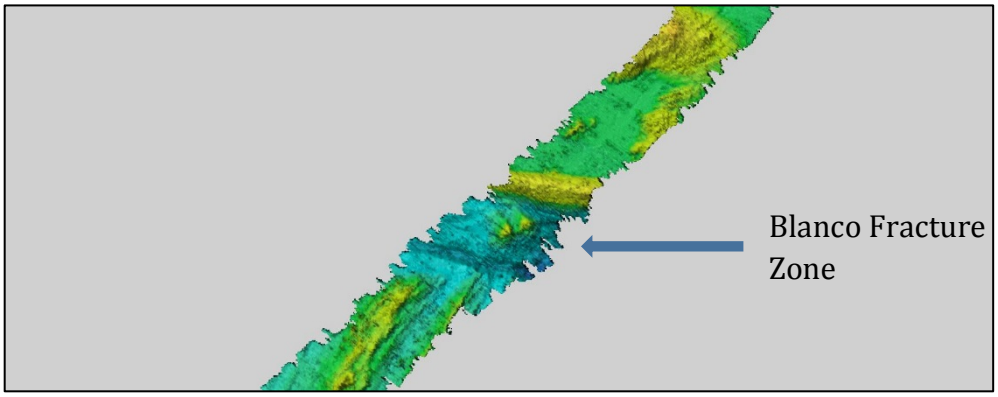


Figure 16 – Multibeam data over Blanco Fracture zone, showing effects of 6 - 8 m seas.

- **<u>JD 268 (Thursday September 25, 2014)</u>**

Continued mapping on the transit with multibeam and sub-bottom profiler throughout the day. Data quality is poor in rough seas. Much of the noise visible on the Knudsen sub-bottom profile, however, appears to be periodic at about 1 minute intervals; we suspect that the source may be the 12 kHz EM122 (Figure 14).

0200Z Stopped pinging on the EM122 to assess the impact on the Knudsen data quality. With the EM122 stopped, the periodic noise on the Knudsen disappeared. We reversed the process by resuming pinging on the EM 122 and stopping pinging on the Knudsen for 30 minutes. It was difficult to know for sure, but the data quality as seen in the online display seemed to improve. Upon restarting the Knudsen, we could clearly see the Knudsen sound pulse propagating through the EM122 water column display. At this time, we decided to resume efforts to synchronize the transmission of the two sounders.

0559Z The SSSG technicians completed the cable/pin rewiring, shifting the Knudsen trigger to EM122 control. Data quality has improved on both sounders (Figure 15).

1115Z Completed our transit to the project area and began the patch test on a small, narrow ridge feature. See Figure 17. Deployed an XCTD for sound speed control for the patch test. The weather has improved considerably; seas are down to ~3 m and we are not taking bubbles under the hull.

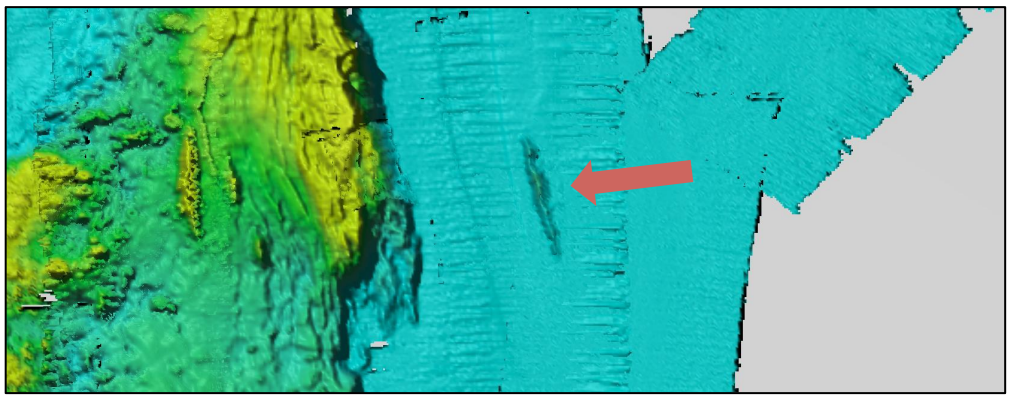


Figure 17 – Patch test site. Small, narrow ridge feature east of main spur is shown in center of image. The ridge is approximately 7000 m long and 900 m across. (Motion artifacts seen in image are in data from another cruise.)

1409Z Completed the patch test, with no negative effects from weather noted, confirming the existing settings with zero changes. Began the main mapping project, traveling south to junction with the existing data from EX09-03, -04, -05.

1803Z Reset the surface sound speed serial feeder to the SIS. The value on the SIS display had been locked at 1516.4 m/s; however,s this was sufficiently close to the true value that no refraction artifacts were introduced. The surface sound speed is now updating regularly. After a 270° turn, began an E – W line to fill a small gap and cross the large J-structure on the north side of Mendocino Ridge. Data quality and coverage diminished while heading into seas.

1935Z Turned onto S – N line, into the trough. Data coverage improved.

- **<u>JD 269 (Friday September 26, 2014)</u>**

Continued mapping around the perimeter of the *Okeanos Explorer* 2009 data. Coverage is reduced when on westward lines into the seas and improved on eastward and N – S lines.

1520Z The ship's bosun began needle-gunning in the crane platform; no adverse effects noted in the coverage or noise in the water column. We are however on a westward line into the seas and the coverage and noise levels are impacted by the seas.

- **JD 270 (Saturday September 27, 2014)**

Continued mapping around the perimeter of the *Okeanos Explorer* data. The weather has been steadily improving during the day, and even on a westward line we are now getting full swath coverage with 65 degrees of swath on each side.

0239Z At the end of our first E – W line on the south side of the Ridge. We likely found the southern extent of some of the volcanic lobes but not all. We will run another parallel line south of this one.

0240Z During the turn from this line onto the next, the bridge will be bring the dynamic positioning system off line to change GPS inputs. This should have no impact on the positioning for the multibeam system.

0300Z DP modifications were complete without effect on mapping system.

0315Z Running eastward along southern side. Obtaining full swath coverage.

1420Z Running northward on west side of northern spur.

1800Z Ran over seafloor elevation that reduced swath width and left gap in coverage. Tried to fill by extending swath to 70 degrees each side, but the gap remained in an acoustic shadow. Returned to 65/65 coverage.

2030Z While mapping over an elevated feature, we lost coverage and determined that the SIS minimum depth was set at 2000 m. Reset the minimum depth to 200 m, broke line, reversed course, and reran the line segment.

2115Z Resumed line on original northward heading.

- **JD 271 (Sunday September 28, 2014)**

Continued mapping in the northern spur area. We mapped several interesting volcanic features including a doughnut shaped knoll and a flat-topped seamount with two craters on the top (Figure 18).

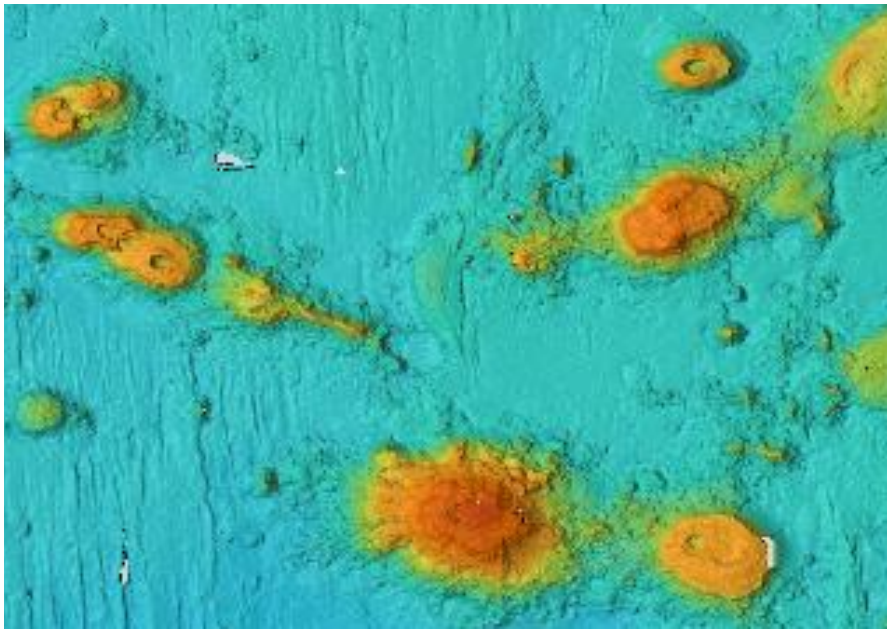


Figure 18 – Volcanic features in northern spur area.

1930Z The ship switched engine configurations as part of their regular routine. We noticed larger amounts of return in the SIS water column display. Upon investigation, we determined that the return we are seeing is the same 2- layer return that has been visible in the upper portion of the water column display, but is now in the middle of the water column in these ~900 m depths.

2015Z The same bands are appearing the upper portion of the water column display, although at the same depth, now that we are in deeper water (Figure 19). Our conclusion is that the engine change has no effect.

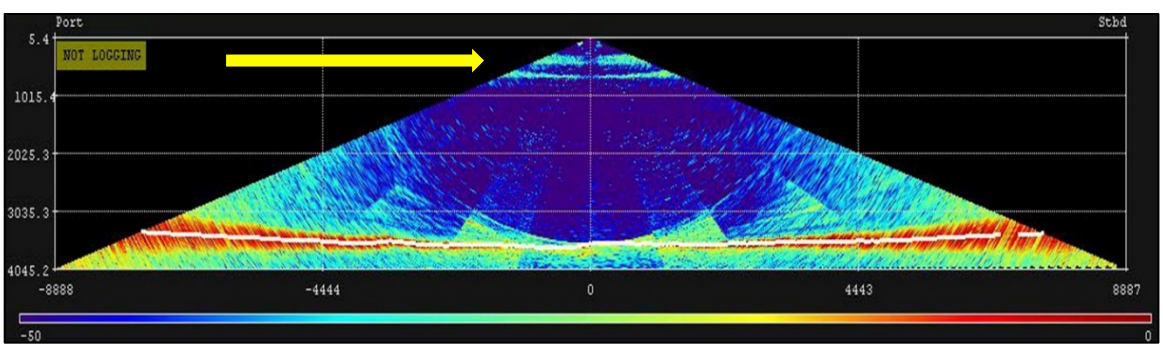


Figure 19 – Water column display showing parallel bands of echo return in upper portion of water column.

- **<u>JD 272 (Monday September 29, 2014)</u>**

Began the (UTC) day by turning westward along the southern margin of the project area, and continuing mapping.

0908Z Completed our long westward line. We concluded that additional work to the south was needed to ensure coverage of the Base of the Slope zone, and ran an additional W – E line to the south.

1114Z We began a diagonal SE – NW line to regain our original line plan. Restarted SIS to change settings so that each cast does not start a new line. We will now resume our practice of changing lines on the UTC six-hour marks.

1700Z Resumed our westward line to develop the outer limit of the 2500-m contour and the seaward end of the "main body" of the Mendocino Ridge.

1800Z The uninterruptible power supply (UPS) supplying the EM122 has tripped off line; the sonar is running on regular ship's power. There is no effect on the operation of the system, but we will try to reset at a waypoint/course change point in about 90 minutes.

2024Z Broke the line (stop logging, stop pinging). The ship will turn a circle while the SSSG technicians attempt to bring the UPS power back to the EM122.

2044Z UPS reset completed and resumed mapping. All appears to be ok, with same SIS settings in place.

2110Z Reduced speed slightly to change engine configuration. We experienced some vibration of the ship during the transition, but the multibeam seems to be ok.

2144Z Incremented line count to check data files and confirmed that the SIS data recorded after the restart is ok. Continued our sounding line to the western end of the project area.

- **JD 273 (Tuesday September 30, 2014)**

0340Z Broke line at the western limit and turned back to the east. We will now begin a series of E – W lines at the seaward end of the Mendocino Ridge project area.

1630Z Changed the sub-bottom profiler range setting from 500 m to 1000 m to ease bottom tracking over irregular seafloor.

1730Z We are ending our westward line at the end of the large lobe of volcanic material on the southern side of the fracture zone (Figure 20). The primary fracture zone axis of the Mendocino Ridge continues westward just to the north of the large volcanic lobe, but we will not extend our mapping along that trend. Our line will resume heading eastward.

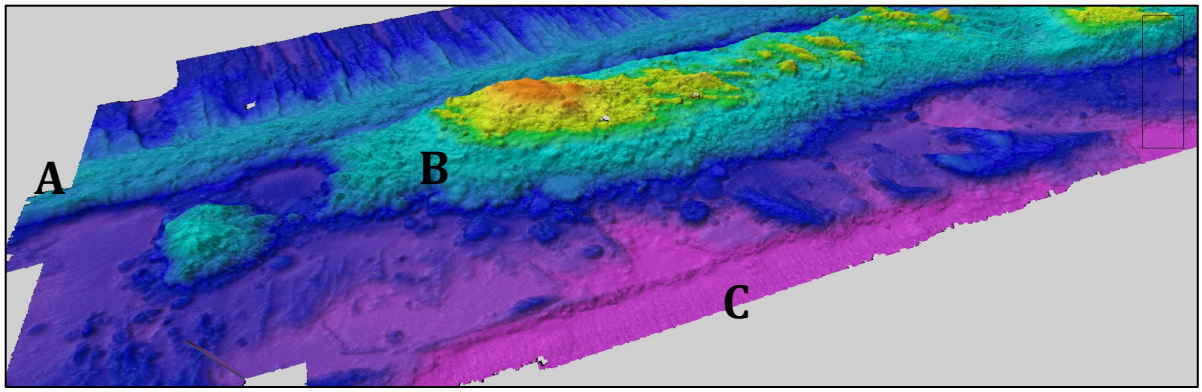


Figure 20 – Primary fracture zone axis (A), main volcanic lobe (B), and small parallel ridge feature (C) at western end of project area.

2345Z At the end of the eastward line, we turned westward for our final line to the seaward end of the project. Shifted to sub-bottom profiler to the 500-m scale, as we are in an area of lower relief.

- **<u>JD 274 (Wednesday October 01, 2014)</u>**

Weather continues fine, with small swell from N and no wind waves. Mapping in the western portion of the project area to square off the seaward end.

1400Z Finishing up squaring off western end and beginning a track to the east along the northern perimeter of our survey and the EX-09 surveys, crossing the series of J-structures along the fracture zone (Figure 21).

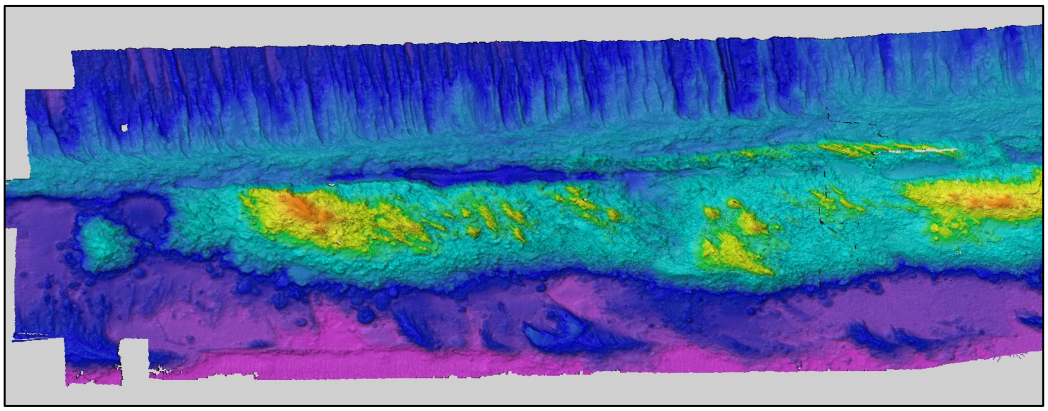


Figure 21 – Seaward end of Mendocino Ridge project area, showing large lobe of volcanic material south of the fracture zone and the J-structures north of the fracture zone.

1730Z Notified by SSSG that the sound speed sensor had frozen and needed to be reset. When reset, the actual sound speed was very close to the frozen value, and there had been no impact to data quality.

1814Z Reduced speed to change engines and resumed regular speed with new configuration.

- **JD 275 (Thursday October 02, 2014)**

Continuing to map along the northern perimeter of the project area, developing the J-structures north of the Ridge.

1400Z turning north to fill in holidays (gaps in coverage) in the northern spur area.

- **JD 276 (Friday October 03, 2014)**

Continued filling holidays in the north.

1400Z Mapping on westward and eastward tracks at the southern perimeter of the project area.

- **JD 277 (Saturday October 04, 2014)**

Continued adding to mapping coverage along the southern perimeter of the project.

2200Z We are seeing persistent noise in the data from the past few hours as the seas have grown somewhat rougher. We have reduced speed by 1 knot to see if we can reduce the noise.

2300Z The EM122 line number jumped from line 135 to line 137. This is possibly the result of a double click on the line increment button. Appears to be no lost data.

- **JD 278 (Sunday October 05, 2014)**

Continuing to map along the southern perimeter.

- **JD 279 (Monday October 06, 2014)**

0037Z Data quality has not improved. Broke line to test system operation. Running BIST test. BIST passed. Making racetrack turn to backtrack along line

0140Z Restarted line on original track. Will examine to see if stopping/starting helped. Stopped pinging with sub-bottom profiler.

0220Z Concluded that something in the day watch processing was introducing the "noise" in the displayed images. The data are ok. We have resumed normal operations, including the sub-bottom profiler.

0236Z Resumed normal mapping speed.

Continuing to map around the perimeter of our project area, overlapping with our earlier coverage.

0230Z Rounding the western end of the project area and starting eastward.

1400Z Eastward line is just mapping the northward extensions of the J-structures along the north side of the ridge as they transition to washboard relief on the deep seafloor of the Pacific Plate.

2100Z The UPS feeding the EM122 has tripped off line. We have stopped logging and pinging the EM122 and are doing a racetrack turn to port while the UPS is restarted.

2120Z SSSG reset the UPS and we turned back on line. We did not have to restart the EM122 or SIS.

- **<u>JD 280 (Tuesday October 07, 2014)</u>**

Continuing to map in the northern volcanic spur area. Weather remains fine.

1840Z We are leaving acoustic shadow holidays on a volcanic seamount. We are turning to port and splitting our line on a reciprocal course to complete the coverage.

1915Z We are turning to 218 to regain our original line by crossing directly over the volcanic cone and crater.

1942Z Back on planned track.

- **<u>JD 281 (Wednesday October 08, 2014)</u>**

Continuing mapping in the northern spur area, expanding coverage westward and filling in data gaps on key features. Weather is even better

0230Z The EM122 lost all bottom detection on the port side and at nadir. Figure 23 is a SIS screen shot showing lost bottom in water column display and dtm display. We are passing between two volcanic peaks. Could there be some bubbles or refraction anomaly in the water column?

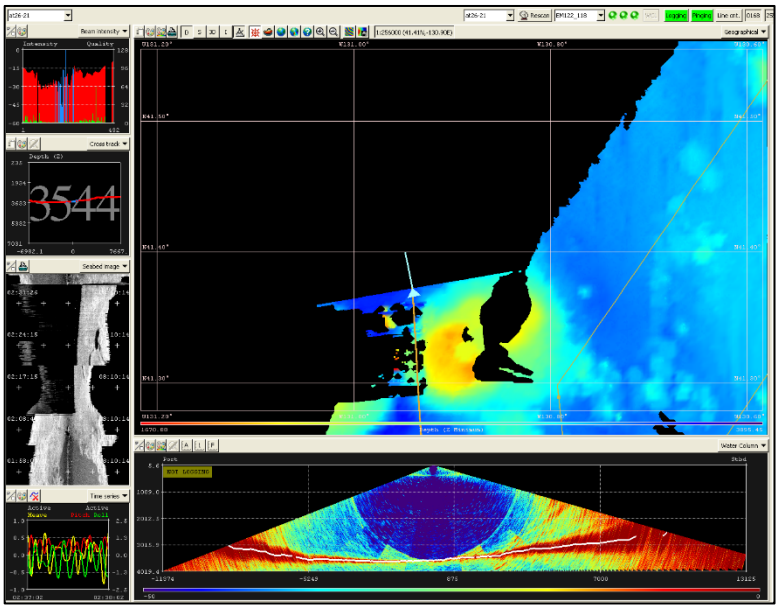


Figure 22 – SIS screenshot showing the effects of a temporary malfunctioning.

0245Z The EM122 has regained bottom track on both sides.

~1300Z Passed alongside the same area as earlier, without incidence, although a bit later the EM122 dropped track for a few pings before recovering. We are diverting from planned track to fill in gaps in coverage.

1752Z Passed through the center of the gap between the two seamounts. EM122 lost track momentarily, but regained after forcing depth. The slopes to either side are very steep, and we left considerable holidays. Deployed an XCTD cast to see if there are any anomalies in the local water column. The XCTD profile looks normal.

1808Z We began a loop to east then north to set up a westward line perpendicular to primary tracks to fill the gaps.

1815Z SIS has been performing poorly (delayed responses, lack of zoom). Restarted SIS and confirmed settings.

1832Z Resumed logging EM122. SIS is performing as it should.

1946Z The coverage gaps were filled, and we resumed planned track southward.

- **JD 282 (Thursday October 09, 2014)**

Mapping southward in a cross swath over existing coverage from this cruise and EX09 cruise to reach southern perimeter of our area. This line will be used for cross-swath quality control and comparison with prior mapping.

We began to see occasional instances of lost bottom tracking on the port side of the EM122. These instances seem to have no relation to bottom slope or type.

- **JD 283 (Friday October 10, 2014)**

Mapping along the southern perimeter of the project, extending coverage south until we break off for San Francisco. Weather continues to be very good.

0010Z Mapping Boutelle Seamount.

~0600Z We completed mapping of Boutelle Seamount (Figure 23), and are beginning a transect along the axis of the Pioneer Fracture Zone.

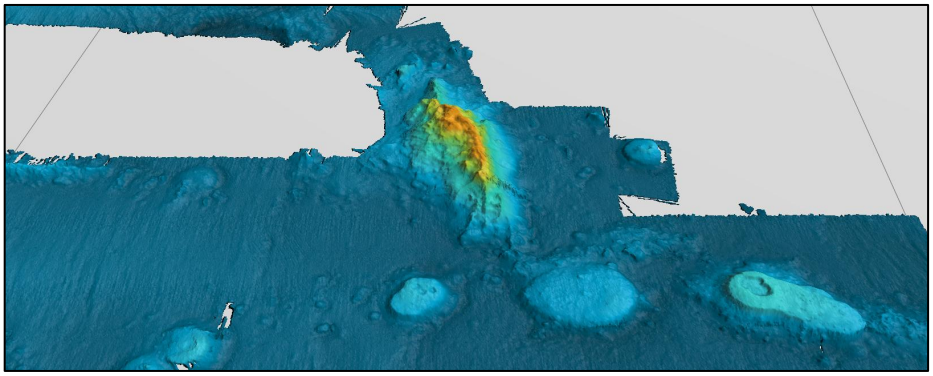


Figure 23 – Boutelle Seamount and surrounding features; view from the north.

2022Z Experienced the nadir and port side data loss again. Regained bottom track by forcing depth. The SIS Stave Display appeared normal during the bottom loss.

2150Z We reached the eastern end of the seafloor surface expression of the Pioneer Fracture Zone, shown in Figure 24 and **ended the survey**.

We have completed all ECS mapping plus additional exploratory work. We will leave the project a bit early in order to beat an approaching storm to San Francisco and permit the ship to arrive at the shipyard pier on a high water slack tide. We will log data on the transit to San Francisco and take XBTs periodically.

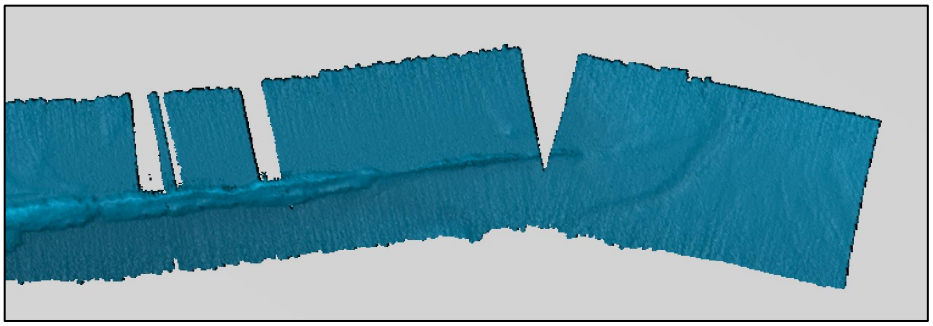


Figure 24 - Eastern end of Pioneer Ridge/Pioneer Fracture Zone.

- **JD 284 (Saturday October 11, 2014)**

Continuing transit to San Francisco as seas increase ahead of storm.

1412Z Stopped logging transit data.

Data Processing

Bathymetry

The raw MBES bathymetry were cleaned and gridded onboard with CARIS HIPS software and loaded into a QPS Fledermaus project for display, quality control, and analysis. The resulting bathymetry for the project area is presented in Figure 25. Bathymetric grid at 50 m, 100 m and 200 m were created, exported from CARIS HIPS & SIPS as xyz ASCII files, and converted to Fledermaus SD files for visualization and inspection.

.

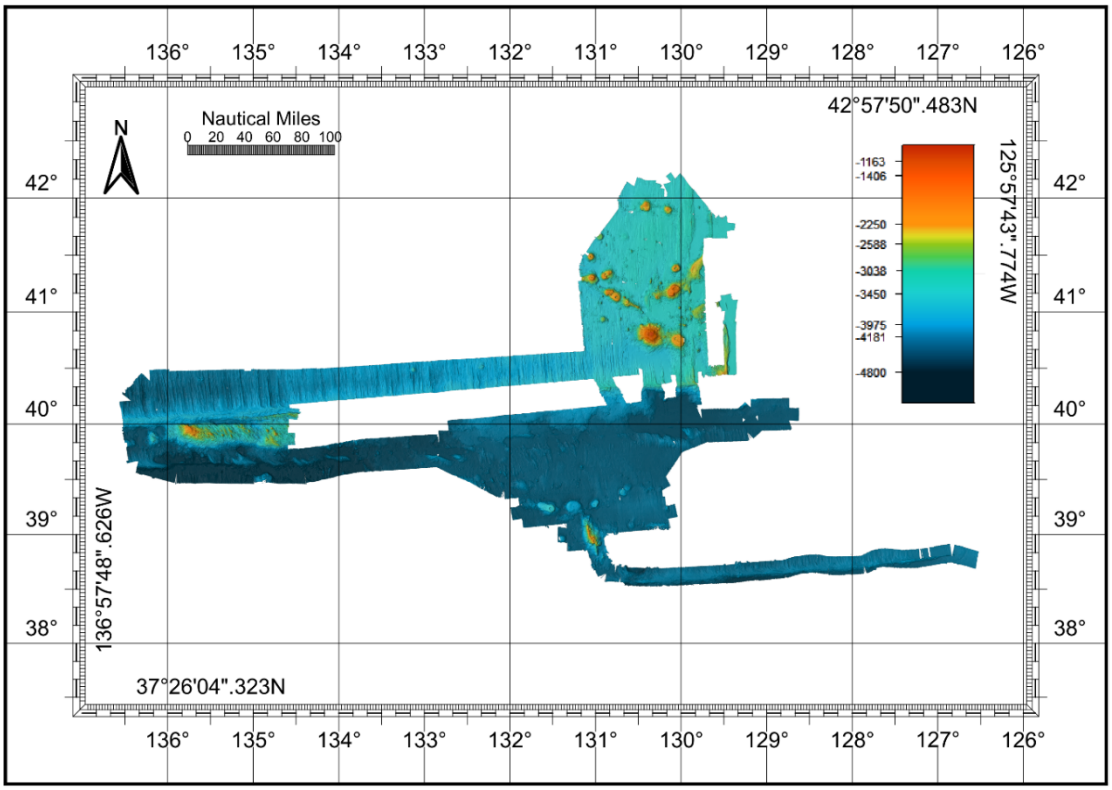


Figure 25 – Resulting bathymetry for the project area (depth in meters).

Bathymetric grid at 50 m, 100 m and 200 m were created, exported from CARIS HIPS & SIPS as xyz ASCII files, and converted to Fledermaus SD files for visualization and inspection.

A bathymetric data compilation between the acquired data and existing surveys (Ex903 and Ex905) was performed. Figure 26 shows the resulting surface.

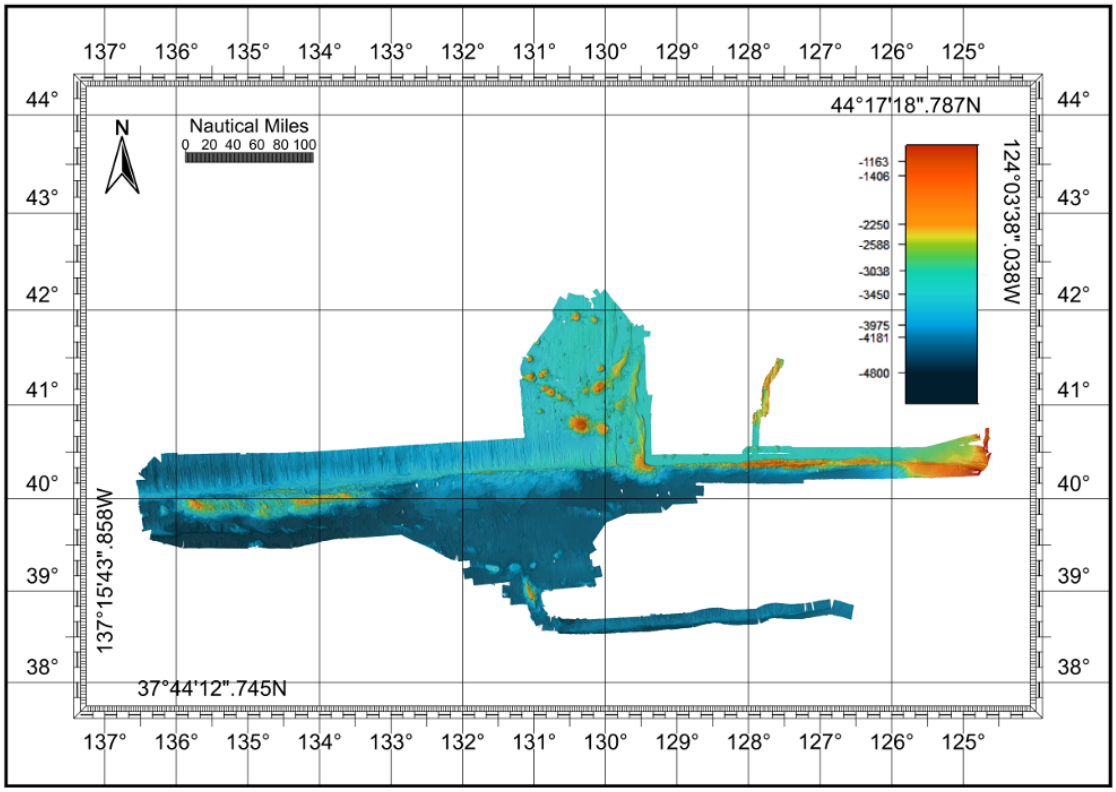


Figure 26 – Bathymetric data compilation between the acquired data and existing surveys (Ex903 and Ex905).

Internal and cross-surveys data consistency analyses were applied with good results. More details are provided in Appendix E.

Seafloor Imagery

The acoustic backscatter data were processed and examined aboard ship using QPS Fledermaus FMGT. The resulting mosaic for the project area is presented in Figure 27 **Error! Reference source not found.**.

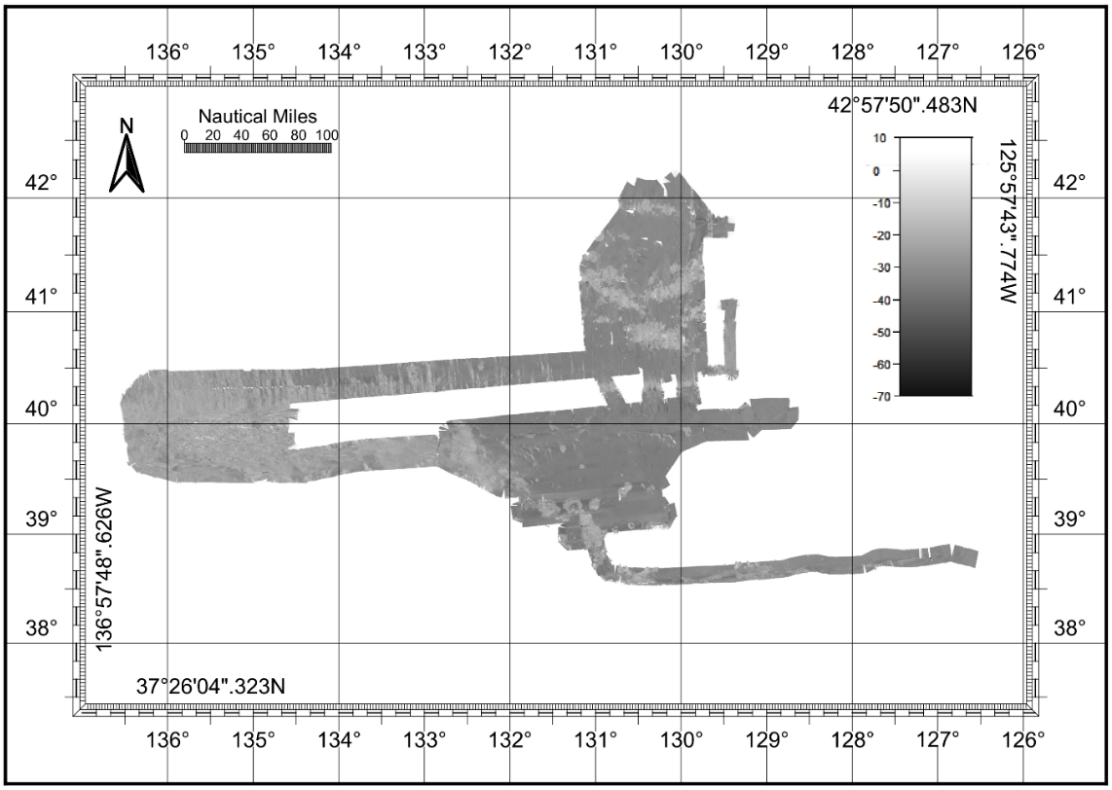


Figure 27 – Resulting mosaic for the project area (backscatter intensity in dB).

All raw MBES files were initially labeled with a unique Kongsberg file designator but the files were renamed to Mendocino_line_XXX, where X is a consecutive line number starting with 201 (see Appendix 1). The renaming was done so that lines from this leg would be consistent with those of Leg 1 and so the individual lines would be unequivocally identified with the survey area in the future.

A high resolution full-coverage multibeam echo sounder survey such as this one obtains redundant data at almost every point on the seafloor, and typically also includes erroneous depths that must be removed in a data-cleaning process. The still-dense data remaining after cleaning are typically gridded for visualization and scientific analysis. The data cleaning process is described below. A series of quality-assurance cross-check techniques are applied to estimate the uncertainty of the processed data. The results of that analysis are presented in Appendix 4.

For Extended Continental Shelf project purposes, all files were post-processed ashore by James V. Gardner of UNH using the University of New Brunswick's OMG/SwathEd software suite, version 2010-04-29. His procedures, as described in the Leg 1 report (Gardner, 2010) are quoted here: "Each .all file is composed of individual data packets of bathymetry, 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 good navigation is merged with the bathymetry and acoustic backscatter files.

The third step involves flagging individual soundings that appear to be fliers, bad points, multipath, 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 soundings are gridded into area DTM [digital terrain model] maps and the co-registered valid acoustic backscatter full beam time series is assembled into a file and gridded into area mosaics.

Sub-Bottom Profiles

The SEG-Y files acquired by the Knudsen 320 B/R have been imported and processed using SonarWiz 5 (v. V5.06.0047). After having applied and verified the bottom-tracking algorithm, the survey data have been exported as Fledermaus SD files for visualization and inspection. The naming convention of the Knudsen lines were not synchronized to follow the naming convention of the MBES lines.

References Cited

Gardner, J. V. and Malik, M. A., "U.S. Law of the Sea Cruise to Map the Eastern Mendocino Ridge, Eastern Pacific Ocean", University of New Hampshire (UNH), Center for Coastal and Ocean Mapping (CCOM)/Joint Hydrographic Center (JHC) Technical Report 09-001, 2009.

Mayer, L., Jakobsson, M, and Armstrong, A, 2002, The compilation and analysis of data relevant to a U.S. Claim under United Nations Law of the Sea Article 76: A preliminary Report. Univ. of New Hampshire Technical Report, 75p.

NOAA Ocean Exploration, Mendocino Ridge Insets Mapping Shakedown Cruise, May 5-26, 2009. http://oceanexplorer.noaa.gov/okeanos/explorations/ex0903/media/ex0903_final_all.pdf

NOAA Ocean Exploration, Water Column Exploration Gorda Ridge and East Blanco Fracture Zone, June 1-12, 2009.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex0904/media/ex0904_final.pdf

NOAA Ocean Exploration, Mendocino Ridge Mapping Field Trials II: Exploring Extent of Volcanic Fields, June 17-27, 2009.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex0905/media/ex0905_final_all.pdf

Smith, W.H.F. and Sandwell, D.T., 1997, Global seafloor topography from satellite altimetry and ship depth soundings, Science, v. 277, p. 1957-1962.
(http://topex.ucsd.edu/marine_topo/mar_topo.html).

- **Appendices**

Appendix A – Cruise Personnel

Andrew Armstrong	NOAA	Chief Scientist
Giuseppe Masetti	UNH	Co-Chief Scientist
Margot Bohan	NOAA	Watch stander
Jennifer Jencks	NOAA-CIRES	Watch stander
Meredith Westington	NOAA	Watch stander
Elliot Lim	NOAA-CIRES	Watch stander
Daishi Horiuchi	UNH	Watch stander

Table 5 – Science Party

David Sims	Technician
Robert Laird	Technician
Robert Hagg	MB Technician

Table 6 – WHOI Scientific Ship Support Group

Al Lunt	Master
Monica Hill	Chief Engineer
Peter Leonard	Chief Mate
Logan Johnsen	2nd Mate
Mike Singleton	3rd Mate

Table 7 – RV *Atlantis*

Appendix B – Sound Speed and XCTD/XBT Cast Information.

#	Filename (.edf)	Date	Time	Longitude	Latitude
1	TD_00001	23-Sep-2014	21:29	124°51.46680W	45°33.17285N
2	TD_00002	24-Sep-2014	21:55	127°47.31152W	42°40.90430N
3	TD_00003	25-Sep-2014	00:09	128°03.90918W	42°24.77441N
4	TD_00004	25-Sep-2014	06:05	128°44.66797W	41°42.03320N
5	C3_00005	25-Sep-2014	11:03	129°24.34180W	41°04.16699N
6	TD_00006	25-Sep-2014	17:59	129°24.56445W	40°29.21655N
7	TD_00007	26-Sep-2014	00:05	129°48.16406W	41°19.49707N
8	TD_00008	26-Sep-2014	02:17	129°48.32715W	41°42.80859N
9	TD_00009	26-Sep-2014	04:40	129°36.22461W	41°47.98096N
10	TD_00010	26-Sep-2014	06:23	129°56.68066W	41°47.10400N
11	TD_00011	26-Sep-2014	08:55	129°55.23242W	41°17.12939N
12	TD_00012	26-Sep-2014	12:07	129°53.47266W	40°40.01953N
13	TD_00013	26-Sep-2014	20:42	131°16.48438W	40°03.70093N
14	TD_00014	26-Sep-2014	21:58	131°34.67871W	40°02.28955N
15	TD_00015	26-Sep-2014	23:41	131°59.72363W	40°00.33911N
16	TD_00016	27-Sep-2014	05:03	132°16.04590W	39°52.45557N
17	TD_00017	27-Sep-2014	07:58	131°30.97363W	39°55.84839N
18	TD_00018	27-Sep-2014	11:19	130°38.64160W	39°59.71289N
19	TD_00019	27-Sep-2014	14:19	129°54.17188W	40°04.50269N
20	TD_00020	27-Sep-2014	16:15	129°59.53027W	40°25.17749N
21	TD_00021	27-Sep-2014	22:13	130°01.87793W	41°21.02783N
22	TD_00022	28-Sep-2014	03:46	130°09.36133W	41°40.06396N
23	TD_00023	28-Sep-2014	06:11	130°08.45703W	41°10.81738N
24	TD_00024	28-Sep-2014	09:50	130°07.15918W	40°26.91235N

#	Filename (.edf)	Date	Time	Longitude	Latitude
25	TD_00025	28-Sep-2014	12:05	130°14.92578W	40°45.29712N
26	TD_00026	28-Sep-2014	14:12	130°15.62109W	41°09.47900N
27	TD_00027	28-Sep-2014	18:55	130°22.84277W	40°56.98120N
28	TD_00028	29-Sep-2014	00:04	130°22.57520W	39°54.93945N
29	TD_00029	29-Sep-2014	05:55	131°49.83008W	39°47.00659N
30	TD_00030	29-Sep-2014	10:21	132°22.39648W	39°38.65601N
31	TD_00031	29-Sep-2014	18:15	133°52.42676W	39°46.13232N
32	TD_00032	29-Sep-2014	23:48	135°08.83594W	39°40.99072N
33	TD_00033	30-Sep-2014	06:50	135°25.35742W	39°48.14795N
34	TD_00034	30-Sep-2014	12:15	134°58.18066W	39°55.29126N
35	TD_00035	30-Sep-2014	18:13	136°14.57812W	40°01.37085N
36	TD_00036	30-Sep-2014	20:32	135°40.40527W	39°58.26416N
37	TD_00037	30-Sep-2014	22:37	135°09.48145W	40°02.32910N
38	TD_00038	01-Oct-2014	04:38	135°21.34277W	40°07.68921N
39	TD_00039	01-Oct-2014	12:10	136°14.85742W	39°59.18359N
40	TD_00040	01-Oct-2014	19:42	134°36.84766W	40°15.03003N
41	TD_00041	01-Oct-2014	22:31	133°53.08789W	40°17.61206N
42	TD_00042	01-Oct-2014	23:02	133°45.23535W	40°18.11499N
43	TD_00043	02-Oct-2014	01:22	133°10.13086W	40°20.35034N
44	TD_00044	02-Oct-2014	02:53	132°47.12012W	40°21.83276N
45	TD_00045	02-Oct-2014	04:24	132°24.30566W	40°23.24780N
46	TD_00046	02-Oct-2014	11:26	130°38.74219W	40°29.93628N
47	TD_00047	02-Oct-2014	15:39	130°30.15527W	41°09.51367N
48	TD_00048	02-Oct-2014	17:18	130°19.99121W	41°25.31104N
49	TD_00049	03-Oct-2014	00:03	129°47.29688W	41°55.23291N

#	Filename (.edf)	Date	Time	Longitude	Latitude
50	TD_00050	03-Oct-2014	03:56	130°02.73926W	41°22.09717N
51	TD_00051	03-Oct-2014	05:44	130°09.09375W	41°02.83838N
52	TD_00052	03-Oct-2014	12:42	130°18.99023W	39°47.17017N
53	TD_00053	03-Oct-2014	15:19	130°58.98340W	39°43.48682N
54	TD_00054	03-Oct-2014	19:58	132°08.65137W	39°36.87524N
55	TD_00055	04-Oct-2014	00:05	131°24.99219W	39°34.09814N
56	TD_00056	04-Oct-2014	03:24	130°39.04102W	39°38.27051N
57	TD_00057	04-Oct-2014	04:44	130°21.99121W	39°40.84424N
58	TD_00058	04-Oct-2014	07:42	129°53.31055W	40°00.58618N
59	TD_00059	04-Oct-2014	15:00	129°06.93359W	40°01.02881N
60	TD_00060	04-Oct-2014	18:34	129°57.46387W	39°50.77954N
61	TD_00061	04-Oct-2014	20:43	130°19.78223W	39°32.14795N
62	TD_00062	04-Oct-2014	21:42	130°34.88477W	39°31.07300N
63	TD_00063	04-Oct-2014	22:23	130°44.36719W	39°30.42798N
64	TD_00064	04-Oct-2014	23:03	130°53.57812W	39°29.67920N
65	TD_00065	05-Oct-2014	01:41	131°13.58789W	39°28.23633N
66	TD_00066	05-Oct-2014	06:04	132°14.60840W	39°28.48096N
67	TD_00067	05-Oct-2014	08:24	132°45.31152W	39°40.16309N
68	TD_00068	05-Oct-2014	13:41	134°00.67090W	39°37.36523N
69	TD_00069	05-Oct-2014	18:37	135°13.69336W	39°33.68213N
70	TD_00070	06-Oct-2014	00:03	136°22.55762W	39°50.22559N
71	TD_00071	06-Oct-2014	06:01	135°32.15039W	40°24.22046N
72	TD_00072	06-Oct-2014	10:28	134°27.98340W	40°25.05103N
73	TD_00073	06-Oct-2014	18:05	132°42.31836W	40°30.18628N
74	TD_00074	07-Oct-2014	00:02	131°22.00879W	40°34.45142N

#	Filename (.edf)	Date	Time	Longitude	Latitude
75	TD_00075	07-Oct-2014	02:45	130°42.98047W	40°36.52686N
76	TD_00076	07-Oct-2014	06:03	130°36.36328W	41°05.53613N
77	TD_00077	07-Oct-2014	11:20	130°17.90234W	42°00.54590N
78	TD_00078	07-Oct-2014	13:40	130°27.94629W	41°51.62012N
79	TD_00079	07-Oct-2014	17:03	130°46.69824W	41°18.86084N
80	TD_00081	07-Oct-2014	18:32	130°43.10059W	41°03.87744N
81	TD_00082	07-Oct-2014	20:40	130°44.49316W	40°55.61792N
82	TD_00083	07-Oct-2014	23:58	130°54.01465W	40°51.40454N
83	TD_00084	08-Oct-2014	03:20	130°49.53711W	41°29.61523N
84	TD_00085	08-Oct-2014	06:02	130°22.87500W	41°55.60938N
85	TD_00086	08-Oct-2014	11:58	131°05.26172W	41°25.51074N
86	TD_00087	08-Oct-2014	16:13	130°50.82715W	41°24.47217N
87	C3_00088	08-Oct-2014	17:46	130°58.87305W	41°18.82617N
88	TD_00089	08-Oct-2014	19:00	130°54.99902W	41°18.82764N
89	TD_00090	08-Oct-2014	20:51	131°04.56836W	41°04.86523N
90	TD_00091	08-Oct-2014	22:17	131°02.93848W	40°47.75317N
91	TD_00092	09-Oct-2014	04:07	130°25.40918W	39°42.44434N
92	TD_00093	09-Oct-2014	08:11	130°51.38379W	39°20.76831N
93	TD_00094	09-Oct-2014	14:33	131°27.43359W	39°10.35742N
94	TD_00095	09-Oct-2014	17:18	130°46.04688W	39°13.39746N
95	TD_00096	09-Oct-2014	20:31	130°12.55176W	39°08.34790N
96	TD_00097	10-Oct-2014	00:17	131°10.24414W	39°04.41895N
97	TD_00098	10-Oct-2014	03:38	130°57.18555W	38°58.66211N
98	TD_00099	10-Oct-14	11:50	129°26.61523'W	38°38.70435'N
99	TD_00100	10-Oct-14	16:27	128°14.46387'W	38°43.18481'N

#	Filename (.edf)	Date	Time	Longitude	Latitude
100	TD_00101	10-Oct-14	20:49	127°06.04199'W	38°48.12500'N
101	TD_00102	10-Oct-14	23:11	126°29.84277'W	38°45.57422'N
102	TD_00103	11-Oct-14	0:03	126°16.99902'W	38°43.27832'N
103	TD_00104	11-Oct-14	6:03	124°54.69727'W	38°27.46338'N

Table 8 – XCTD/XBT Casts Information.

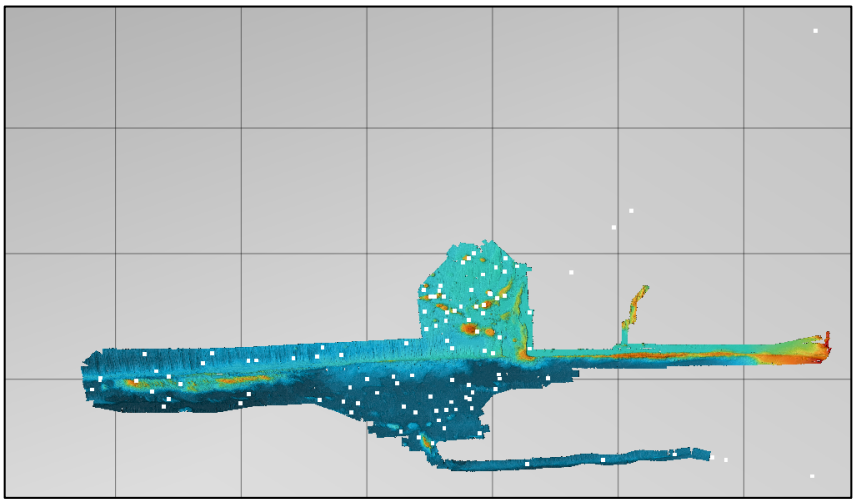


Figure 28 – Location of XBT casts (white squares).

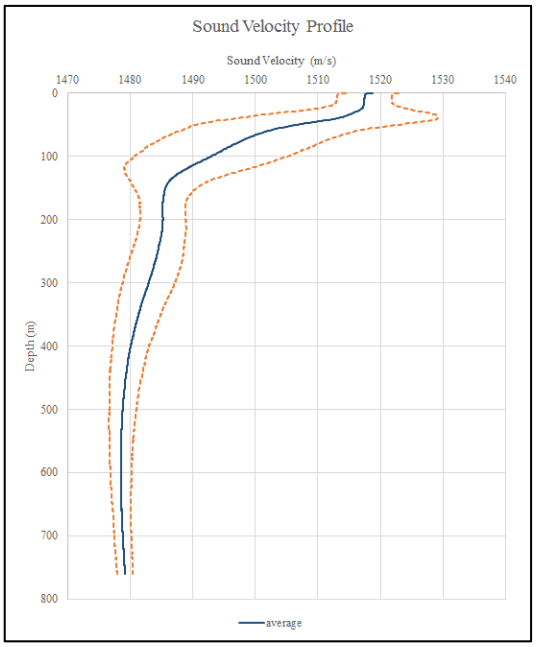


Figure 29 – Average sound speed profile (blue) and 2 standard deviation range (red). Sound speed derived from XBT with surface salinity and World Ocean Atlas (2009) salinity tables.

Appendix C – Calibration Reports for *Atlantis* sound speed sensors

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	Woods Hole Oceangraphic Institution		
Job Number:	71603	**Date of Report:**	12/17/2012
Model Number	SBE 48	**Serial Number:**	480040

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/15/2012 Drift since last cal: +0.00004 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

Figure 30 – SBE 48 S/N 480040 'As Received' Calibration Report.

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0040
CALIBRATION DATE: 15-Dec-12

SBE 48 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

```
a0 =  5.044685e-005
a1 =  2.676354e-004
a2 = -1.944175e-006
a3 =  1.376164e-007
```

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	729039.2	1.0001	0.0001
4.5000	622084.8	4.4999	-0.0001
15.0000	394175.3	15.0001	0.0001
18.5000	340688.7	18.5000	0.0000
24.0001	272541.8	24.0000	-0.0001
29.0000	223859.8	28.9999	-0.0001
32.5000	195704.9	32.5001	0.0001

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature

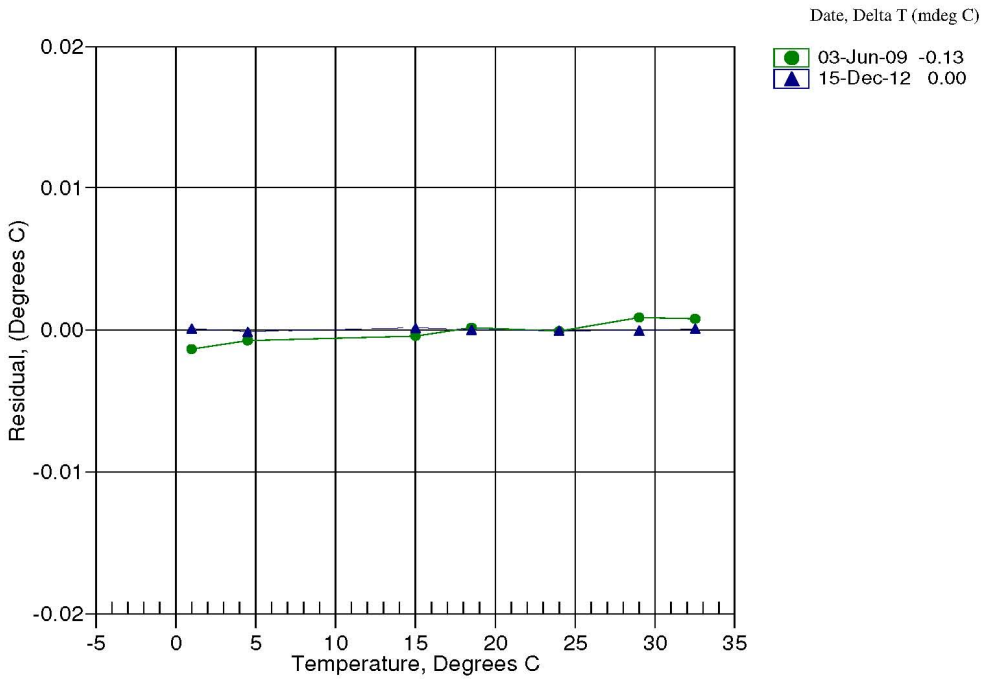


Figure 31 – SBE 48 S/N 480040 'As Received' Calibration Coefficients.

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	Woods Hole Oceangraphic Institution		
Job Number:	74709	**Date of Report:**	7/30/2013
Model Number	SBE 45	**Serial Number:**	4530841-0063

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☐ Performed ✔ Not Performed

Date: Drift since last cal: Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☑ Performed ☐ Not Performed

Date: 7/30/2013 Drift since Last cal: N/A Degrees Celsius/year

Comments:

Figure 32 – SBE 45 S/N 4540841-0063 'After Repair' Temperature Calibration Report.

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0063
CALIBRATION DATE: 30-Jul-13

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

```
a0 = -9.247709e-005
a1 =  2.971959e-004
a2 = -4.082075e-006
a3 =  1.978005e-007
```

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	693875.0	0.9999	-0.0000
4.5000	593451.6	4.5000	0.0000
15.0000	378526.2	14.9999	-0.0001
18.5000	327841.8	18.5001	0.0001
24.0000	263100.4	24.0000	-0.0000
29.0000	216709.7	29.0000	0.0000
32.5001	189817.7	32.5001	-0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature

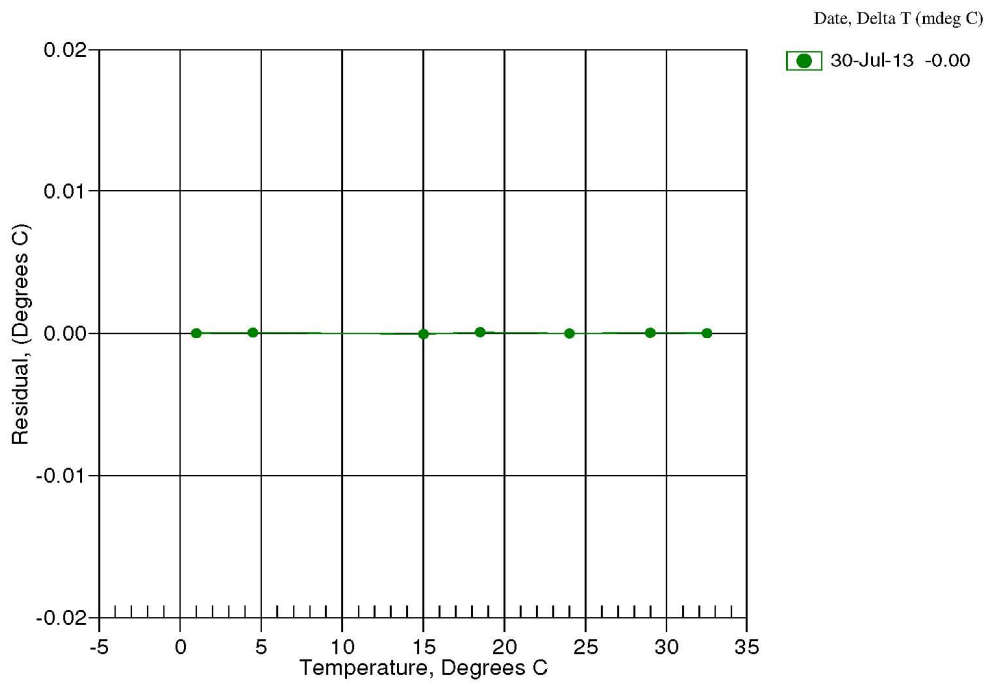


Figure 33 – SBE 45 S/N 4540841-0063 'After Repair' Temperature Calibration Coefficients.

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Woods Hole Oceangraphic Institution		
Job Number:	74709	**Date of Report:**	7/30/2013
Model Number	SBE 45	**Serial Number:**	4530841-0063

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☐ Performed ☑ Not Performed

Date: Drift since last cal: PSU/month*

Comments:

'CALIBRATION AFTER REPAIR' ☑ Performed Not Performed

Date: 7/30/2013 Drift since Last cal: N/A PSU/month*

Comments:

Measured at 3.0 S/m

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

Figure 34 – SBE 45 S/N 4540841-0063 'After Repair' Conductivity Calibration Report.

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0063
CALIBRATION DATE: 30-Jul-13

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -1.032808e+000          CPcor = -9.5700e-008
h =  1.435089e-001          CTcor =  3.2500e-006
i = -3.664591e-004          WBOTC =  1.3277e-005
j =  4.674467e-005
```

BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2688.37	0.00000	0.00000
0.9999	34.8508	2.97862	5298.61	2.97862	0.00000
4.5000	34.8305	3.28593	5497.19	3.28593	-0.00000
15.0000	34.7860	4.26829	6087.86	4.26830	0.00001
18.5000	34.7768	4.61369	6282.04	4.61369	0.00000
24.0000	34.7667	5.17206	6583.51	5.17206	-0.00000
29.0000	34.7613	5.69432	6853.10	5.69432	-0.00001
32.5001	34.7584	6.06705	7038.98	6.06705	0.00000

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity

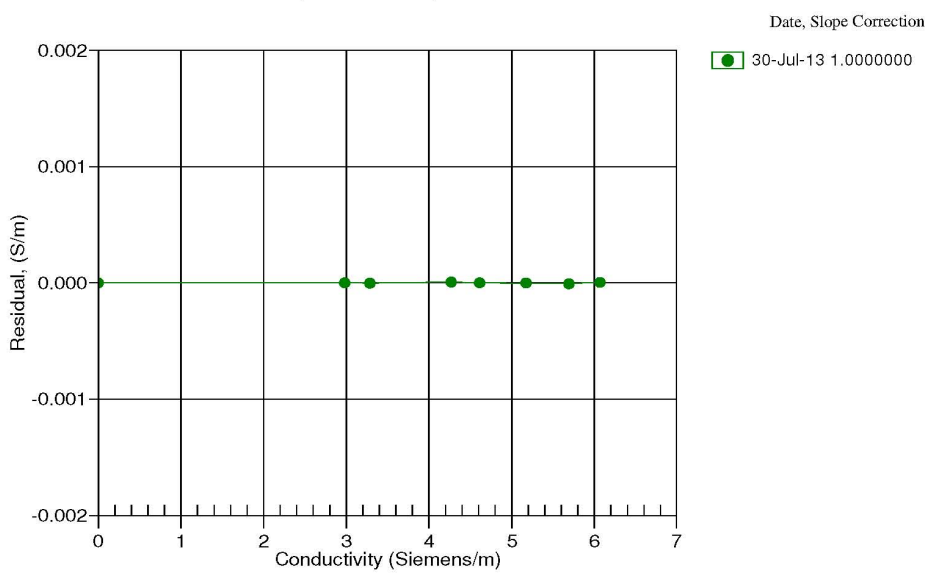


Figure 35 – SBE 45 S/N 4540841-0063 'After Repair' Conductivity Calibration Coefficients.

Appendix D – BIST Test No. 1 Results

```
Saved: 2014.09.22 23:59:31

Sounder Type:  122, Serial no.:  118

Date       Time          Ser. No.    BIST      Result

-------------------------------------------------------------------------------

2014.09.22 23:51:52.656  118         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 A1 HPI: ok
BSP 1 PCI TO SLAVE A2 HPI: ok
BSP 1 PCI TO SLAVE A3 HPI: ok
BSP 1 PCI TO SLAVE B1 HPI: ok
BSP 1 PCI TO SLAVE B2 HPI: ok
BSP 1 PCI TO SLAVE B3 HPI: ok
BSP 1 PCI TO SLAVE C1 HPI: ok
BSP 1 PCI TO SLAVE C2 HPI: ok
BSP 1 PCI TO SLAVE C3 HPI: ok
BSP 1 PCI TO SLAVE D1 HPI: ok
BSP 1 PCI TO SLAVE D2 HPI: ok
BSP 1 PCI TO SLAVE D3 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 A1 HPI: ok
BSP 2 PCI TO SLAVE A2 HPI: ok
BSP 2 PCI TO SLAVE A3 HPI: ok
BSP 2 PCI TO SLAVE B1 HPI: ok
BSP 2 PCI TO SLAVE B2 HPI: ok
BSP 2 PCI TO SLAVE B3 HPI: ok
BSP 2 PCI TO SLAVE C1 HPI: ok
BSP 2 PCI TO SLAVE C2 HPI: ok
BSP 2 PCI TO SLAVE C3 HPI: ok
BSP 2 PCI TO SLAVE D1 HPI: ok
BSP 2 PCI TO SLAVE D2 HPI: ok
BSP 2 PCI TO SLAVE D3 HPI: ok

Summary:
BSP 1: OK
BSP 2: OK

--------------------------------------------------------------------------------

2014.09.22 23:51:55.489  118         1         OK

High Voltage Br. 1
------------------
TX36   Spec: 108.0  - 132.0
0-1   121.3
0-2   120.5
0-3   121.7
0-4   120.9
0-5   120.9
0-6   120.5
0-7   120.9
0-8   120.5
0-9   120.9
0-10   120.9
0-11  120.9
0-12  120.9
0-13  120.9
0-14  120.5
0-15  120.5
```

```
0-16  120.5
0-17  120.5
0-18  121.3
0-19  120.5
0-20  120.9
0-21  120.5
0-22  121.3
0-23  121.7
0-24  121.3


High Voltage Br. 2
------------------
TX36   Spec: 108.0  - 132.0
0-1   120.9
0-2   120.5
0-3   121.7
0-4   120.5
0-5   120.9
0-6   120.5
0-7   120.5
0-8   120.5
0-9   120.9
0-10   121.3
0-11  120.9
0-12  121.3
0-13  120.5
0-14  120.5
0-15  120.9
0-16  120.9
0-17  120.5
0-18  121.3
0-19  120.9
0-20  120.5
0-21  120.9
0-22  121.7
0-23  121.7
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    11.9
0-6    11.8
0-7    11.8
0-8    11.8
0-9    11.8
0-10    11.8
0-11   11.9
0-12   11.8
```

```
0-13   11.9
0-14   11.8
0-15   11.8
0-16   11.8
0-17   11.9
0-18   11.9
0-19   11.9
0-20   11.8
0-21   11.8
0-22   11.9
0-23   11.8
0-24   11.8


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    36.8
0-2    35.6
0-3    33.6
0-4    34.8
0-5    35.2
0-6    35.2
```

```
0-7    35.2
0-8    34.8
0-9    34.8
0-10    34.4
0-11   34.0
0-12   34.0
0-13   34.4
0-14   34.0
0-15   34.8
0-16   34.8
0-17   36.0
0-18   36.4
0-19   36.8
0-20   36.4
0-21   36.0
0-22   34.4
0-23   33.2
0-24   33.2


Input Current 12V
-----------------
TX36   Spec:  0.3  -  1.5
0-1     0.6
0-2     0.5
0-3     0.5
0-4     0.4
0-5     0.5
0-6     0.5
0-7     0.5
0-8     0.5
0-9     0.5
0-10     0.6
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    0.5
0-18    0.5
0-19    0.5
0-20    0.5
0-21    0.5
0-22    0.5
0-23    0.5
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
```

```
--------------------------------------------------------------------------------

2014.09.22 23:52:10.173  118         2         OK

Input voltage 12V
-----------------
RX32   Spec: 11.0  - 13.0
7-1    11.7
7-2    11.7
7-3    11.7
7-4    11.7


Input voltage 6V
----------------
RX32   Spec:  5.0  -  7.0
7-1     5.7
7-2     5.7
7-3     5.7
7-4     5.7


Digital 3.3V
------------
RX32   Spec:  2.8  -  3.5
7-1     3.3
7-2     3.3
7-3     3.3
7-4     3.3


Digital 2.5V
------------
RX32   Spec:  2.4  -  2.6
7-1     2.5
7-2     2.4
7-3     2.5
7-4     2.5


Digital 1.5V
------------
RX32   Spec:  1.4  -  1.6
7-1     1.5
7-2     1.5
7-3     1.5
7-4     1.5


Temperature
-----------
RX32   Spec: 15.0  - 75.0
7-1    34.0
7-2    35.0
```

```
7-3    34.0
7-4    32.0


Input Current 12V
-----------------
RX32   Spec:  0.4  -  1.5
7-1     0.7
7-2     0.6
7-3     0.6
7-4     0.6


Input Current 6V
----------------
RX32   Spec:  2.4  -  3.3
7-1     2.7
7-2     2.7
7-3     2.6
7-4     2.6


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 Feb 18 2010/1.11

RX32 unique firmware test OK

-------------------------------------------------------------------------------

2014.09.22 23:52:10.273  118         3         OK

High Voltage Br. 1
------------------
TX36   Spec: 108.0  - 132.0
0-1   121.3
0-2   120.5
0-3   121.7
0-4   120.9
0-5   120.9
0-6   120.5
0-7   120.5
0-8   120.5
0-9   120.9
0-10   120.9
0-11  120.9
0-12  120.9
0-13  120.9
0-14  120.5
0-15  120.5
0-16  120.5
0-17  120.5
0-18  121.3
0-19  120.5
```

```
0-20  120.9
0-21  120.5
0-22  121.3
0-23  121.7
0-24  121.3


High Voltage Br. 2
------------------
TX36   Spec: 108.0  - 132.0
0-1   120.9
0-2   120.5
0-3   121.7
0-4   120.5
0-5   120.9
0-6   120.5
0-7   120.5
0-8   120.5
0-9   120.9
0-10   120.9
0-11  120.9
0-12  121.3
0-13  120.5
0-14  120.5
0-15  120.9
0-16  120.9
0-17  120.9
0-18  121.3
0-19  120.9
0-20  120.5
0-21  120.9
0-22  121.7
0-23  121.7
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    11.9
0-6    11.8
0-7    11.8
0-8    11.8
0-9    11.8
0-10    11.8
0-11   11.8
0-12   11.8
0-13   11.9
0-14   11.8
0-15   11.8
0-16   11.9
```

```
0-17   11.9
0-18   11.9
0-19   11.9
0-20   11.8
0-21   11.8
0-22   11.9
0-23   11.8
0-24   11.8


RX32   Spec: 11.0  - 13.0
7-1    11.7
7-2    11.7
7-3    11.7
7-4    11.7


Input voltage 6V
----------------
RX32   Spec:  5.0  -  7.0
7-1     5.7
7-2     5.7
7-3     5.7
7-4     5.7

TRU  power test passed

-------------------------------------------------------------------------------

2014.09.22 23:52:10.373  118         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

-------------------------------------------------------------------------------

2014.09.22 23:54:34.321  118         5         OK

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

-------------------------------------------------------------------------------

2014.09.22 23:54:41.205  118         6         OK

Receiver impedance limits [350.0 700.0] ohm
Board  1      2      3     4
 1: 548.2  558.9  562.4  561.4
```

2:	569.5	556.7	522.3	550.2
3:	494.8	502.5	559.5	523.4
4:	532.6	540.4	519.7	540.0
5:	563.7	534.2	502.3	533.3
6:	531.7	493.4	550.5	515.8
7:	522.7	563.1	552.1	579.6
8:	483.0	560.5	547.3	527.2
9:	565.4	551.2	573.7	528.0
10:	543.3	560.1	526.2	558.9
11:	557.4	510.0	563.6	560.3
12:	518.4	551.7	545.0	539.3
13:	563.8	537.3	553.1	464.0
14:	561.5	514.7	527.5	511.2
15:	539.6	518.4	547.4	553.0
16:	535.9	524.4	544.3	546.2
17:	514.1	542.9	537.6	546.4
18:	577.5	564.7	572.1	564.7
19:	530.7	572.0	523.1	540.4
20:	487.5	536.1	514.0	567.0
21:	530.1	531.3	537.1	531.2
22:	572.1	532.9	552.8	574.4
23:	570.4	554.8	533.8	543.6
24:	535.1	548.2	536.2	542.8
25:	528.6	569.7	547.0	548.7
26:	546.5	564.6	560.0	542.3
27:	566.9	533.2	520.6	559.5
28:	536.5	526.0	557.8	539.5
29:	584.8	500.1	489.6	529.2
30:	554.2	585.8	578.7	536.4
31:	562.9	575.3	548.5	552.1
32:	538.9	491.0	569.0	497.1

Receiver Phase limits [-20.0 20.0] deg

Board	1	2	3	4
1:	-0.5	-2.6	-1.1	-1.5
2:	-2.2	-1.8	1.3	-0.5
3:	3.6	3.2	-1.2	1.3
4:	1.0	-0.1	2.0	0.8
5:	-1.7	0.9	3.9	0.0
6:	0.0	3.4	-1.3	2.2
7:	1.4	-1.9	-0.9	-3.3
8:	4.7	-2.1	-0.3	1.1
9:	-1.7	-0.6	-2.1	0.4
10:	0.1	-1.1	2.4	-1.8
11:	-1.6	3.6	-1.2	-1.6
12:	2.2	-0.8	0.1	-0.1
13:	-1.5	-0.6	-0.6	6.2
14:	-1.2	2.5	0.9	2.9
15:	0.4	1.8	-0.2	-1.0
16:	0.2	0.9	-0.2	-1.0
17:	2.1	0.2	-0.7	-0.1
18:	-3.0	-1.9	-2.2	-1.5
19:	1.1	-2.5	1.6	0.5
20:	4.4	0.0	1.8	-2.1
21:	1.3	1.0	0.2	1.1

22:	-1.9	0.4	-1.0	-3.2
23:	-2.2	-1.2	0.2	-0.7
24:	0.3	-0.8	0.0	-0.8
25:	1.3	-2.1	-0.4	-0.2
26:	0.0	-2.1	-0.7	0.1
27:	-2.1	0.9	0.9	-0.8
28:	0.7	1.8	-1.3	0.6
29:	-3.6	3.7	4.3	0.8
30:	0.0	-2.6	-2.5	-0.2
31:	-1.7	-3.1	0.1	-0.7
32:	0.1	3.5	-1.8	3.3

Rx Channels test passed

2014.09.22 23:55:15.154 118 7 OK

Tx Channels test passed

2014.09.22 23:57:57.086 118 8 OK

RX NOISE LEVEL

Board No:	1	2	3	4	
0:	71.4	69.6	71.1	71.0	dB
1:	69.9	70.8	74.4	71.5	dB
2:	70.5	71.5	72.4	71.6	dB
3:	73.4	70.6	71.5	71.0	dB
4:	72.0	70.7	71.9	70.5	dB
5:	71.1	69.9	70.2	70.9	dB
6:	71.3	71.4	71.1	71.7	dB
7:	70.7	68.8	70.1	69.8	dB
8:	70.6	69.7	71.0	73.0	dB
9:	70.4	69.9	70.7	70.6	dB
10:	70.6	70.5	70.7	70.6	dB
11:	70.7	70.2	70.3	70.3	dB
12:	70.0	70.7	70.3	71.6	dB
13:	71.4	71.2	70.5	70.0	dB
14:	69.9	73.1	70.2	72.2	dB
15:	69.9	69.0	69.7	70.0	dB
16:	52.5	70.3	72.2	68.4	dB
17:	71.1	69.7	70.4	70.7	dB
18:	70.3	71.1	70.5	73.1	dB
19:	70.0	70.9	70.7	70.7	dB
20:	70.4	69.8	70.1	71.8	dB
21:	69.9	70.6	70.3	70.5	dB
22:	71.1	71.0	71.2	71.3	dB
23:	66.8	67.5	69.8	68.7	dB
24:	74.5	73.9	70.7	71.3	dB
25:	70.8	70.2	71.1	71.4	dB
26:	71.7	72.5	71.2	70.8	dB
27:	70.1	70.1	70.9	73.5	dB

28:	71.0	70.4	71.2	71.4	dB
29:	70.2	70.5	70.5	70.2	dB
30:	71.1	70.2	70.3	71.8	dB
31:	68.5	68.9	71.3	72.2	dB

Maximum noise at Board 1 Channel 24 Level: 74.5 dB

Broadband noise test

Average noise at Board 1	70.7 dB	OK
Average noise at Board 2	70.7 dB	OK
Average noise at Board 3	71.0 dB	OK
Average noise at Board 4	71.2 dB	OK

2014.09.22 23:58:05.436 118 9 OK

RX NOISE SPECTRUM

Board No:	1	2	3	4	
10.0 kHz:	72.3	72.6	72.3	73.9	dB
10.2 kHz:	71.9	72.1	72.5	73.0	dB
10.3 kHz:	75.0	74.3	75.2	75.8	dB
10.4 kHz:	75.2	75.2	75.7	76.1	dB
10.6 kHz:	75.1	74.0	75.0	76.2	dB
10.7 kHz:	75.9	75.6	76.6	76.0	dB
10.9 kHz:	75.6	74.8	75.3	75.5	dB
11.0 kHz:	75.6	74.8	76.2	76.4	dB
11.2 kHz:	75.6	75.1	76.8	76.1	dB
11.3 kHz:	76.8	76.6	77.1	77.7	dB
11.4 kHz:	75.1	75.1	75.8	75.7	dB
11.6 kHz:	75.5	75.6	75.8	76.1	dB
11.7 kHz:	73.1	73.4	74.1	74.0	dB
11.9 kHz:	74.2	74.9	74.9	77.1	dB
12.0 kHz:	74.8	74.9	75.6	76.1	dB
12.1 kHz:	75.4	75.2	75.6	75.6	dB
12.3 kHz:	74.6	74.2	74.3	74.9	dB
12.4 kHz:	73.4	74.6	74.5	74.9	dB
12.6 kHz:	73.6	73.9	73.7	74.3	dB
12.7 kHz:	73.6	73.8	74.2	74.1	dB
12.9 kHz:	73.1	73.3	73.2	73.5	dB
13.0 kHz:	73.0	72.3	72.9	72.8	dB

Maximum noise at Board 4 Frequency 11.3 kHz Level: 77.7 dB

Spectral noise test

Average noise at Board 1	74.6 dB	OK
Average noise at Board 2	74.5 dB	OK
Average noise at Board 3	75.1 dB	OK
Average noise at Board 4	75.5 dB	OK

```
2014.09.22 23:58:13.786  118         10        OK

CPU: PP 432/05x PENTIUM4
Clock 2166 MHz
Die   47 oC (peak: 49 oC @ 2014-09-22 - 23:48:11)
Board 43 oC (peak: 44 oC @ 2014-09-22 - 23:48:11)
Core  1.02 V
3V3   3.27 V
12V   11.91 V
-12V  -11.91 V
BATT  1.77 V
Primary network: 157.237.14.60:0xffff0000
Secondary network: 192.168.36.102:0xffff0000

-------------------------------------------------------------------------------

2014.09.22 23:58:13.819  118         15        OK

EM 122

BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.2.3 110321
DDS: 3.5.2 101013
RX32 version : Feb 18 2010 Rev 1.11
TX36 LC version : Jun 17 2008 Rev 1.11
VxWorks 5.5.1 Build V1.19-01 Oct  8 2009, 13:31:43

-------------------------------------------------------------------------------
```

Appendix E – Cross-check Analyses

Cross-check analyses were performed both internally and with existing surveys. Survey lines 101, 117, and 181 have been selected for internal consistency check since they are temporally and spatially distributed in time and in the project area, as well as with large overlap over other survey lines.

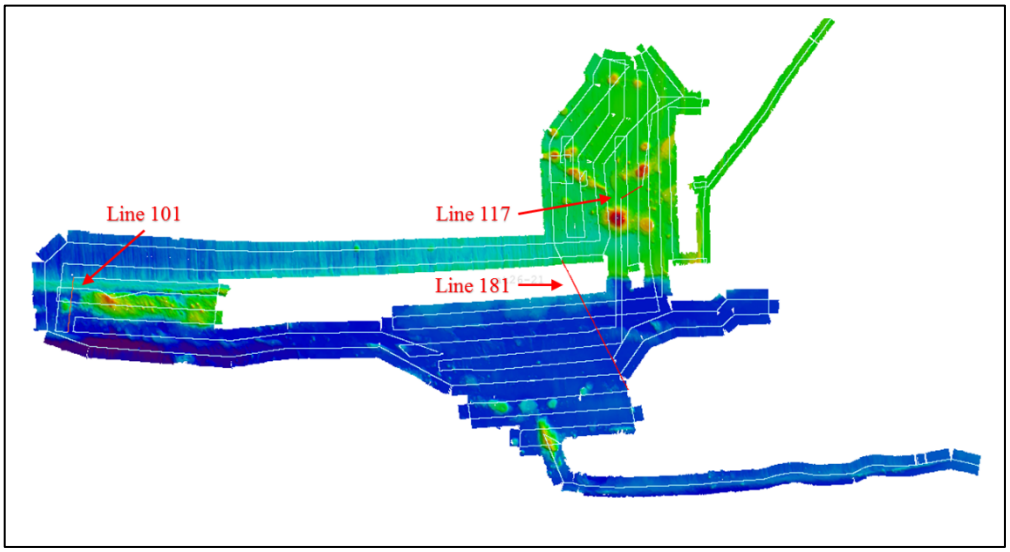


Figure 36 – Surveylines selected for internal cross-check analyses.

Table 109 shows the results of differencing the surface obtained from the selected lines and a surface created with all the remaining data. Histograms for each pair are provided in Figures 36, 37, and 38.

Selected surveyline #	Average difference (m)	Standard deviation (m)	Number of samples
101	0.6	16.2	92,614
117	-0.1	6.1	29,647
181	0.2	7.9	173,919

Table 9 – Results of the surface comparison with previous surveys.

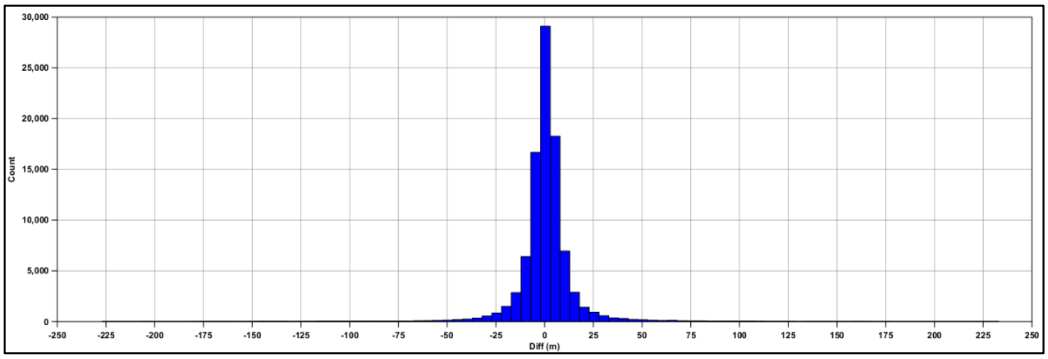


Figure 37– Sounding depth difference (m) between line number 101 and the remaining survey data.

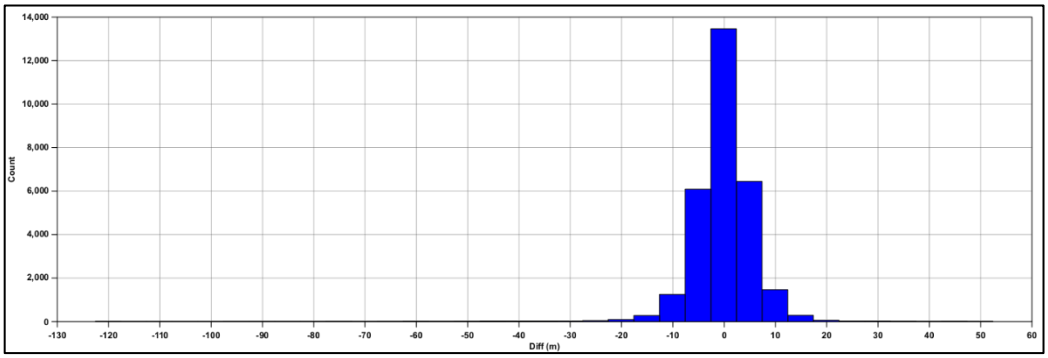


Figure 38– Sounding depth difference (m) between line number 117 and the remaining survey data.

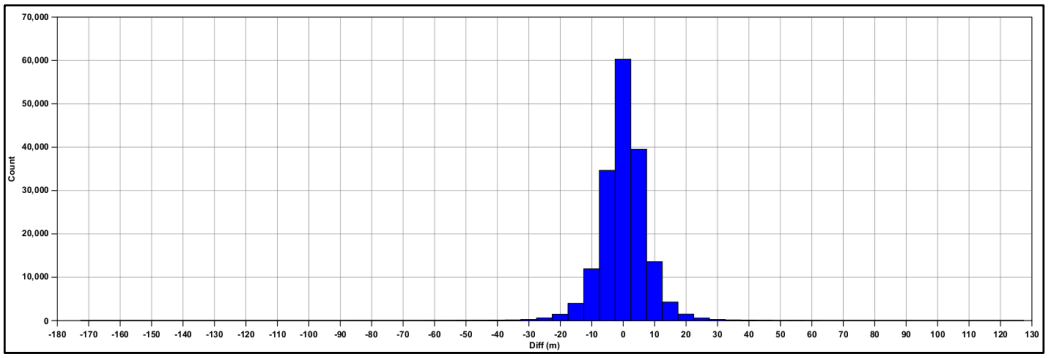


Figure 39– Sounding depth difference (m) between line number 181 and the remaining survey data.

Figure 40 shows the overlapping areas between the collected data and previous surveys (Ex903 and Ex905).

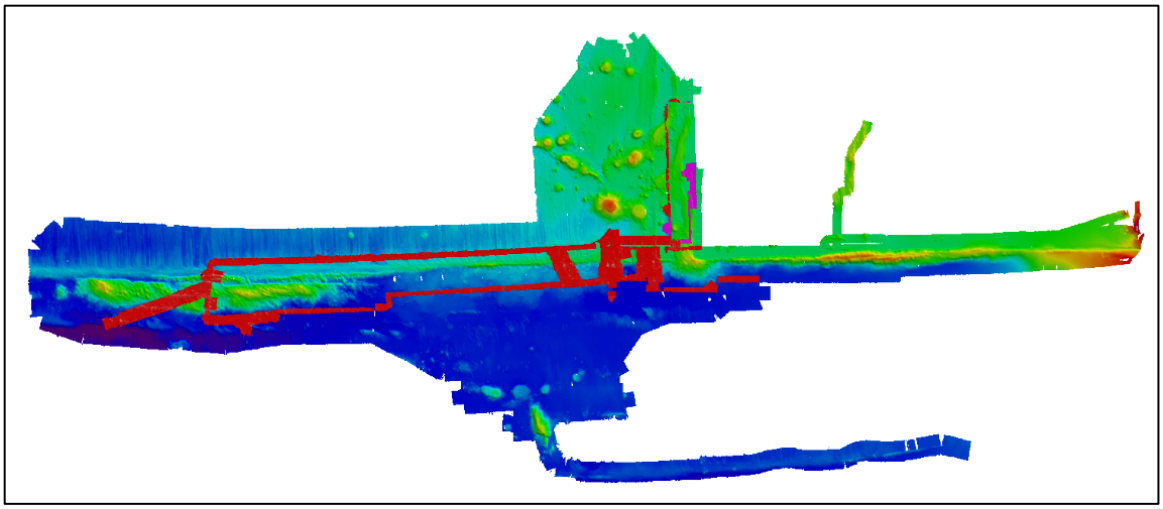


Figure 40 – Overlapping areas with previous surveys: Ex903 (red) and Ex905 (magenta).

Table 10 shows the results of differencing the surface obtained from the acquired data and existing surveys surfaces. Histograms for each pair are provided in Figure 41, Figure 42, and Figure 43.

Compared survey	Average difference (m)	Standard deviation (m)	Number of samples
Ex903 west	-2.0	19.3	763,462
Ex903 east	-2.2	17.9	964,844
Ex905	2.4	16.9	83,142

Table 10 – Results of the surface comparison with previous surveys.

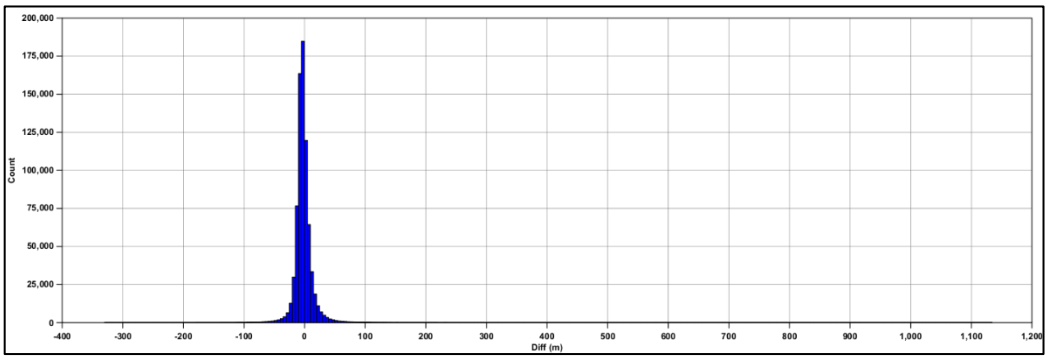


Figure 41 – Sounding depth difference (m) between acquired data and survey Ex903 (west area).

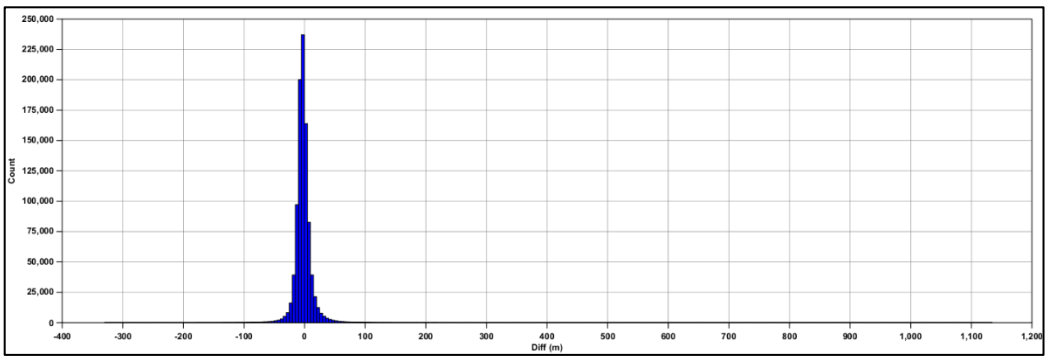


Figure 42 – Sounding depth difference (m) between acquired data and survey Ex903 (east area).

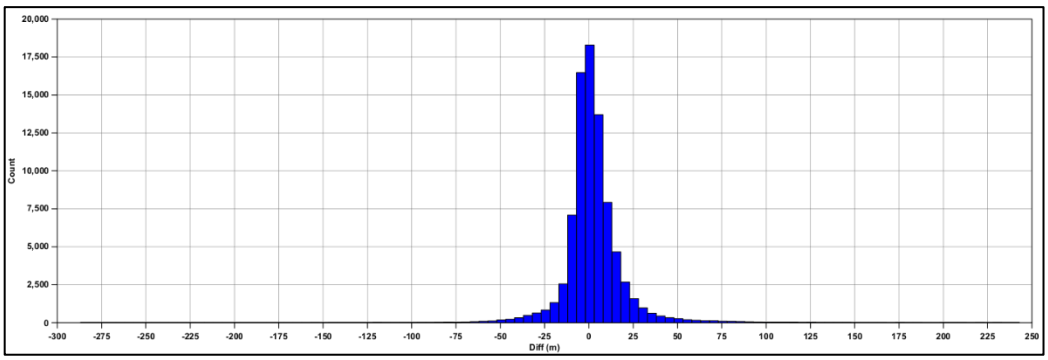


Figure 43 – Sounding depth difference (m) between acquired data and survey Ex905.

Appendix F – Information about the acquired MBES lines.

Filename (.all)	Start time	End time	Total time [d:h:m]	Average heading	Length [nmi]	Speed [kt]
0000_20140923_210249_Atlantis	9/23/2014 21:02	9/23/2014 21:47	0:00:44	217.0	8.04	10.8
0001_20140923_214732_Atlantis	9/23/2014 21:47	9/23/2014 23:24	0:01:37	217.8	17.45	10.8
0002_20140924_031116_Atlantis	9/24/2014 3:11	9/24/2014 3:13	0:00:01	217.7	0.24	8.1
0003_20140924_031303_Atlantis	9/24/2014 3:12	9/24/2014 6:00	0:02:47	218.4	21.44	7.7
0004_20140924_060020_Atlantis	9/24/2014 6:00	9/24/2014 12:00	0:06:00	219.6	52.05	8.7
0005_20140924_120005_Atlantis	9/24/2014 11:59	9/24/2014 18:40	0:06:40	218.4	54.50	8.2
0006_20140924_184005_Atlantis	9/24/2014 18:39	9/24/2014 22:10	0:03:30	219.3	31.30	8.9
0007_20140924_221022_Atlantis	9/24/2014 22:10	9/24/2014 22:11	0:00:01	219.0	0.17	9.3
0008_20140924_221112_Atlantis	9/24/2014 22:11	9/25/2014 0:00	0:01:49	220.6	16.69	9.1
0009_20140925_000049_Atlantis	9/25/2014 0:00	9/25/2014 0:16	0:00:15	221.4	2.37	9.3
0010_20140925_001603_Atlantis	9/25/2014 0:16	9/25/2014 1:24	0:01:08	220.9	10.66	9.4
0011_20140925_012906_Atlantis	9/25/2014 1:29	9/25/2014 1:37	0:00:08	222.1	1.33	9.5
0012_20140925_013728_Atlantis	9/25/2014 1:37	9/25/2014 2:01	0:00:24	221.2	3.68	9.2
0013_20140925_020132_Atlantis	9/25/2014 2:01	9/25/2014 2:32	0:00:31	219.6	4.84	9.3
0014_20140925_023251_Atlantis	9/25/2014 2:32	9/25/2014 6:00	0:03:27	217.8	29.87	8.6
0015_20140925_060025_Atlantis	9/25/2014 6:00	9/25/2014 6:14	0:00:13	214.8	2.09	9.0
0016_20140925_061423_Atlantis	9/25/2014 6:14	9/25/2014 6:15	0:00:43	221.8	0.11	9.2
0017_20140925_061507_Atlantis	9/25/2014 6:15	9/25/2014 11:01	0:04:45	222.2	46.70	9.8
0018_20140925_110106_Atlantis	9/25/2014 11:01	9/25/2014 11:13	0:00:12	265.6	2.29	11.3
			Total		**Total**	**Avg**
			1:11:02		**305.81**	**9.3**

Table 11 – Information about surveylines during transit from Astoria, OR.

Filename (.all)	Start time	End time	Total time [d:h:m]	Average heading	Length [nmi]	Speed [kt]
0019_20140925_111310_Atlantis	9/25/2014 11:13	9/25/2014 11:14	0:00:01	267.0	0.20	11.3
0020_20140925_111355_Atlantis	9/25/2014 11:13	9/25/2014 11:15	0:00:01	265.6	0.30	11.2
0021_20140925_111524_Atlantis	9/25/2014 11:15	9/25/2014 11:34	0:00:18	266.9	3.44	11.1
0022_20140925_113402_Atlantis	9/25/2014 11:34	9/25/2014 11:40	0:00:06	93.9	1.03	10.3
0023_20140925_114003_Atlantis	9/25/2014 11:40	9/25/2014 12:09	0:00:29	86.0	5.35	11.0
0024_20140925_120924_Atlantis	9/25/2014 12:09	9/25/2014 12:21	0:00:12	82.8	1.36	6.6
0025_20140925_122145_Atlantis	9/25/2014 12:21	9/25/2014 13:18	0:00:56	266.2	6.07	6.4
0026_20140925_131819_Atlantis	9/25/2014 13:18	9/25/2014 13:37	0:00:19	359.7	3.14	9.8
0027_20140925_133731_Atlantis	9/25/2014 13:37	9/25/2014 14:09	0:00:32	88.4	5.79	10.8
0028_20140925_140938_Atlantis	9/25/2014 14:09	9/25/2014 17:38	0:03:29	185.8	39.99	11.5
0029_20140925_173849_Atlantis	9/25/2014 17:38	9/25/2014 18:03	0:00:24	11.0	4.68	11.3
0030_20140925_180343_Atlantis	9/25/2014 18:03	9/25/2014 18:12	0:00:08	271.9	1.46	10.6
0031_20140925_181203_Atlantis	9/25/2014 18:12	9/25/2014 19:30	0:01:18	271.7	13.91	10.6
0032_20140925_193026_Atlantis	9/25/2014 19:30	9/25/2014 19:33	0:00:03	351.4	0.53	10.3
0033_20140925_193333_Atlantis	9/25/2014 19:33	9/26/2014 0:00	0:04:27	2.3	50.12	11.3
0034_20140926_000037_Atlantis	9/26/2014 0:00	9/26/2014 0:09	0:00:08	1.7	1.55	10.8
0035_20140926_000916_Atlantis	9/26/2014 0:09	9/26/2014 0:32	0:00:22	2.3	4.16	10.9
0036_20140926_003215_Atlantis	9/26/2014 0:32	9/26/2014 1:16	0:00:44	2.3	8.03	10.9
0037_20140926_011628_Atlantis	9/26/2014 1:16	9/26/2014 2:24	0:01:07	15.0	12.67	11.2
0038_20140926_022425_Atlantis	9/26/2014 2:24	9/26/2014 2:25	0:00:00	98.2	0.17	12.3
0039_20140926_022517_Atlantis	9/26/2014 2:25	9/26/2014 2:37	0:00:11	95.1	2.41	12.3
0040_20140926_023704_Atlantis	9/26/2014 2:37	9/26/2014 3:31	0:00:54	95.4	11.21	12.4
0041_20140926_033127_Atlantis	9/26/2014 3:31	9/26/2014 4:00	0:00:28	9.4	5.25	10.9
0042_20140926_040020_Atlantis	9/26/2014 4:00	9/26/2014 4:50	0:00:50	280.1	8.51	10.1
0043_20140926_045034_Atlantis	9/26/2014 4:50	9/26/2014 5:52	0:01:02	273.8	10.11	9.7
0044_20140926_055248_Atlantis	9/26/2014 5:52	9/26/2014 6:30	0:00:37	243.9	6.63	10.5
0045_20140926_063043_Atlantis	9/26/2014 6:30	9/26/2014 8:08	0:01:37	182.5	19.47	12.0

Filename (.all)	Start time	End time	Total time [d:h:m]	Average heading	Length [nmi]	Speed [kt]
0046_20140926_080826_Atlantis	9/26/2014 8:08	9/26/2014 9:12	0:01:04	182.4	12.75	11.9
0047_20140926_091250_Atlantis	9/26/2014 9:12	9/26/2014 12:15	0:03:02	182.5	35.58	11.7
0048_20140926_121541_Atlantis	9/26/2014 12:15	9/26/2014 14:38	0:02:22	182.4	28.12	11.9
0049_20140926_143800_Atlantis	9/26/2014 14:38	9/26/2014 20:34	0:05:56	269.1	64.31	10.8
0050_20140926_203452_Atlantis	9/26/2014 20:34	9/26/2014 20:45	0:00:10	269.5	1.98	11.0
0051_20140926_204541_Atlantis	9/26/2014 20:45	9/26/2014 22:02	0:01:16	269.7	14.12	11.1
0052_20140926_220209_Atlantis	9/26/2014 22:02	9/26/2014 23:44	0:01:42	269.9	19.55	11.4
0053_20140926_234450_Atlantis	9/26/2014 23:44	9/27/2014 1:13	0:01:28	270.3	16.76	11.3
0054_20140927_011331_Atlantis	9/27/2014 1:13	9/27/2014 2:38	0:01:25	270.3	16.12	11.3
0055_20140927_023850_Atlantis	9/27/2014 2:38	9/27/2014 3:25	0:00:46	174.5	7.46	9.7
0056_20140927_032511_Atlantis	9/27/2014 3:25	9/27/2014 5:11	0:01:45	90.6	21.12	12.0
0057_20140927_051107_Atlantis	9/27/2014 5:11	9/27/2014 6:01	0:00:50	90.5	9.90	11.8
0058_20140927_060120_Atlantis	9/27/2014 6:01	9/27/2014 8:08	0:02:07	90.1	25.78	12.2
0059_20140927_080834_Atlantis	9/27/2014 8:08	9/27/2014 11:27	0:03:18	89.6	40.24	12.2
0060_20140927_112706_Atlantis	9/27/2014 11:27	9/27/2014 14:27	0:03:00	84.0	36.14	12.0
0061_20140927_142734_Atlantis	9/27/2014 14:27	9/27/2014 16:24	0:01:56	353.3	21.34	11.0
0062_20140927_162404_Atlantis	9/27/2014 16:24	9/27/2014 20:31	0:04:07	2.9	47.19	11.4
0063_20140927_203155_Atlantis	9/27/2014 20:31	9/27/2014 21:08	0:00:36	183.6	6.99	11.6
0064_20140927_210814_Atlantis	9/27/2014 21:08	9/27/2014 22:18	0:01:09	4.0	13.29	11.4
0065_20140927_221802_Atlantis	9/27/2014 22:18	9/27/2014 22:19	0:00:01	5.1	0.19	11.5
0066_20140927_221902_Atlantis	9/27/2014 22:19	9/27/2014 22:20	0:00:00	4.7	0.19	11.5
0067_20140927_222003_Atlantis	9/27/2014 22:20	9/27/2014 23:12	0:00:52	2.8	10.15	11.5
0068_20140927_231257_Atlantis	9/27/2014 23:12	9/28/2014 0:49	0:01:36	3.2	18.66	11.6
0069_20140928_004913_Atlantis	9/28/2014 0:49	9/28/2014 1:37	0:00:48	3.1	9.53	11.7
0070_20140928_013759_Atlantis	9/28/2014 1:38	9/28/2014 2:05	0:00:27	270.5	5.62	12.2
0071_20140928_020541_Atlantis	9/28/2014 2:05	9/28/2014 3:50	0:01:45	183.5	21.15	12.1
0072_20140928_035057_Atlantis	9/28/2014 3:50	9/28/2014 5:25	0:01:34	183.4	19.27	12.2

Filename (.all)	Start time	End time	Total time [d:h:m]	Average heading	Length [nmi]	Speed [kt]
0073_20140928_052528_Atlantis	9/28/2014 5:25	9/28/2014 6:19	0:00:53	183.6	10.72	12.0
0074_20140928_061912_Atlantis	9/28/2014 6:19	9/28/2014 9:58	0:03:38	185.0	44.02	12.1
0075_20140928_095806_Atlantis	9/28/2014 9:58	9/28/2014 12:11	0:02:13	351.5	25.92	11.6
0076_20140928_121143_Atlantis	9/28/2014 12:11	9/28/2014 14:19	0:02:07	3.5	24.51	11.5
0077_20140928_141936_Atlantis	9/28/2014 14:19	9/28/2014 15:49	0:01:30	3.6	17.23	11.4
0078_20140928_154957_Atlantis	9/28/2014 15:49	9/28/2014 16:21	0:00:31	273.1	5.76	11.0
0079_20140928_162131_Atlantis	9/28/2014 16:21	9/28/2014 19:08	0:02:46	184.1	33.48	12.1
0080_20140928_190803_Atlantis	9/28/2014 19:08	9/29/2014 0:09	0:05:01	185.4	61.44	12.2
0081_20140929_000931_Atlantis	9/29/2014 0:09	9/29/2014 6:01	0:05:51	268.5	68.52	11.7
0082_20140929_060121_Atlantis	9/29/2014 6:01	9/29/2014 9:08	0:03:07	270.1	36.97	11.8
0083_20140929_090843_Atlantis	9/29/2014 9:08	9/29/2014 9:48	0:00:39	138.5	7.90	12.0
0084_20140929_094810_Atlantis	9/29/2014 9:48	9/29/2014 11:07	0:01:19	89.8	16.15	12.2
0085_20140929_110740_Atlantis	9/29/2014 11:07	9/29/2014 11:14	0:00:07	304.6	1.33	10.9
0086_20140929_112214_Atlantis	9/29/2014 11:22	9/29/2014 14:01	0:02:39	293.1	29.75	11.2
0087_20140929_140119_Atlantis	9/29/2014 14:01	9/29/2014 18:01	0:03:59	273.2	45.76	11.4
0088_20140929_180112_Atlantis	9/29/2014 18:01	9/29/2014 20:24	0:02:23	266.5	28.25	11.8
0089_20140929_204413_Atlantis	9/29/2014 20:44	9/29/2014 21:44	0:01:00	276.6	11.58	11.6
0090_20140929_214422_Atlantis	9/29/2014 21:44	9/30/2014 0:00	0:02:15	276.9	26.14	11.5
0091_20140930_000020_Atlantis	9/30/2014 0:00	9/30/2014 3:40	0:03:40	277.3	41.46	11.3
0092_20140930_034047_Atlantis	9/30/2014 3:40	9/30/2014 4:20	0:00:39	14.3	7.52	11.5
0093_20140930_042007_Atlantis	9/30/2014 4:20	9/30/2014 10:08	0:05:48	96.8	68.46	11.8
0094_20140930_100813_Atlantis	9/30/2014 10:08	9/30/2014 10:47	0:00:39	3.4	7.40	11.2
0095_20140930_104743_Atlantis	9/30/2014 10:47	9/30/2014 17:31	0:06:43	277.4	77.79	11.6
0096_20140930_173116_Atlantis	9/30/2014 17:31	9/30/2014 18:09	0:00:38	12.3	7.42	11.7
0097_20140930_180919_Atlantis	9/30/2014 18:09	10/1/2014 0:00	0:05:50	97.0	69.08	11.8
0098_20141001_000006_Atlantis	10/1/2014 0:00	10/1/2014 0:54	0:00:54	96.3	10.72	11.8
0099_20141001_005444_Atlantis	10/1/2014 0:54	10/1/2014 1:27	0:00:32	11.3	6.22	11.3

Filename (.all)	Start time	End time	Total time [d:h:m]	Average heading	Length [nmi]	Speed [kt]
0100_20141001_012742_Atlantis	10/1/2014 1:27	10/1/2014 7:41	0:06:14	276.5	72.04	11.6
0101_20141001_074150_Atlantis	10/1/2014 7:41	10/1/2014 10:01	0:02:19	189.6	27.16	11.7
0102_20141001_100134_Atlantis	10/1/2014 10:01	10/1/2014 10:32	0:00:31	278.3	6.18	11.9
0103_20141001_103239_Atlantis	10/1/2014 10:32	10/1/2014 13:21	0:02:48	10.5	33.47	11.9
0104_20141001_132121_Atlantis	10/1/2014 13:21	10/1/2014 19:58	0:06:37	96.4	78.84	11.9
0105_20141001_195827_Atlantis	10/1/2014 19:58	10/2/2014 0:08	0:04:10	92.4	49.86	12.0
0106_20141002_000838_Atlantis	10/2/2014 0:08	10/2/2014 6:00	0:05:51	91.6	68.53	11.7
0107_20141002_060009_Atlantis	10/2/2014 6:00	10/2/2014 12:02	0:06:02	90.6	69.13	11.5
0108_20141002_120218_Atlantis	10/2/2014 12:02	10/2/2014 12:54	0:00:52	24.8	9.39	10.8
0109_20141002_125419_Atlantis	10/2/2014 12:54	10/2/2014 16:08	0:03:14	359.0	35.85	11.1
0110_20141002_160832_Atlantis	10/2/2014 16:08	10/2/2014 18:01	0:01:52	43.1	21.56	11.5
0111_20141002_180105_Atlantis	10/2/2014 18:01	10/2/2014 19:46	0:01:45	47.2	20.14	11.5
0112_20141002_194613_Atlantis	10/2/2014 19:46	10/2/2014 21:56	0:02:10	342.8	24.37	11.2
0113_20141002_215622_Atlantis	10/2/2014 21:56	10/2/2014 22:14	0:00:17	62.3	3.14	10.6
0114_20141002_221411_Atlantis	10/2/2014 22:14	10/3/2014 0:49	0:02:35	145.1	28.44	11.0
0115_20141003_004959_Atlantis	10/3/2014 0:50	10/3/2014 2:25	0:01:35	243.5	17.63	11.0
0116_20141003_022548_Atlantis	10/3/2014 2:25	10/3/2014 5:29	0:03:03	192.2	35.56	11.6
0117_20141003_052922_Atlantis	10/3/2014 5:29	10/3/2014 6:32	0:01:02	242.0	12.21	11.7
0118_20141003_063200_Atlantis	10/3/2014 6:32	10/3/2014 12:36	0:06:04	183.7	70.69	11.7
0119_20141003_123601_Atlantis	10/3/2014 12:36	10/3/2014 18:00	0:05:24	268.1	63.82	11.8
0120_20141003_180011_Atlantis	10/3/2014 18:00	10/3/2014 20:18	0:02:18	267.9	27.05	11.7
0121_20141003_201824_Atlantis	10/3/2014 20:18	10/3/2014 20:42	0:00:24	172.4	4.81	11.7
0122_20141003_204258_Atlantis	10/3/2014 20:42	10/4/2014 0:00	0:03:17	91.8	35.75	10.9
0123_20141004_000013_Atlantis	10/4/2014 0:00	10/4/2014 4:36	0:04:36	88.2	49.68	10.8
0124_20141004_043656_Atlantis	10/4/2014 4:36	10/4/2014 6:16	0:01:39	34.6	17.34	10.5
0125_20141004_061612_Atlantis	10/4/2014 6:16	10/4/2014 8:19	0:02:03	72.1	21.78	10.6
0126_20141004_081941_Atlantis	10/4/2014 8:19	10/4/2014 10:19	0:02:00	93.2	21.88	10.9

Filename (.all)	Start time	End time	Total time [d:h:m]	Average heading	Length [nmi]	Speed [kt]
0127_20141004_101943_Atlantis	10/4/2014 10:19	10/4/2014 10:59	0:00:39	44.0	7.23	11.0
0128_20141004_105901_Atlantis	10/4/2014 10:59	10/4/2014 12:50	0:01:51	94.0	20.68	11.2
0129_20141004_125013_Atlantis	10/4/2014 12:50	10/4/2014 13:25	0:00:35	184.0	6.86	11.6
0130_20141004_132545_Atlantis	10/4/2014 13:25	10/4/2014 14:55	0:01:29	272.1	16.90	11.3
0131_20141004_145515_Atlantis	10/4/2014 14:55	10/4/2014 15:36	0:00:41	230.8	7.99	11.5
0132_20141004_153650_Atlantis	10/4/2014 15:36	10/4/2014 17:38	0:02:01	271.9	23.43	11.5
0133_20141004_173848_Atlantis	10/4/2014 17:38	10/4/2014 18:59	0:01:20	250.9	16.43	12.2
0134_20141004_185939_Atlantis	10/4/2014 18:59	10/4/2014 20:50	0:01:50	224.6	22.75	12.3
0135_20141004_205016_Atlantis	10/4/2014 20:50	10/4/2014 23:00	0:02:09	269.4	24.54	11.3
0137_20141004_230016_Atlantis	10/4/2014 23:00	10/5/2014 0:00	0:00:59	269.8	10.53	10.6
0138_20141005_000008_Atlantis	10/5/2014 0:00	10/5/2014 0:37	0:00:37	269.8	5.93	9.5
0140_20141005_005750_Atlantis	10/5/2014 0:57	10/5/2014 1:10	0:00:12	89.9	1.73	8.1
0141_20141005_011037_Atlantis	10/5/2014 1:10	10/5/2014 1:27	0:00:16	90.2	2.27	8.3
0142_20141005_013151_Atlantis	10/5/2014 1:31	10/5/2014 1:46	0:00:14	270.9	2.25	9.3
0143_20141005_014629_Atlantis	10/5/2014 1:46	10/5/2014 5:17	0:03:31	270.3	38.97	11.1
0144_20141005_051731_Atlantis	10/5/2014 5:17	10/5/2014 8:49	0:03:31	302.2	40.22	11.4
0145_20141005_084903_Atlantis	10/5/2014 8:49	10/5/2014 12:57	0:04:08	272.8	46.59	11.3
0146_20141005_125707_Atlantis	10/5/2014 12:57	10/5/2014 15:16	0:02:19	265.0	26.81	11.5
0147_20141005_151639_Atlantis	10/5/2014 15:16	10/5/2014 21:17	0:06:00	278.1	70.31	11.7
0148_20141005_211722_Atlantis	10/5/2014 21:17	10/5/2014 23:10	0:01:52	294.1	22.10	11.8
0149_20141005_231003_Atlantis	10/5/2014 23:10	10/6/2014 1:58	0:02:48	1.8	33.59	11.9
0150_20141006_015858_Atlantis	10/6/2014 1:58	10/6/2014 3:16	0:01:18	51.7	15.14	11.6
0151_20141006_031659_Atlantis	10/6/2014 3:17	10/6/2014 10:19	0:07:02	97.0	79.25	11.3
0152_20141006_101911_Atlantis	10/6/2014 10:19	10/6/2014 12:00	0:01:41	94.9	18.40	10.9
0153_20141006_120023_Atlantis	10/6/2014 12:00	10/6/2014 18:00	0:05:59	92.8	63.98	10.7
0154_20141006_180020_Atlantis	10/6/2014 18:00	10/6/2014 21:00	0:03:00	92.1	33.19	11.0
0155_20141006_211816_Atlantis	10/6/2014 21:18	10/7/2014 0:00	0:02:41	91.7	29.62	11.0

Filename (.all)	Start time	End time	Total time [d:h:m]	Average heading	Length [nmi]	Speed [kt]
0156_20141007_000005_Atlantis	10/7/2014 0:00	10/7/2014 3:30	0:03:30	91.1	38.62	11.0
0157_20141007_033008_Atlantis	10/7/2014 3:30	10/7/2014 6:54	0:03:24	359.0	38.41	11.3
0158_20141007_065455_Atlantis	10/7/2014 6:54	10/7/2014 9:16	0:02:21	38.6	26.98	11.4
0159_20141007_091654_Atlantis	10/7/2014 9:16	10/7/2014 11:49	0:02:32	5.0	28.23	11.1
0160_20141007_114908_Atlantis	10/7/2014 11:49	10/7/2014 12:25	0:00:36	276.3	7.51	12.4
0161_20141007_122533_Atlantis	10/7/2014 12:25	10/7/2014 14:46	0:02:21	185.7	26.99	11.5
0162_20141007_144655_Atlantis	10/7/2014 14:46	10/7/2014 17:13	0:02:26	218.8	26.30	10.8
0163_20141007_171306_Atlantis	10/7/2014 17:13	10/7/2014 18:22	0:01:09	179.4	13.71	11.9
0164_20141007_182217_Atlantis	10/7/2014 18:22	10/7/2014 19:42	0:01:19	2.1	15.62	11.7
0166_20141007_194205_Atlantis	10/7/2014 19:42	10/7/2014 22:07	0:02:25	179.6	28.84	11.9
0167_20141007_220741_Atlantis	10/7/2014 22:07	10/7/2014 22:52	0:00:45	275.4	8.79	11.7
0168_20141007_225256_Atlantis	10/7/2014 22:52	10/8/2014 2:40	0:03:47	2.6	44.38	11.7
0169_20141008_024043_Atlantis	10/8/2014 2:40	10/8/2014 6:52	0:04:11	42.6	50.69	12.1
0170_20141008_065430_Atlantis	10/8/2014 6:54	10/8/2014 7:56	0:01:02	290.3	13.22	12.8
0171_20141008_075837_Atlantis	10/8/2014 7:58	10/8/2014 12:44	0:04:45	211.5	57.90	12.2
0172_20141008_124401_Atlantis	10/8/2014 12:44	10/8/2014 13:37	0:00:53	184.3	10.97	12.3
0173_20141008_134108_Atlantis	10/8/2014 13:41	10/8/2014 16:30	0:02:49	30.5	33.97	12.1
0174_20141008_163016_Atlantis	10/8/2014 16:30	10/8/2014 17:00	0:00:30	276.0	5.56	10.9
0175_20141008_170055_Atlantis	10/8/2014 17:00	10/8/2014 18:07	0:01:06	186.6	13.25	11.9
0176_20141008_180819_Atlantis	10/8/2014 18:08	10/8/2014 18:15	0:00:07	93.2	1.56	12.3
0177_20141008_183249_Atlantis	10/8/2014 18:32	10/8/2014 18:55	0:00:23	348.5	4.54	11.8
0178_20141008_185551_Atlantis	10/8/2014 18:55	10/8/2014 19:43	0:00:47	270.6	8.97	11.2
0179_20141008_194606_Atlantis	10/8/2014 19:46	10/8/2014 23:22	0:03:36	181.0	43.75	12.2
0180_20141008_232207_Atlantis	10/8/2014 23:22	10/9/2014 0:00	0:00:38	157.3	8.01	12.6
0181_20141009_000018_Atlantis	10/9/2014 0:00	10/9/2014 5:47	0:05:47	156.8	71.93	12.4
0182_20141009_055037_Atlantis	10/9/2014 5:50	10/9/2014 12:19	0:06:28	269.3	78.56	12.1
0183_20141009_121903_Atlantis	10/9/2014 12:19	10/9/2014 12:56	0:00:37	176.1	7.50	12.0

Filename (.all)	Start time	End time	Total time [d:h:m]	Average heading	Length [nmi]	Speed [kt]
0184_20141009_125642_Atlantis	10/9/2014 12:56	10/9/2014 19:39	0:06:42	89.8	79.54	11.9
0185_20141009_193926_Atlantis	10/9/2014 19:39	10/9/2014 19:41	0:00:02	163.6	0.39	11.4
0186_20141009_194131_Atlantis	10/9/2014 19:41	10/9/2014 20:16	0:00:35	174.5	7.15	12.2
0187_20141009_201641_Atlantis	10/9/2014 20:16	10/10/2014 0:57	0:04:40	269.7	56.02	12.0
0188_20141010_005702_Atlantis	10/10/2014 0:57	10/10/2014 1:36	0:00:39	183.9	8.01	12.2
0189_20141010_013631_Atlantis	10/10/2014 1:36	10/10/2014 3:01	0:01:24	89.9	16.59	11.8
0190_20141010_030112_Atlantis	10/10/2014 3:01	10/10/2014 3:20	0:00:19	90.0	3.75	11.8
0191_20141010_032454_Atlantis	10/10/2014 3:24	10/10/2014 4:18	0:00:53	303.5	10.34	11.7
0192_20141010_042113_Atlantis	10/10/2014 4:21	10/10/2014 6:25	0:02:03	161.4	25.89	12.5
0193_20141010_062513_Atlantis	10/10/2014 6:25	10/10/2014 12:40	0:06:15	93.5	78.57	12.6
0194_20141010_124031_Atlantis	10/10/2014 12:40	10/10/2014 17:56	0:05:15	89.7	65.14	12.4
0195_20141010_175600_Atlantis	10/10/2014 17:56	10/10/2014 21:49	0:03:53	85.6	48.16	12.4
0196_20141010_215330_Atlantis	10/10/2014 21:53	10/10/2014 23:00	0:01:07	107.4	13.91	12.5
			Total		**Total**	**Avg**
			15:9:54		**4284.77**	**11.4**

Table 12 – Information about surveylines in the project area.

Filename (.all)	Start time	End time	Total time [d:h:m]	Average heading	Length [nmi]	Speed [kt]
0197_20141010_230032_Atlantis	10/10/2014 23:00	10/11/2014 0:00	0:00:59	105.474	12.1	12.1
0198_20141011_000015_Atlantis	10/11/2014 0:00	10/11/2014 6:00	0:05:59	105.374	66.5	11.1
0199_20141011_060004_Atlantis	10/11/2014 6:00	10/11/2014 9:11	0:03:11	104.917	27.6	8.7
0200_20141011_091116_Atlantis	10/11/2014 9:11	10/11/2014 14:12	0:05:01	105.406	43.0	8.6
			Total		**Total**	**Avg**
			0:15:11		**149.2**	**10.1**

Table 13 – Information about survey lines during transit to San Francisco, CA.

Appendix G – Conversion table of Kongsberg .all file names to UNH .all file names.

JD	DataFolder	Kongsberg .all file name *Line_yyyymmdd_time_Ship.all*	UNH file name *.all*	Notes
266	**140923**	**0000_20140923_210249_Atlantis**	**Mendocino_line_200tran**	**transit**
266		0001_20140923_214732_Atlantis	Mendocino_line_201tran	transit
267	**140924**	**0002_20140924_031116_Atlantis**	**Mendocino_line_202tran**	**transit**
267		0003_20140924_031303_Atlantis	Mendocino_line_203tran	transit
267		0004_20140924_060020_Atlantis	Mendocino_line_204tran	transit
267		0005_20140924_120005_Atlantis	Mendocino_line_205tran	transit
267		0006_20140924_184005_Atlantis	Mendocino_line_206tran	transit
267		0007_20140924_221022_Atlantis	Mendocino_line_207tran	Transit very short file
267		0008_20140924_221112_Atlantis	Mendocino_line_208tran	transit
268	**201425**	**0009_20140925_000049_Atlantis**	**Mendocino_line_209tran**	**Transit very short file**
268		0010_20140925_001603_Atlantis	Mendocino_line_210tran	Transit short file
268		0011_20140925_012906_Atlantis	Mendocino_line_211tran	Transit very short file
268		0012_20140925_013728_Atlantis	Mendocino_line_212tran	Transit short file
268		0013_20140925_020132_Atlantis	Mendocino_line_213tran	transit short file
268		0014_20140925_023251_Atlantis	Mendocino_line_214tran	transit
268		0015_20140925_060025_Atlantis	Mendocino_line_215tran	Transit synced Knudsen
268		0016_20140925_061423_Atlantis	Mendocino_line_216tran	Transit very short file
268		0017_20140925_061507_Atlantis	Mendocino_line_217tran	transit
268		0018_20140925_110106_Atlantis	Mendocino_line_218patch	Patch test not processed
268		0019_20140925_111310_Atlantis	Mendocino_line_219patch	Patch test not processed
268		0020_20140925_111355_Atlantis	Mendocino_line_220patch	Patch test not processed
268		0021_20140925_111524_Atlantis	Mendocino_line_221patch	Patch test not processed
268		0022_20140925_113402_Atlantis	Mendocino_line_222patch	Patch test not processed
268		0023_20140925_114003_Atlantis	Mendocino_line_223patch	Patch test not processed

JD	DataFolder	Kongsberg .all file name *Line_yyyymmdd_time_Ship.all*	UNH file name *.all*	Notes
268		0024_20140925_120924_Atlantis	Mendocino_line_224patch	Patch test not processed
268		0025_20140925_122145_Atlantis	Mendocino_line_225patch	Patch test not processed
268		0026_20140925_131819_Atlantis	Mendocino_line_226patch	Patch test not processed
268		0027_20140925_133731_Atlantis	Mendocino_line_227patch	Patch test not processed
268		0028_20140925_140938_Atlantis	Mendocino_line_228	Begin mapping Mendocino
268		0029_20140925_173849_Atlantis	Mendocino_line_229	Turn from 047 to 270
268		0030_20140925_180343_Atlantis	Mendocino_line_230	Very short line
268		0031_20140925_181203_Atlantis	Mendocino_line_231	Very noisy data heading into seas
268		0032_20140925_193026_Atlantis	Mendocino_line_232	Turn very short file
268		0033_20140925_193333_Atlantis	Mendocino_line_233	Heading north
269	**140926**	**0034_20140926_000037_Atlantis**	**Mendocino_line_234**	**Turn very short line**
269		0035_20140926_000916_Atlantis	Mendocino_line_235	Very short line
269		0036_20140926_003215_Atlantis	Mendocino_line_236	Short line
269		0037_20140926_011628_Atlantis	Mendocino_line_237	Turn at end of file
269		0038_20140926_022425_Atlantis	Mendocino_line_238	Turning very short line
269		0039_20140926_022517_Atlantis	Mendocino_line_239	Very short line in turn
269		0040_20140926_023704_Atlantis	Mendocino_line_240	Heading east
269		0041_20140926_033127_Atlantis	Mendocino_line_241	Turn to heading north
269		0042_20140926_040020_Atlantis	Mendocino_line_242	heading west very noisy
269		0043_20140926_045034_Atlantis	Mendocino_line_243	Heading west
269		0044_20140926_055248_Atlantis	Mendocino_line_244	turn
269		0045_20140926_063043_Atlantis	Mendocino_line_245	Heading south
269		0046_20140926_080826_Atlantis	Mendocino_line_246	
269		0047_20140926_091250_Atlantis	Mendocino_line_247	
269		0048_20140926_121541_Atlantis	Mendocino_line_248	

JD	DataFolder	Kongsberg .all file name *Line_yyyymmdd_time_Ship.all*	UNH file name *.all*	Notes
269		0049_20140926_143800_Atlantis	Mendocino_line_249	Heading west—very noisy
269		0050_20140926_203452_Atlantis	Mendocino_line_250	Very short file
269		0051_20140926_204541_Atlantis	Mendocino_line_251	Still heading west
269		0052_20140926_220209_Atlantis	Mendocino_line_252	
269		0053_20140926_234450_Atlantis	Mendocino_line_253	
270	**140927**	**0054_20140927_011331_Atlantis**	Mendocino_line_254	
270		0055_20140927_023850_Atlantis	Mendocino_line_255	turn
270		0056_20140927_032511_Atlantis	Mendocino_line_256	Heading east
270		0057_20140927_051107_Atlantis	Mendocino_line_257	
270		0058_20140927_060120_Atlantis	Mendocino_line_258	
270		0059_20140927_080834_Atlantis	Mendocino_line_259	
270		0060_20140927_112706_Atlantis	Mendocino_line_260	Turn to north at end of line
270		0061_20140927_142734_Atlantis	Mendocino_line_261	Heading north
270		0062_20140927_162404_Atlantis	Mendocino_line_262	Bad line at end-min depth limit 2000
270		0063_20140927_203155_Atlantis	Mendocino_line_263	Turn to south then heading south-tur
270		0064_20140927_210814_Atlantis	Mendocino_line_264	return to survey -heading north-
270		0065_20140927_221802_Atlantis	Mendocino_line_265	Very short line
270		0066_20140927_221902_Atlantis	Mendocino_line_266	Very short line
270		0067_20140927_222003_Atlantis	Mendocino_line_267	
270		0068_20140927_231257_Atlantis	Mendocino_line_268	
271	**140928**	**0069_20140928_004913_Atlantis**	**Mendocino_line_269**	
271		0070_20140928_013759_Atlantis	Mendocino_line_270	Turn to the south
271		0071_20140928_020541_Atlantis	Mendocino_line_271	South heading
271		0072_20140928_035057_Atlantis	Mendocino_line_272	
271		0073_20140928_052528_Atlantis	Mendocino_line_273	

JD	DataFolder	Kongsberg .all file name *Line_yyyymmdd_time_Ship.all*	UNH file name *.all*	Notes
271		0074_20140928_061912_Atlantis	Mendocino_line_274	Turn at end of line
271		0075_20140928_095806_Atlantis	Mendocino_line_275	Turn to the north
271		0076_20140928_121143_Atlantis	Mendocino_line_276	
271		0077_20140928_141936_Atlantis	Mendocino_line_277	
271		0078_20140928_154957_Atlantis	Mendocino_line_278	Turn to the west
271		0079_20140928_162131_Atlantis	Mendocino_line_279	
271		0080_20140928_190803_Atlantis	Mendocino_line_280	Heading south then turn to west
272	**140929**	**0081_20140929_000931_Atlantis**	**Mendocino_line_281**	**heading west**
272		0082_20140929_060121_Atlantis	Mendocino_line_282	
272		0083_20140929_090843_Atlantis	Mendocino_line_283	Turn to east
272		0084_20140929_094810_Atlantis	Mendocino_line_284	Heading east
272		0085_20140929_110740_Atlantis	Mendocino_line_285	turn
272		0086_20140929_112214_Atlantis	Mendocino_line_286	Heading 280 (west)
272		0087_20140929_140119_Atlantis	Mendocino_line_287	
272		0088_20140929_180112_Atlantis	Mendocino_line_288	
272		0089_20140929_204413_Atlantis	Mendocino_line_289	
272		0090_20140929_214422_Atlantis	Mendocino_line_290	
273	**140930**	**0091_20140930_000020_Atlantis**	Mendocino_line_291	
273		0092_20140930_034047_Atlantis	Mendocino_line_292	Short line-turn to east
273		0093_20140930_042007_Atlantis	Mendocino_line_293	Heading east
273		0094_20140930_100813_Atlantis	Mendocino_line_294	Short line-turn to west
273		0095_20140930_104743_Atlantis	Mendocino_line_295	Heading west
273		0096_20140930_173116_Atlantis	Mendocino_line_296	Turn to north
273		0097_20140930_180919_Atlantis	Mendocino_line_297	Heading east
274	**141001**	**0098_20141001_000006_Atlantis**	Mendocino_line_298	

JD	DataFolder	Kongsberg .all file name *Line_yyyymmdd_time_Ship.all*	UNH file name *.all*	Notes
274		0099_20141001_005444_Atlantis	Mendocino_line_299	Short line-turning to north
274		0100_20141001_012742_Atlantis	Mendocino_line_300	
274		0101_20141001_074150_Atlantis	Mendocino_line_301	Short line-turning to the south
274		0102_20141001_100134_Atlantis	Mendocino_line_302	Very short line-turning to north
274		0103_20141001_103239_Atlantis	Mendocino_line_303	Heading north
274		0104_20141001_132121_Atlantis	Mendocino_line_304	Turn to east
274		0105_20141001_195827_Atlantis	Mendocino_line_305	Heading east
274		0106_20141002_000838_Atlantis	Mendocino_line_306	
275	**141002**	**0107_20141002_060009_Atlantis**	**Mendocino_line_307**	
275		0108_20141002_120218_Atlantis	Mendocino_line_308	Turn-short line
275		0109_20141002_125419_Atlantis	Mendocino_line_309	Heading north
275		0110_20141002_160832_Atlantis	Mendocino_line_310	Turn to northeast
275		0111_20141002_180105_Atlantis	Mendocino_line_311	Heading northeast
275		0112_20141002_194613_Atlantis	Mendocino_line_312	
275		0113_20141002_215622_Atlantis	Mendocino_line_313	Very short line
275		0114_20141002_221411_Atlantis	Mendocino_line_314	Heading southeast
276	**141003**	**0115_20141003_004959_Atlantis**	**Mendocino_line_315**	**Turn to south**
276		0116_20141003_022548_Atlantis	Mendocino_line_316	Heading south
276		0117_20141003_052922_Atlantis	Mendocino_line_317	
276		0118_20141003_063200_Atlantis	Mendocino_line_318	
276		0119_20141003_123601_Atlantis	Mendocino_line_319	Turn and heading west
276		0120_20141003_180011_Atlantis	Mendocino_line_320	Very short line
276		0121_20141003_201824_Atlantis	Mendocino_line_321	
276		0122_20141003_204258_Atlantis	Mendocino_line_322	Heading east
277	**141004**	**0123_20141004_000013_Atlantis**	**Mendocino_line_323**	

JD	DataFolder	Kongsberg .all file name *Line_yyyymmdd_time_Ship.all*	UNH file name *.all*	Notes
277		0124_20141004_043656_Atlantis	Mendocino_line_324	Heading northeast
277		0125_20141004_061612_Atlantis	Mendocino_line_325	
277		0126_20141004_081941_Atlantis	Mendocino_line_326	Heading east
277		0127_20141004_101943_Atlantis	Mendocino_line_327	Very short line-turning to east
277		0128_20141004_105901_Atlantis	Mendocino_line_328	Heading east
277		0129_20141004_125013_Atlantis	Mendocino_line_329	Turning south-very short line
277		0130_20141004_132545_Atlantis	Mendocino_line_330	Turning to southwest
277		0131_20141004_145515_Atlantis	Mendocino_line_331	Turning to west
277		0132_20141004_153650_Atlantis	Mendocino_line_332	Heading southwest
277		0133_20141004_173848_Atlantis	Mendocino_line_333	
277		0134_20141004_185939_Atlantis	Mendocino_line_334	Heading west
277		0135_20141004_205016_Atlantis	Mendocino_line_335	
227		No line 0136	No line 336	
277		0137_20141004_230016_Atlantis	Mendocino_line_337	Short line
278	**141005**	**0138_20141005_000008_Atlantis**	**Mendocino_line_338**	**Short line**
227		No line 0139	No line 339	
278		0140_20141005_005750_Atlantis	Mendocino_line_340	Turning- very short line
278		0141_20141005_011037_Atlantis	Mendocino_line_341	very short line
278		0142_20141005_013151_Atlantis	Mendocino_line_342	Turning - very short line
278		0143_20141005_014629_Atlantis	Mendocino_line_343	Heading west
278		0144_20141005_051731_Atlantis	Mendocino_line_344	
278		0145_20141005_084903_Atlantis	Mendocino_line_345	
278		0146_20141005_125707_Atlantis	Mendocino_line_346	
278		0147_20141005_151639_Atlantis	Mendocino_line_347	
278		0148_20141005_211722_Atlantis	Mendocino_line_348	

JD	DataFolder	Kongsberg .all file name *Line_yyyymmdd_time_Ship.all*	UNH file name *.all*	Notes
278		0149_20141005_231003_Atlantis	Mendocino_line_349	
279	**141006**	**0150_20141006_015858_Atlantis**	**Mendocino_line_350**	**Short line**
279		0151_20141006_031659_Atlantis	Mendocino_line_351	
279		0152_20141006_101911_Atlantis	Mendocino_line_352	
279		0153_20141006_120023_Atlantis	Mendocino_line_353	
279		0154_20141006_180020_Atlantis	Mendocino_line_354	
279		0155_20141006_211816_Atlantis	Mendocino_line_355	Heading east on volcanic spur
280	**141007**	**0156_20141007_000005_Atlantis**	**Mendocino_line_356**	**Heading east on volcanic spur**
280		0157_20141007_033008_Atlantis	Mendocino_line_357	Heading north on volcanic spur
280		0158_20141007_065455_Atlantis	Mendocino_line_358	Heading NE
280		0159_20141007_091654_Atlantis	Mendocino_line_359	Turn and heading N
280		0160_20141007_114908_Atlantis	Mendocino_line_360	Turn and heading west
280		0161_20141007_122533_Atlantis	Mendocino_line_361	Turning and heading south
280		0162_20141007_144655_Atlantis	Mendocino_line_362	Heading SW and then turning
280		0163_20141007_171306_Atlantis	Mendocino_line_363	Heading south
280		0164_20141007_182217_Atlantis	Mendocino_line_364	turning
		No line 165	No line 365	
280		0166_20141007_194205_Atlantis	Mendocino_line_366	Heading south
280		0167_20141007_220741_Atlantis	Mendocino_line_367	turn
280		0168_20141007_225256_Atlantis	Mendocino_line_368	Heading north (chopped last 180 pin
281	**141008**	**0169_20141008_024043_Atlantis**	**Mendocino_line_369**	**Heading NE**
281		0170_20141008_065430_Atlantis	Mendocino_line_370	Twists and turns
281		0171_20141008_075837_Atlantis	Mendocino_line_371	
281		0172_20141008_124401_Atlantis	Mendocino_line_372	
281		0173_20141008_134108_Atlantis	Mendocino_line_373	Turn in middle of line

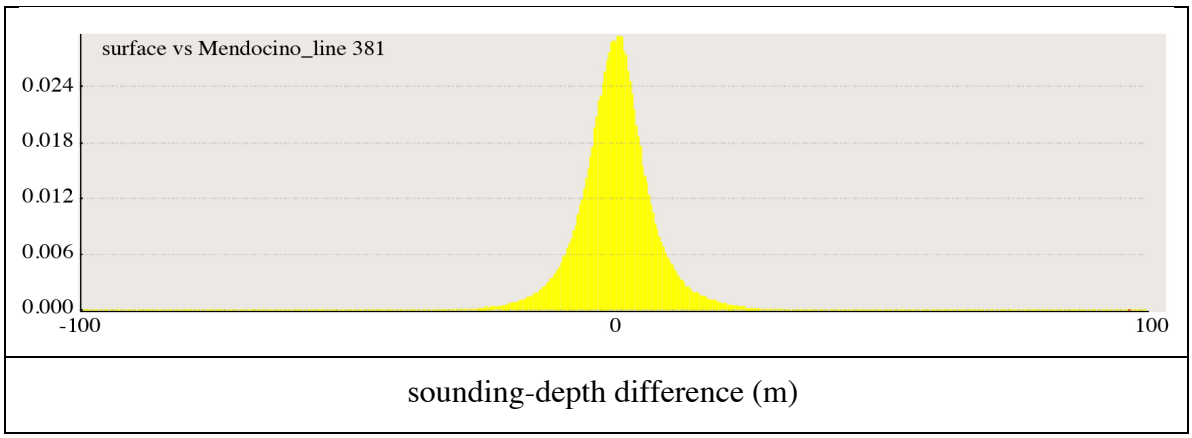
JD	DataFolder	Kongsberg .all file name *Line_yyyymmdd_time_Ship.all*	UNH file name *.all*	Notes
281		0174_20141008_163016_Atlantis	Mendocino_line_374	Turning—very short
281		0175_20141008_170055_Atlantis	Mendocino_line_375	More turning—weird end
281		0176_20141008_180819_Atlantis	Mendocino_line_376	Very short--turn
281		0177_20141008_183249_Atlantis	Mendocino_line_377	Very short
281		0178_20141008_185551_Atlantis	Mendocino_line_378	Heading west—short line
281		0179_20141008_194606_Atlantis	Mendocino_line_379	Heading west
281		0180_20141008_232207_Atlantis	Mendocino_line_380	Very short line
282	**141009**	**0181_20141009_000018_Atlantis**	**Mendocino_line_381**	**Cross line heading south**
282		0182_20141009_055037_Atlantis	Mendocino_line_382	
282		0183_20141009_121903_Atlantis	Mendocino_line_383	Very short line--turn
282		0184_20141009_125642_Atlantis	Mendocino_line_384	Turn and headed east
282		0185_20141009_193926_Atlantis	Mendocino_line_385	Very short-turn
282		0186_20141009_194131_Atlantis	Mendocino_line_386	Short line heading south
282		0187_20141009_201641_Atlantis	Mendocino_line_387	Turning and heading west
283	**141010**	**0188_20141010_005702_Atlantis**	Mendocino_line_388	**Boutelle Seamount-short line**
283		0189_20141010_013631_Atlantis	Mendocino_line_389	Boutelle Seamount
283		0190_20141010_030112_Atlantis	Mendocino_line_390	Boutelle Seamount -short line
283		0191_20141010_032454_Atlantis	Mendocino_line_391	Boutelle Seamount-short line
283		0192_20141010_042113_Atlantis	Mendocino_line_392	Boutelle Seamount
283		0193_20141010_062513_Atlantis	Mendocino_line_393	Pioneer Fracture Zone
283		0194_20141010_124031_Atlantis	Mendocino_line_394	Pioneer Fracture Zone
283		0195_20141010_175600_Atlantis	Mendocino_line_395	Pioneer Fracture Zone
283		0196_20141010_215330_Atlantis	Mendocino_line_396	Begin transit to San Francisco
283		0197_20141010_230032_Atlantis	Mendocino_line_397tran	Transit to San Francisco
284	**141011**	**0198_20141011_000015_Atlantis**	**Mendocino_line_398tran**	**Transit to San Francisco**

JD	DataFolder	Kongsberg .all file name *Line_yyyymmdd_time_Ship.all*	UNH file name *.all*	Notes
284		0199_20141011_060004_Atlantis	Mendocino_line_399tran	Transit to San Francisco
284		0200_20141011_091116_Atlantis	Mendocino_line_400tran	Transit to San Francisco
		END OF CRUISE	END OF CRUISE	

Table 14.

Conversion table of Kongsberg .all file names to UNH .all file names.

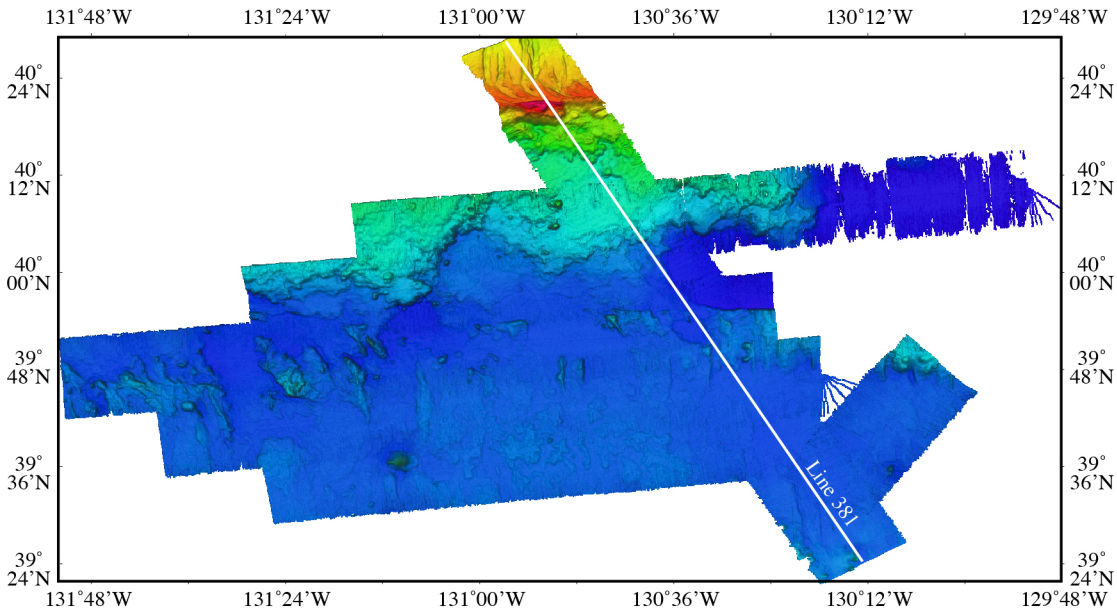
Cross-check analysis of 2014 surface vs Line 381



(upper) Histogram of sounding-depth differences from cross-line check of surface DTM versus Line 381. (lower) DTM showing area of cross-line check (dashed polygon).

Surface vs line 381	Mean water depth	44493 m
	Mean Z difference	0.349 m
	Standard deviation	15.47 m
	Number of samples	373,130
	Percent of water depth	0.35 at 2σ

Statistics of cross-check analysis between surface DTM and Line 381



Map view of cross-check surface DTM versus L381.