NOAA *Okeanos Explorer* Program

MAPPING DATA REPORT

CRUISE EX1006

Exploration Mapping: Honolulu, HI to Alameda, CA

October 19 – 29, 2010
Honolulu, HI to Alameda, CA

Report Contributors:

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November 15, 2010

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1. Introduction

The *Okeanos Explorer* Program

Commissioned in August 2008, the NOAA Ship *Okeanos Explorer* is the nation's only federal vessel dedicated to ocean exploration. With 95% of the world's oceans left unexplored, the ship's combination of scientific and technological tools uniquely positions it to systematically explore new areas of our largely unknown ocean. These exploration cruises are explicitly designed to generate hypotheses and lead to further investigations by the wider scientific community.

Using a high-resolution multibeam sonar with water column capabilities, a deep water remotely operated vehicle, and telepresence technology, *Okeanos Explorer* provides NOAA the ability to foster scientific discoveries by identifying new targets in real time, diving on those targets shortly after initial detection, and then sending this information back to shore for immediate near-real-time collaboration with scientists and experts at Exploration Command Centers around the world. The subsequent transparent and rapid dissemination of information-rich products to the scientific community ensures that discoveries are immediately available to experts in relevant disciplines for research and analysis

Through the *Okeanos Explorer* Program, NOAA's Office of Ocean Exploration and Research (OER) provides the nation with unparalleled capacity to discover and investigate new oceanic regions and phenomena, conduct the basic research required to document discoveries, and seamlessly disseminate data and information-rich products to a multitude of users. The program strives to develop technological solutions and innovative applications to critical problems in undersea exploration and to provide resources for developing, testing, and transitioning solutions to meet these needs.

Okeanos Explorer Management – a unique partnership within NOAA

The *Okeanos Explorer* Program combines the capabilities of the NOAA Ship *Okeanos Explorer* with shore-based high speed networks and infrastructure for systematic telepresence-enabled exploration of the world ocean. The ship is operated, managed and maintained by NOAA's Office of Marine and Aviation Operations, which includes commissioned officers of the NOAA Corps and civilian wage mariners. OER owns and is responsible for operating and managing the cutting-edge ocean exploration systems on the vessel (ROV, mapping and telepresence) and ashore including Exploration Command Centers and terrestrial high speed networks. The ship and shore-based infrastructure combine to be the only federal program dedicated to systematic telepresence-enabled exploration of the planet's largely unknown ocean.

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2. Report Purpose

The purpose of this report is to briefly describe the mapping data collection and processing methods, and to report the results of the cruise. For a detailed description of the *Okeanos Explorer* mapping capabilities, see appendix D and the ship's readiness report, which can be obtained by contacting the ships operations officer (ops.explorer@noaa.gov).

3. Cruise Objectives

The overall purpose of the cruise was to transit in a safe and timely manner between Honolulu, HI and San Francisco Bay, CA. The ship will go into dry dock in Alameda, CA for winter repairs. Continuous multibeam data collection occurred, and is described in this report.

The planned transit route is follows coordinates in Table 1, and is shown in Figure1.

Table 1. Transit route coordinates following the great circle route, planned by the *Okeanos Explorer* Navigation Officer.

Latitude	Longitude
21° 17’ N	157° 32’ W
26° 06.3’ N	150° W
31° 22.75’ N	140° W
35 ° 25.1’ N	130° W
37° 35.0’ N	122° 57.0’ W

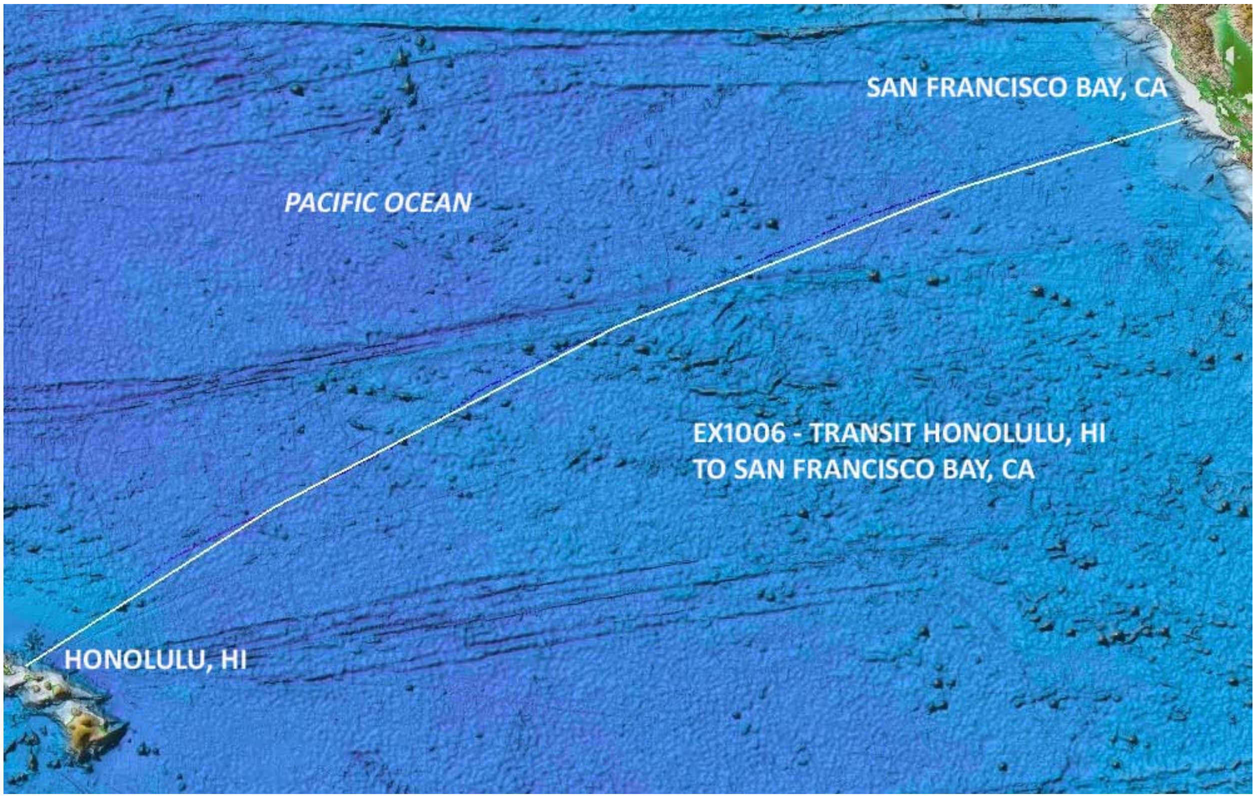


Figure 1. EX1006 planned transit trackline following the great circle route from Honolulu, HI to San Francisco Bay, CA. Background data: Sandwell and Smith. Image created in Photoshop and Fledermaus. Image credit: NOAA.

The route is roughly parallel to the 2009 transit from San Francisco to Hawaii, cruise EX0908. This provided opportunities for system performance and data quality comparisons between data from EX0908 and EX1006. See Section 8: Multibeam Data Quality Assessment and Data Processing. The mapping departments cruise objectives included:

1. Collecting continuous high-quality multibeam data
2. Comparison of multibeam data between cruises EX0908 to EX1006
3. Deep water collection settings testing to further understand optimal deep water system performance

Two surveys of opportunity were also conducted during EX1006 by visiting scientists from the National Marine Fisheries Service (NMFS) and Scripps Institution of Oceanography. The first, a Continuous Plankton Recorder (CPR) tow, collects phytoplankton and zooplankton samples, which will be used to describe species composition and evaluate diversity gradients. In combination with the CPR survey during EX1005, this data represents potentially the longest CPR tow known to science. The second, a combination of manta net and bucket tows, will collect plastic samples at the sea surface while the ship transits through the Pacific Garbage Patch. The samples will be used for quantifying size and abundance of plastic particles, and a quarter of the samples will be sent for chemical analysis for presence of persisting organic pollutants (POPs), such as PCBs and DDT. The results will be used in Miriam Goldstein's PhD research at Scripps Institution of Oceanography. The details of these surveys are not included in this mapping report.

4. Participating Personnel (mapping mission only)

NAME	ROLE	AFFILIATION
CDR Robert Kamphaus	Commanding Officer	NOAA Corps
LT Nicola VerPlanck	Field Operations Officer	NOAA Corps
Donald Brouillette (Donny)	Mapping Watchstander	OARS / UCAR
Kelley Elliott	Cruise Coordinator	NOAA OER
Ashley Harris (Ash)	Mapping Watchstander	UCAR
Karma Kissinger	Mapping Watchstander	NOAA OER / UCAR Intern
Elizabeth Lobecker (Meme)	Mapping Team Lead	NOAA OER (ERT Inc.)
Theresa Standfast (Tessi)	Mapping Watchstander	NOAA OER / UCAR Intern
Elaine Stuart	Senior Survey Technician	NOAA OMAO
Lillian Stuart	Mapping Watchstander	NOAA OMAO

5. Cruise Statistics

Dates	10/19/10 – 10/29/10
Weather delays	0
Total non-mapping days	0
Total survey mapping days	0
Total transit mapping days	10.5
Line kilometers of survey	3925
Square kilometers mapped	19,240
Number of bathymetric multibeam files	61
Data volume of raw multibeam data files	15.1 GB
Number of water column multibeam files	3
Data volume of water column multibeam files	221 MB
Number of XBT casts	41
Number of CTD casts	0

6. Mapping Sonar Setup

The NOAA Ship *Okeanos Explorer* is equipped with a 30 kHz Kongsberg EM 302 multibeam sonar. During this cruise EM 302 bottom bathymetric and backscatter data were collected. The ship used a POS MV, ver. 4, to record and correct the multibeam data for any vessel motion. A C-Nav GPS system provided DGPS correctors with positional accuracy expected to be better than 2.0 m.

All corrections (motion, sound speed profile, sound speed at sonar head, draft, sensor offsets) are applied during real time data acquisition. Expendable bathythermograph (XBT) casts (Sippican Deep Blue, max depth 760 m, and Sippican T5, max depth 1830 m) were taken every six hours and/or as necessary to correct for sound speed. The XBT cast data were converted to SIS compliant format using NOAA Velocipy. See Appendix E for a complete list of software used for data processing.

The PCB TX36 LC board remained in partially failed status. This slot has been critically damaging boards since the summer of 2009. The system is able to perform with this partially failed board. Kongsberg Maritime technicians continue to troubleshoot the equipment. See previous *Okeanos Explorer* cruise reports for additional details.

7. Data Acquisition Summary

Sandwell and Smith global bathymetry were loaded into SIS to provide a background layer to provide watchstanders information regarding when potential features of interest were ahead.

Table 2 lists the transducer and attitude sensor offsets determined during the February 2010 sea acceptance test (EX1001). The pitch attitude offset of -0.8 was increased from the previous value of -0.7 while a Kongsberg technician was onboard in April (EX1002 Leg 3). Apart from this change, the PU Parameters were setup to be identical to the 2009 survey season. For complete processing unit setup utilized for the cruise, refer to Appendix F.

Table 2. Angular offsets for Transmit (TX) and Receive (TX) transducer and attitude sensor.

	Roll	Pitch	Heading
TX Transducer	0.0	0.0	359.98
RX Transducer	0.0	0.0	0.03
Attitude	0	-0.8	0.0

Multibeam data was continuously collected during the entire transit from Honolulu, HI to San Francisco Bay, CA. Interruptions in data continuity are due to built in system tests (BIST) periodically run on the multibeam system for approximately 10 to 40 minutes. All data is either within the US Exclusive Economic Zone or the high seas. All data will be archived at NGDC (www.ngdc.noaa.gov) with individual metadata records. All raw and processed data products are in WGS84 coordinate system.

A note on time zone changes: all multibeam and associated data are time stamped with UTC time. The daily cruise log included in this report uses local ship's time, and gives details of when ship's time was shifted for gradual time zone adjustment throughout the cruise.

8. Multibeam Data Quality Assessment and Data Processing

Comparison to previous data: EX0908 vs. EX1006

Data overlap occurred between cruises EX0908 and EX1006. The Fledermaus CrossCheck tool (version 7) was used to compare the overlapping data.

Line 0032_20090806_175611_EX.all was compared to the reference surface EX1006_100m_WGS84_1.sd, and showed the following results:

388819 # Number of Points of Comparison
-4109.057193 meters # Data Mean (EX0908)
-4099.465146 meters # Reference Mean (EX1006)
-9.592000 meters # Mean (Difference)
-15.077000 meters # Median (Difference)
50.124000 meters # Std. Deviation (Difference)

Lines 0022_20090804_055609_EX.all, 0023_20090804_115614_EX.all, and 0024_20090804_175617_EX.all were compared to the reference surface EX1006_100m_WGS84_2.sd, and showed the following results:

Line 0022_20090804_055609_EX.all
31033 # Number of Points of Comparison
-5238.361132 meters # Data Mean (EX0908)
-5226.172875 meters # Reference Mean (EX1006)
-12.188000 meters # Mean
-17.627000 meters # Median
28.841000 meters # Std. Deviation

Line 0023_20090804_115614_EX.all
286259 # Number of Points of Comparison
-5469.976214 meters # Data Mean (EX0908)
-5451.741992 meters # Reference Mean (EX1006)
-18.234000 meters # Mean
-24.149000 meters # Median
33.042000 meters # Std. Deviation

Line 0024_20090804_175617_EX.all
248023 # Number of Points of Comparison
-5398.570563 meters # Data Mean
-5390.649464 meters # Reference Mean
-7.921100 meters # Mean
-22.024000 meters # Median
55.425000 meters # Std. Deviation

Along Track Ping Spacing

On October 24 at 1902 (ship time), deep water across track beam spacing testing was conducted. The maximum coverage angle was reduced to 20° port and starboard. The ping mode was Very Deep, and the test depth range was 4900-5050 meters. The ship speed was 2 knots (the ship was slowed for a manta tow). Prior to starting the test, the maximum coverage angles were set to 50° port and starboard, and the actual achieved angles were 38° (port) and 40° (starboard). In both cases, the beam spacing was set to high density equidistant. While the maximum angles were set to 50°, the swath coverage was 7.5 kilometers. While the maximum angle was constrained 20° port and starboard, the swath coverage was 3.6 kilometers.

The results showed that across track beam spacing was initially 17.5 – 19 meters in both the near nadir and outer beams (see Figures 2 and 3) while the coverage angles were not limited. Reducing the coverage angles to 20° port and starboard reduced the across track beam spacing to 8 meters (see Figures 4 and 5). This test provides useful information for sounding density and resolution in deep waters.

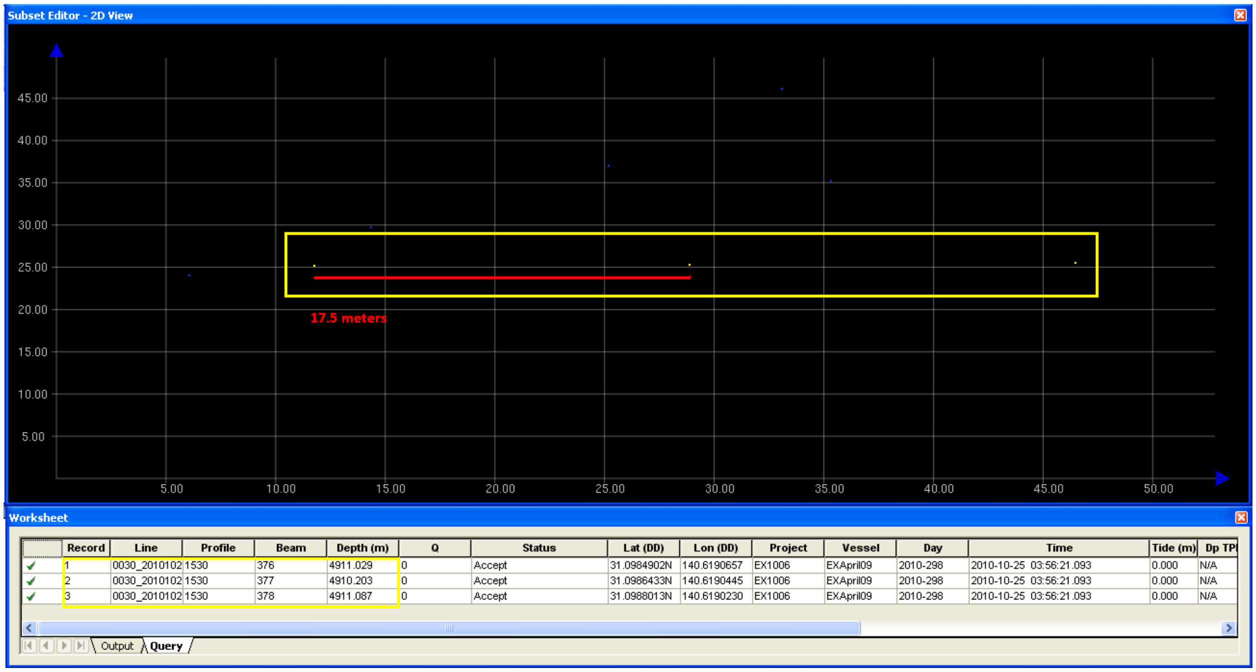
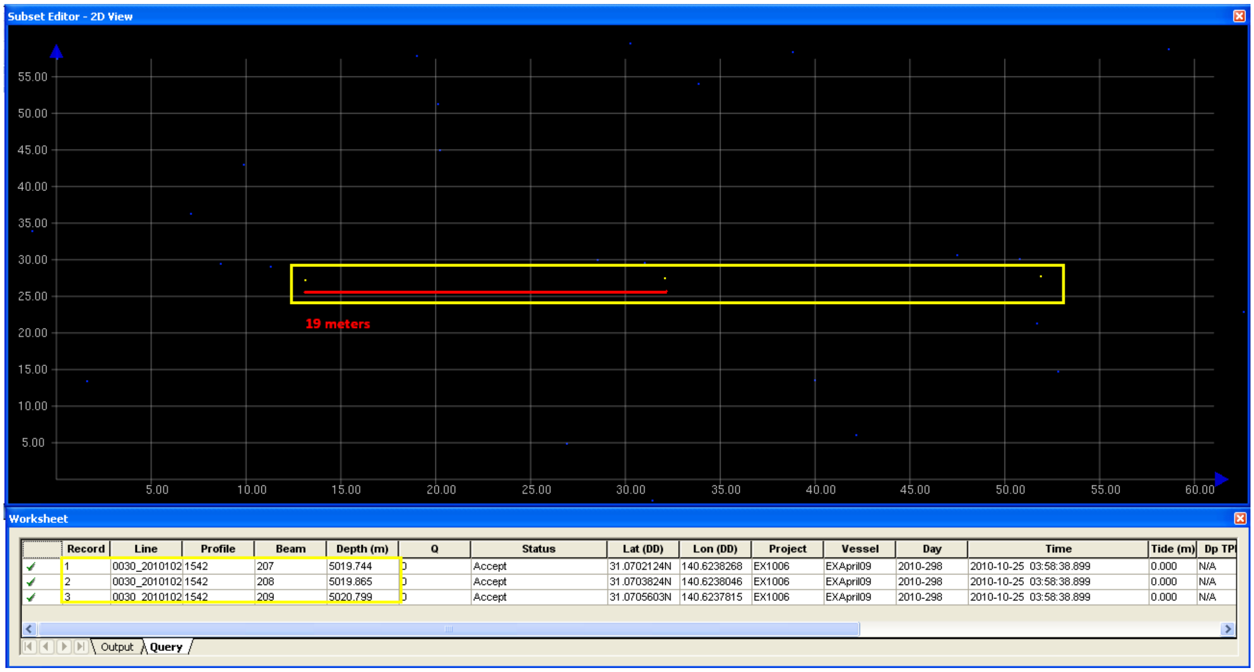
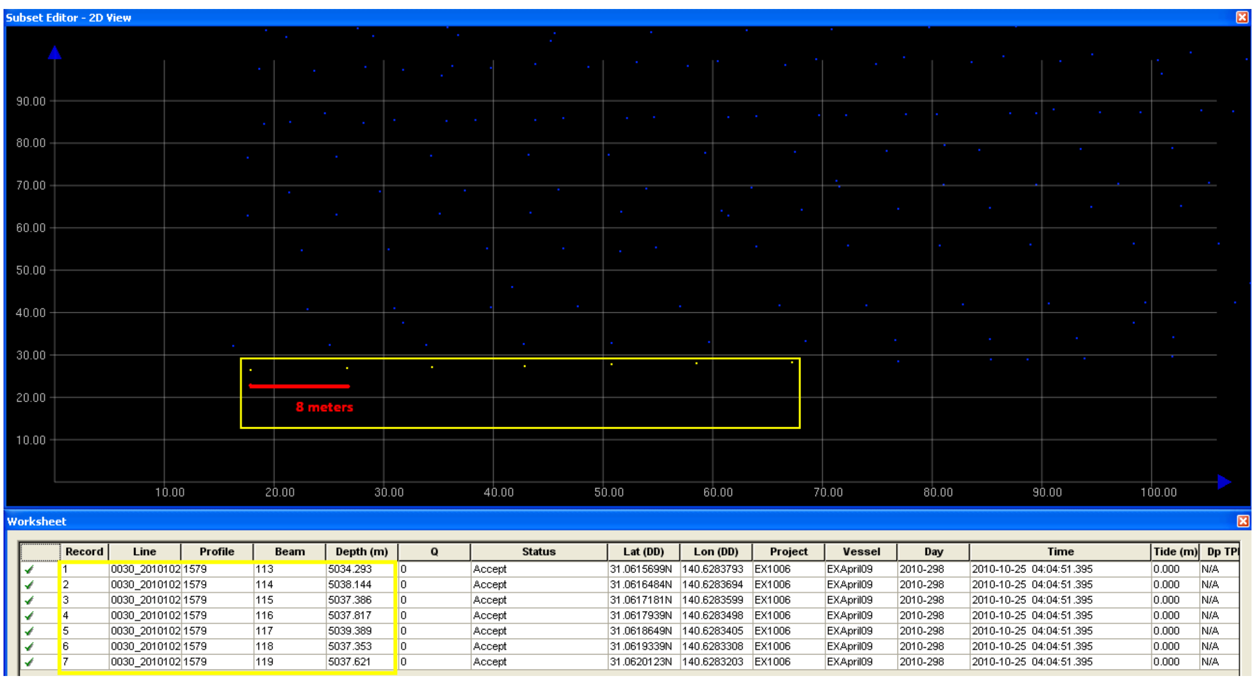


Figure 2. Screengrab made in CARIS showing across track beam spacing with maximum coverage angles set wide open. Observed coverage angles were 38° port and 40° starboard. Across track beam spacing in outer beams was 17.5 meters.



	Record	Line	Profile	Beam	Depth (m)	Q	Status	Lat (DD)	Lon (DD)	Project	Vessel	Day	Time	Tide (m)	Dp TPI
✓	1	0030_2010102	1542	207	5019.744	0	Accept	31.0702124N	140.6238268	EX1006	EXApril09	2010-298	2010-10-25 03:58:38.899	0.000	N/A
✓	2	0030_2010102	1542	208	5019.865	0	Accept	31.0703824N	140.6238046	EX1006	EXApril09	2010-298	2010-10-25 03:58:38.899	0.000	N/A
✓	3	0030_2010102	1542	209	5020.799	0	Accept	31.0705603N	140.6237815	EX1006	EXApril09	2010-298	2010-10-25 03:58:38.899	0.000	N/A

Figure 3. Screengrab made in CARIS showing across track beam spacing with maximum coverage angles set wide open. Observed coverage angles were 38° port and 40° starboard. Across track beam spacing in near nadir beams was 19 meters.



	Record	Line	Profile	Beam	Depth (m)	Q	Status	Lat (DD)	Lon (DD)	Project	Vessel	Day	Time	Tide (m)	Dp TPI
✓	1	0030_2010102	1579	113	5034.293	0	Accept	31.0615699N	140.6283793	EX1006	EXApril09	2010-298	2010-10-25 04:04:51.395	0.000	N/A
✓	2	0030_2010102	1579	114	5038.144	0	Accept	31.0616484N	140.6283694	EX1006	EXApril09	2010-298	2010-10-25 04:04:51.395	0.000	N/A
✓	3	0030_2010102	1579	115	5037.386	0	Accept	31.0617181N	140.6283599	EX1006	EXApril09	2010-298	2010-10-25 04:04:51.395	0.000	N/A
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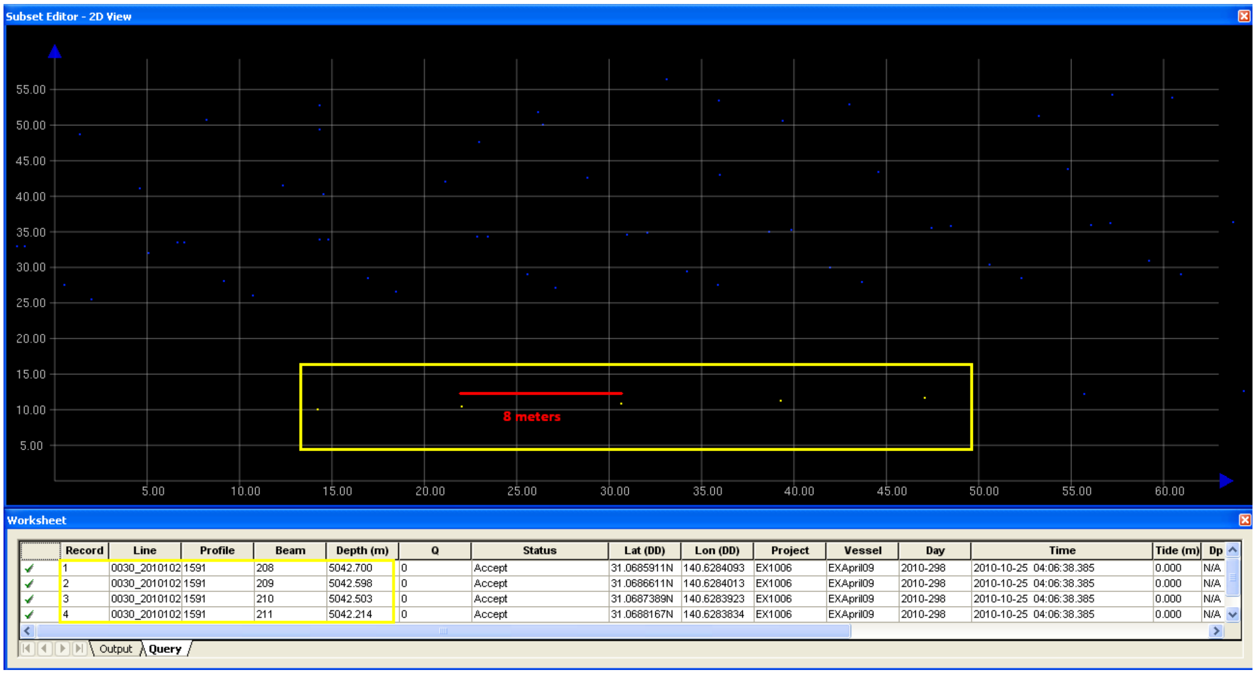
✓	5	0030_2010102	1579	117	5039.389	0	Accept	31.0618649N	140.6283405	EX1006	EXApril09	2010-298	2010-10-25 04:04:51.395	0.000	N/A
✓	6	0030_2010102	1579	118	5037.353	0	Accept	31.0619339N	140.6283308	EX1006	EXApril09	2010-298	2010-10-25 04:04:51.395	0.000	N/A
✓	7	0030_2010102	1579	119	5037.621	0	Accept	31.0620123N	140.6283203	EX1006	EXApril09	2010-298	2010-10-25 04:04:51.395	0.000	N/A

Figure 4. Screengrab made in CARIS showing across track beam spacing with maximum coverage angles constrained to 20° port and starboard. Across track beam spacing in beams 113 – 119 was 8 meters.



	Record	Line	Profile	Beam	Depth (m)	Q	Status	Lat (DD)	Lon (DD)	Project	Vessel	Day	Time	Tide (m)	Dp
✓	1	0030_2010102	1591	208	5042.700	0	Accept	31.0685911N	140.6284093	EX1006	EXApril09	2010-298	2010-10-25 04:06:38.385	0.000	N/A
✓	2	0030_2010102	1591	209	5042.598	0	Accept	31.0686611N	140.6284013	EX1006	EXApril09	2010-298	2010-10-25 04:06:38.385	0.000	N/A
✓	3	0030_2010102	1591	210	5042.503	0	Accept	31.0687389N	140.6283923	EX1006	EXApril09	2010-298	2010-10-25 04:06:38.385	0.000	N/A
✓	4	0030_2010102	1591	211	5042.214	0	Accept	31.0688167N	140.6283834	EX1006	EXApril09	2010-298	2010-10-25 04:06:38.385	0.000	N/A

Figure 5. Screengrab made in CARIS showing across track beam spacing with maximum coverage angles constrained to 20° port and starboard. Across track beam spacing in near nadir beams was 8 meters.

Speed

The plankton and plastic surveys of opportunity that took place during the cruise required the ship slow down to 1 to 2 knots, three times per day (0600-0630, 1200-1230, 1800-1830). This provided daily opportunities for speed versus multibeam swath width testing in a variety of conditions over a variety of seabed types. During these periods of slowed speed, the coverage angle setting in SIS was set to wide open, or 70° on either side, in order to collect the largest possible swath. In all cases, the swath width was observed to increase.

Figure 2 shows a comparison between swath coverage at 1.5 knots and 9.7 knots over a harder seabed with depths ranging from 3700 meters to 4700 meters. At 1.5 knots, swath coverage was 10.4 kilometers. At 9.7 knots, swath coverage was 5.8 kilometers.

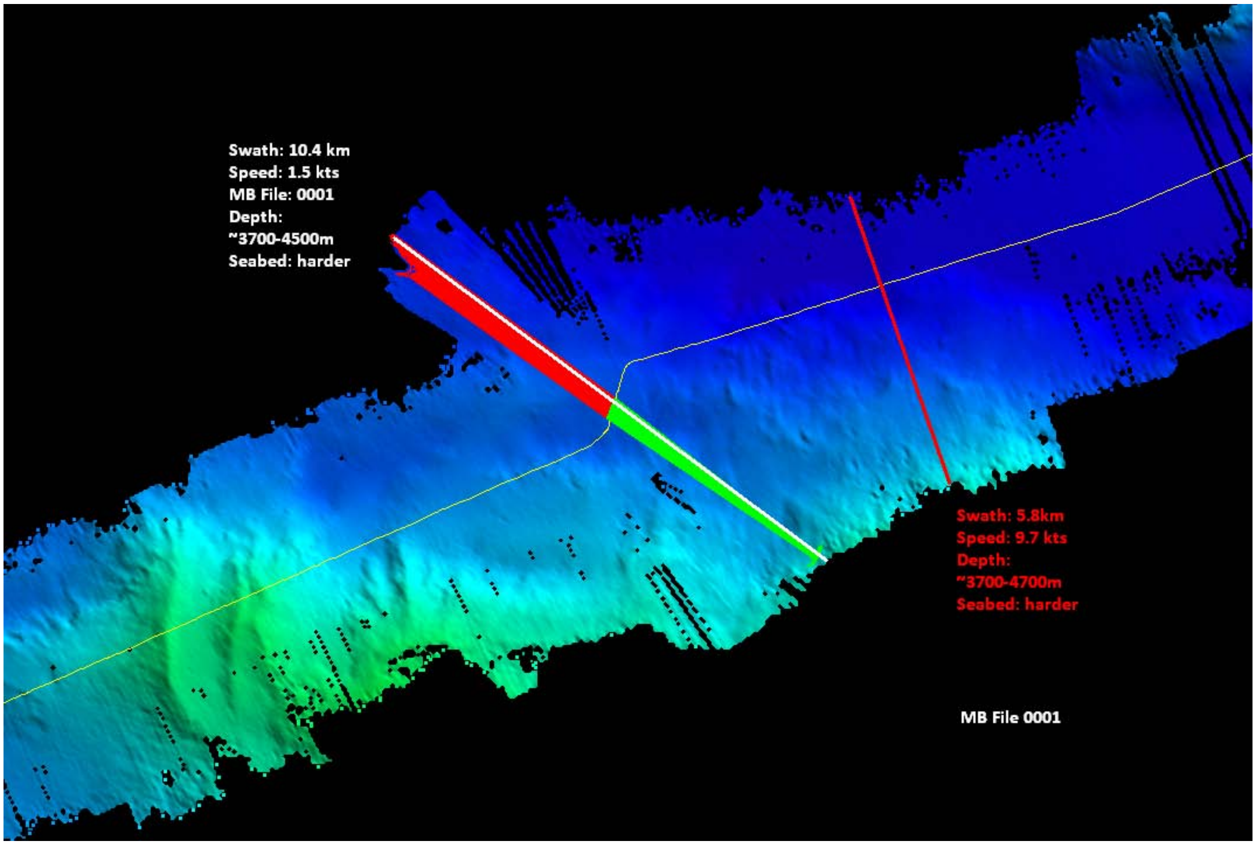


Figure 6. Screengrab taken in CARIS showing difference in swath coverage at 1.5 knots (white line) and 9.7 knots (red line) over a harder seabed.

Figure 3 shows a comparison between swath coverage at 2 knots and 10 knots over a harder seabed with depths ranging from 3400 meters to 4600 meters. At 2 knots, swath coverage was 8.6 kilometers. At 10 knots, swath coverage was 6.1 kilometers.

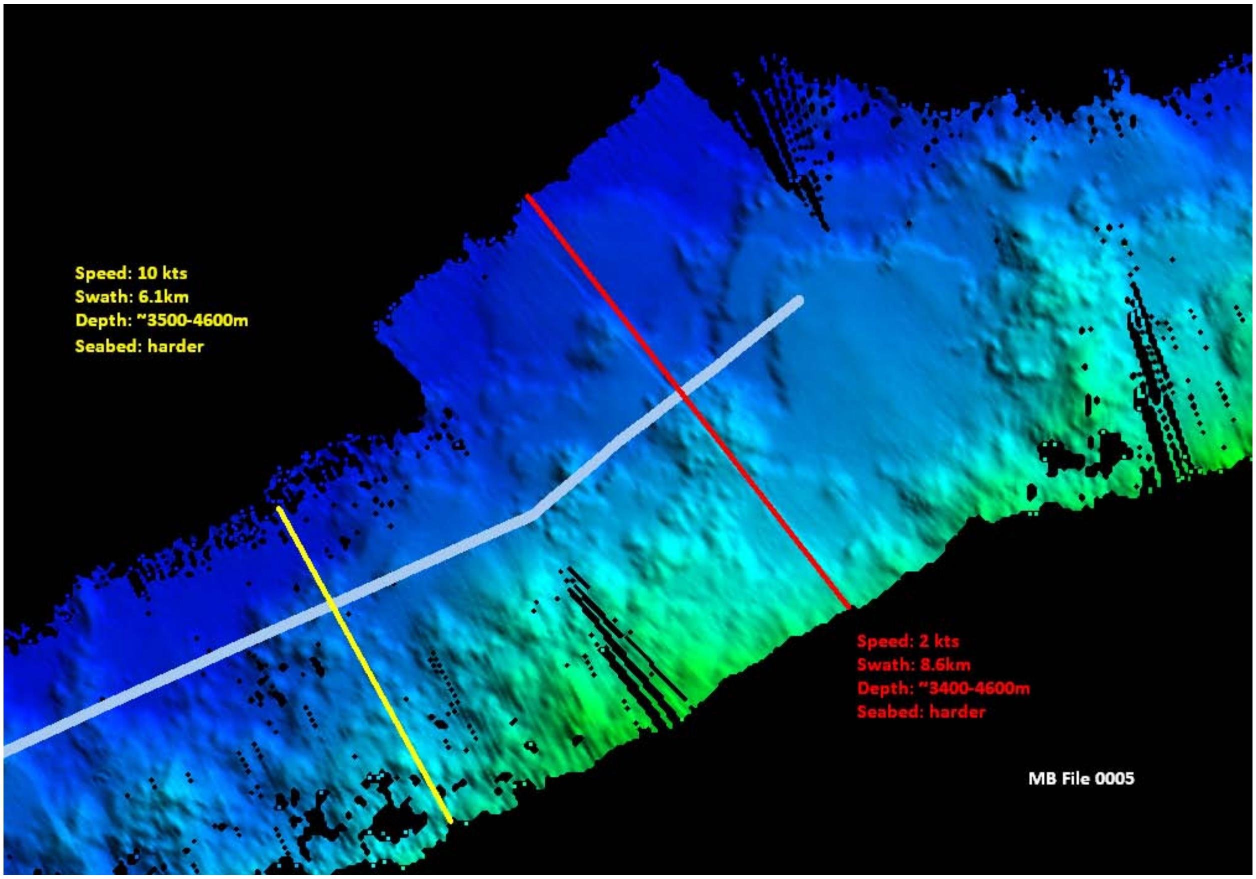


Figure 7. Screengrab taken in CARIS showing difference in swath coverage at 2 knots (red line) and 10 knots (yellow line) over a harder seabed.

Figure 4 shows a comparison between swath coverage at 2 knots and 10 knots over a harder seabed with depths ranging from 5300 meters to 5375 meters. At 2 knots, swath coverage was 7.8 kilometers. At 10 knots, swath coverage was 5.1 kilometers.

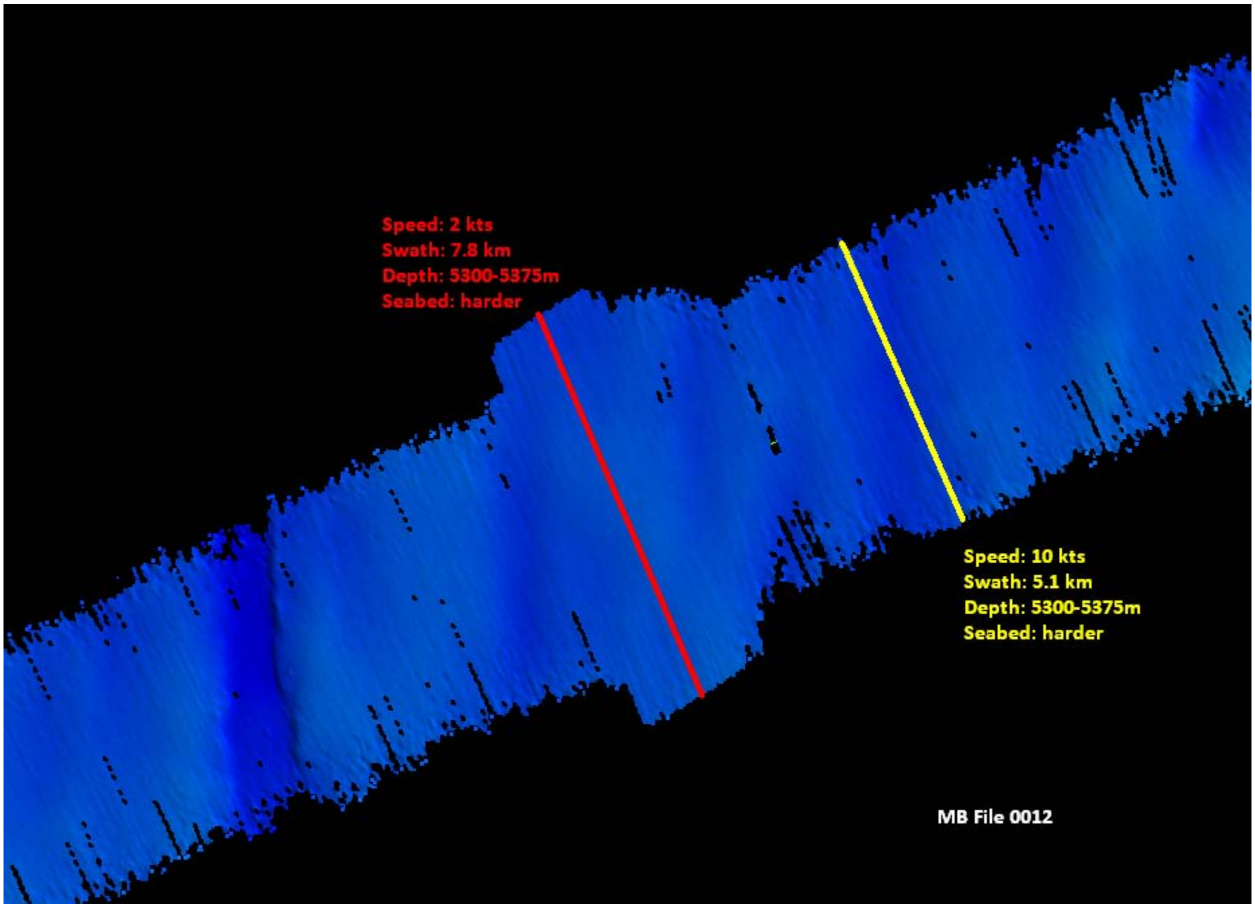


Figure 8. Screengrab taken in CARIS showing difference is swath coverage at 2 knots and 10 knots over a harder seabed.

Built In System Tests (BISTS)

BISTS were run once per day to monitor TRU system performance. The BIST log is included in Appendix B. Noise levels were in acceptable range throughout the cruise.

9. Cruise Calendar

October 2010						
Sun	Mon	Tues	Wed	Thurs	Fri	Sat
						16 Mapping compliment board EX at Pearl Harbor, Honolulu HI: Brouilllette, Elliott, Harris, Kissinger, Lobecker, Standfast
17 Conducted mapping	18 Conducted mapping	19 Departed dock 1000	20 24 mapping during transit	21 24 mapping during transit	22 24 mapping during transit	23 24 mapping during transit

introduction to ship/multibeam system	introduction to ship/multibeam system		to San Francisco Bay	to San Francisco Bay	to San Francisco Bay. Time change: 0400 became 0500.	to San Francisco Bay
24 24 mapping during transit to San Francisco Bay	25 24 mapping during transit to San Francisco Bay	26 24 mapping during transit to San Francisco Bay	27 24 mapping during transit to San Francisco Bay	28 24 mapping during transit to San Francisco Bay	29 Sonar secured at 0820. Came into port Pier 30, San Francisco.	30 In port, Pier 30, San Francisco, CA.
31 Mapping complement departs vessel in San Francisco, CA.						

10. Daily Cruise Log

October 16, 2010
Mapping mission personnel arrived to ship: Donald “Donny” Brouillette, Kelley Elliott, Ashley “Ash” Harris, Karma Kissinger, Thomas “Tom” Kok, Elizabeth “Meme” Lobecker, Theresa “Tessi” Standfast.

At the start of the cruise, local time was Hawaii Standard Time (UTC minus 10 hours).
October 17, 2010
Introduction to mapping system, control room, and general ship protocol were conducted with new mapping personnel.

October 18, 2010
Introduction to mapping system, control room, and general ship protocol were conducted with new mapping personnel. Science introduction meeting was conducted. Educational component of cruise was introduced.

October 19, 2010
Departed from dock at Ford Island 1000.

Powered on EM302 TRU at 1109. Started pinging, confirmed sonar was able to lock onto the seafloor. Ceased pinging to run a built in system test. Noise levels were normal, and TX 36 LC board remains in failed status. EM302 pinging was resumed, and mapping was commenced.

The planned transit route for EX1006 is generally offset approximately 5 miles from the EX0908 route. The EX0908 route did not follow a straight line, so at certain times during EX1006, the ship crossed over EX0908 data, creating excellent data quality comparison opportunities. Initial quality control checks of data show 0.1% or less of water depth difference between areas of overlap of EX0809 and EX1006 data in 800 to 5000 meters water. These quality checks were done using simple comparisons of 100 meter grids in Fledermaus.

Swath coverage in depths greater than 4000 meters remains less than a 1:1 ratio. It is thought this is due to ship speed (~10 kts) and environmental conditions (the ship is heading into the swell, although it is only 3-5 feet). In the adjacent EX0908 data, swath coverage was consistently 6000 meters across. This swath coverage difference will be further investigated.

When the ship slows down for manta tow operations throughout the cruise (3 times per day), Sippican T5 XBT probes will be utilized. These require a slower deployment speed, but they sample a larger section of the water column (1830 meters) than the Deep Blue probes (760 meters) typically used onboard.

As time allows, the following educational products will be developed onboard: Donny Brouillette will produce Fledermaus movies of INDEX-SATAL data; Ash Harris will produce a descriptive flowchart describing onboard multibeam data collection and processing procedures to make the full data evolution transparent to newcomers and visitors/guests; Karma Kissinger will produce a poster discussing the sticks and boxes exploration method using data from EX0908 and EX1006; Tessi Standfast will produce a poster describing the surveys of opportunity that are being conducted during the cruise.

The ship fire and abandon ship drills in the afternoon. New personnel donned survival suits.

October 20, 2010
24 hour mapping operations continued.

One of the two XBT launchers requires retermination. Once plugged in to the deck unit on the fantail, it cannot maintain connection to the rack unit in the dry lab.

While the ship slows down for manta tow operations, the maximum angles on the EM302 are set to 70 degrees to determine how much swath is achieved at slowed speeds. Preliminary results indicate that at 2 knots in 5400 meters of water over a soft bottom the swath is approximately 7km, or 1.3 x water depth. At 10 kts over the same bottom, the swath is 4.5 – 5 km, or less than 1 x the water depth.

October 21, 2010
24 hour mapping operations continued.

Early this morning a new anomaly was observed in the EM302 SIS display. Figure 2 below shows a screengrab showing a red cone in the water column, and associated along track data gaps in the bathymetry and backscatter (white stripe). It is not clear if the red cone is directly associated with a single sector of the beam fan. The TRU was in Extra Deep mode, which has either 2 or 4 sectors, depending on water depth. The red cone did not appear to be representative of half nor a quarter of the total beam fan. Troubleshooting included looking at the SIS stave display to see if there was any indication of a problem with specific element(s) - there did not appear to be. Two BISTs were run, and showed that RX board 1 channel 14 had unusually high noise levels. The TRU was inspected, and the power was cycled. Pinging was resumed, and the system appeared to be back to normal. BIST #8 was run and the RX noise level for RX board 1, channel 14 had come down but as still in the 60's which is higher than normal. The details, including BIST results and screengrab, were sent to Kongsberg for review. The complete BIST log, which details all BISTs collected during the cruise, is included in the appendix section of this report.

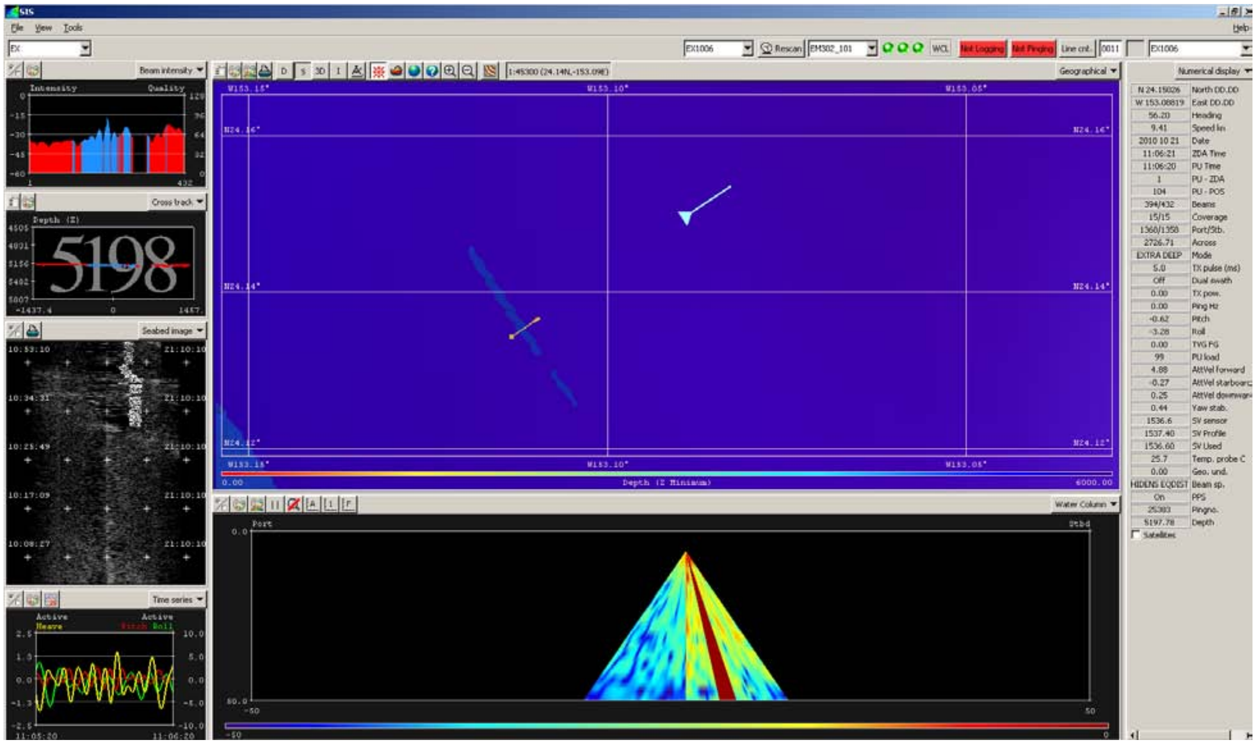


Figure 9. Screengrab of "red cone" error seen in SIS on 10/31/10.

The following image was created for the daily Situation Report sent back to shore and for the daily update on the Okeanos Explorer website today by the OER Expedition Coordinator. The image highlights a parasitic cone on a 1000 meter high ridge.

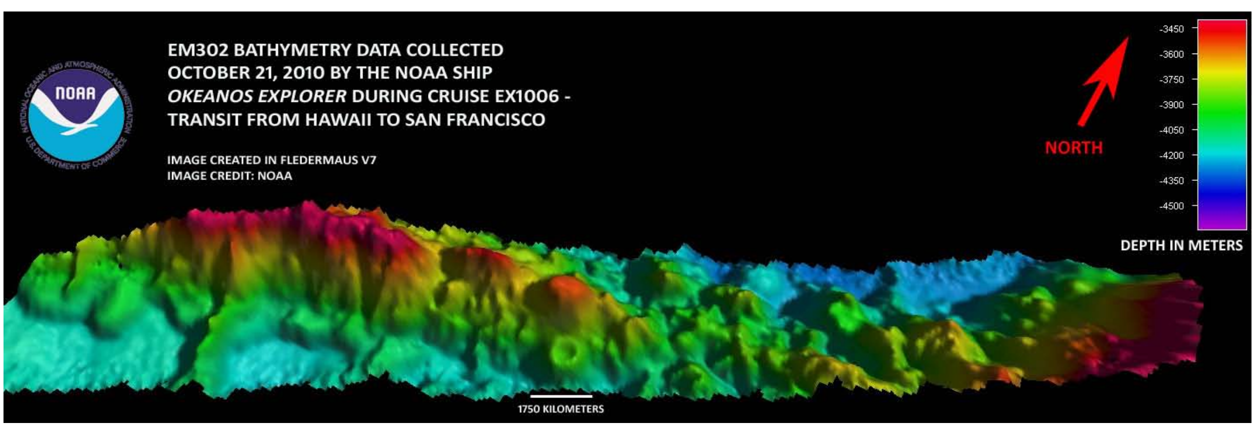


Figure 10. Data collected on 10/21/10 showing a parasitic cone on a ridge rising 1000 meters off the surrounding seafloor. Image created in Fledermaus and Photoshop. Vertical exaggeration 3. Image credit: NOAA.

October 22, 2010

24 hour mapping operations continued. Data quality remains good due to calm weather, depths around 4500 meters, and a more acoustically reflective seabed (according to the SIS waterfall display) than previous days.

The spare XBT launcher was reterminated and tested successfully.

During the transit to the west coast, the ship will undergo three time changes to adjust for the time zone change from Hawaii to California. This morning was the first time change, when 0400 became 0500. Ship time is now UTC minus 9 hours.

The graphic shown below in Figure 4 was created for the Okeanos Explorer website created to track cruise EX1006. The graphic shows small-scale features at depths approaching the maximum limits of the EM302 multibeam sonar's capabilities. The red 2 kilometer scale bar is placed near a feature that rises approximately 280 meters from the surrounding seafloor. The crater in the center of the cone-like structure indicates this feature might be volcanic.

The Sandwell and Smith satellite-derived bathymetry provides invaluable guidance on what the mapping team onboard the Okeanos Explorer will encounter while exploring new areas of the seafloor. Sometimes, the satellite-derived bathymetry is misleading. In this case, we were expecting to see a slight rise in the seafloor, indicated by the red oval feature in the background image. Instead, a series of small ridges of up to 125 meters high indicated by black arrows, was found.

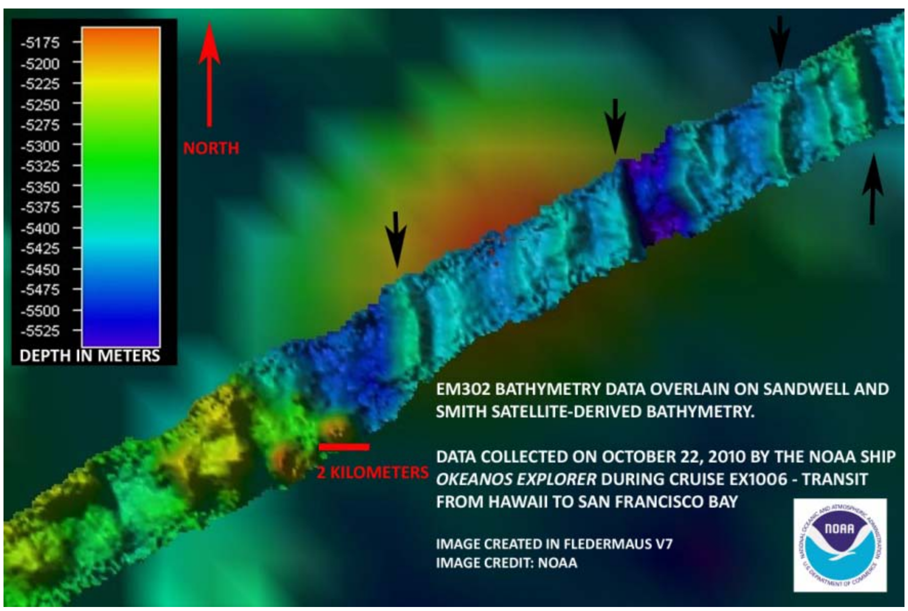


Figure 11. Data collected on 10/22/10 showing a series of small ridges in > 5000 meters of water. Image created in Fledermaus and Photoshop. Image credit: NOAA.

Two potential discoveries were mapped in the late evening (2200). See Appendices A for DISCO-P (Discover-Potential) reports with full details. Both are seamounts greater than 1000 meters high, which were underrepresented in the Sandwell and Smith satellite-derived bathymetry data, and do not appear as seamounts on NOAA nautical chart #530. Each seamount has at least one clearly defined crater. It is important to note that these are *potential* discoveries, and require further detailed research before making any conclusive statements about discoveries. Neither feature was mapped in its entirety.

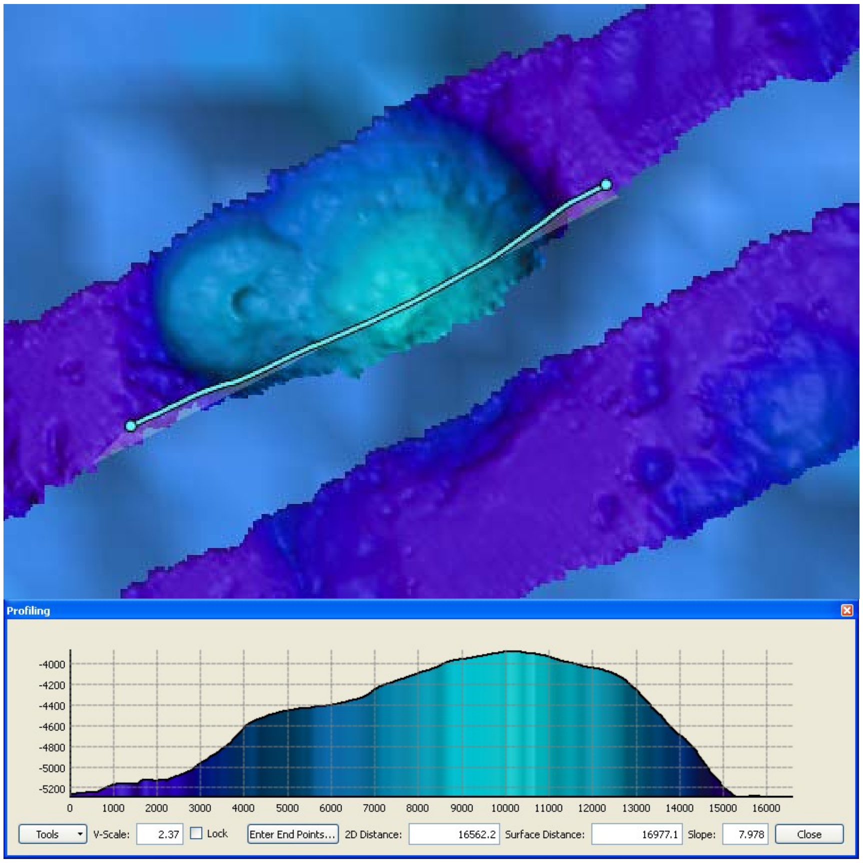


Figure 12. Plan view (north up) of EM302 data overlain on Sandwell and Smith satellite-derived data indicating the feature is ~1380 meters high. Profile drawn west to east (left to right) with depths shown in meters. Image created in Fledermaus v7. Vertical exaggeration 3. Image credit: NOAA.

Plan view of first potential discovery located at 27.63N, 147.14W, and profile showing depths measured by EM302. Also shown is adjacent data to the immediate south collected during EX0908 – the 2009 transit from San Francisco to Hawaii.

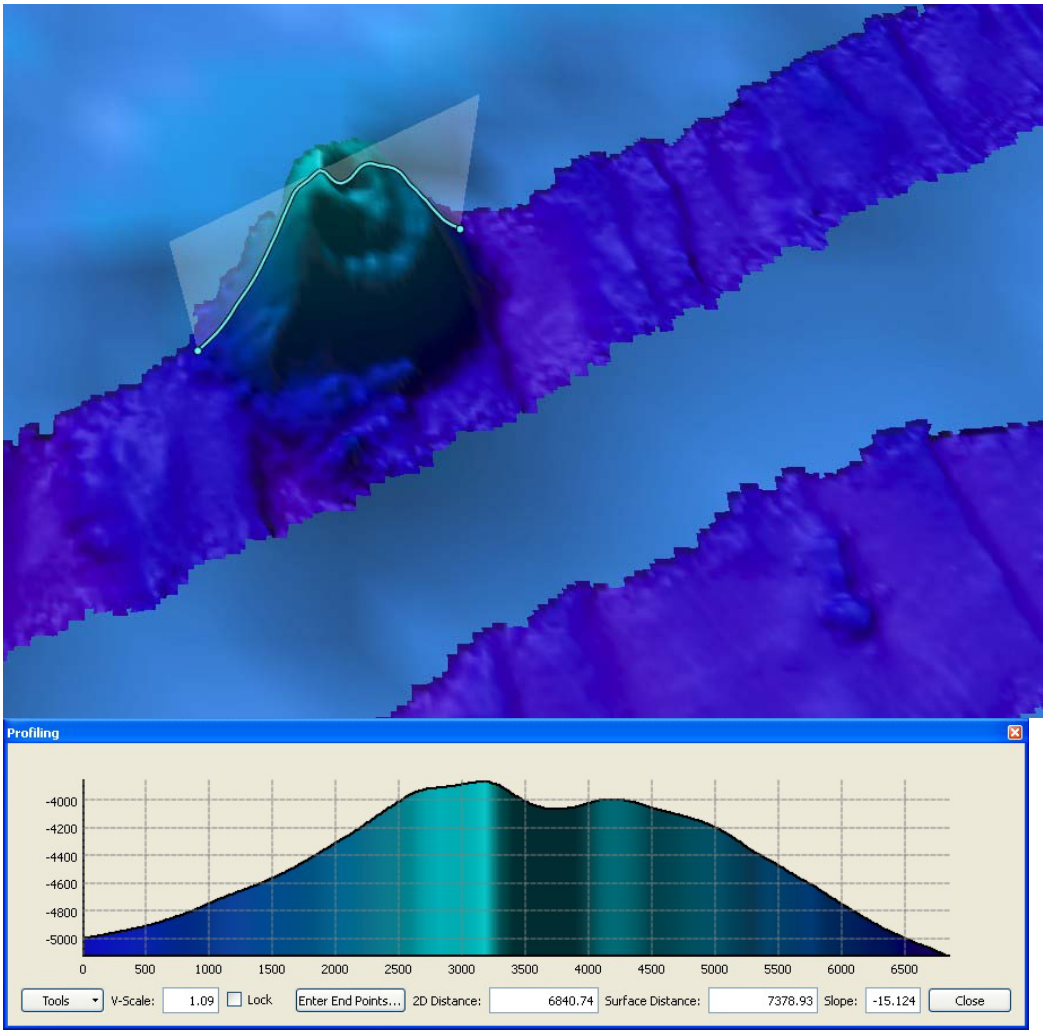


Figure 13. Oblique view (north up) of EM302 data overlain on Sandwell and Smith satellite-derived data indicating the feature is ~1145 meters high. Profile drawn west to east (left to right) with depths shown in meters. Image created in Fledermaus v7. Vertical exaggeration 3. Image credit: NOAA.

Oblique view of second potential discovery located at 27.76N, 146.95W, and profile showing depths measured by EM302. Also shown is adjacent data to the immediate south collected during EX0908 – the 2009 transit from San Francisco to Hawaii.

October 23, 2010

24 hour mapping operations continued. Data quality remains good due to calm weather, depths around 4500 meters, and a more acoustically reflective seabed than previous days.

The mapping department continues to provide daily georeferenced tiff images of the latest cleaned multibeam data to the Global Atlas team at NCDDC for daily progress in near real-time.

October 24, 2010

24 hour mapping operations continued.

Data quality remains high due to calm weather, and a more acoustically reflective seabed. Numerous small features are present in today's data, including several small (< 400 meters high) volcanic cones.

The EM302 mapped a third potential discovery today – a seamount that was not seen in the Sandwell and Smith data or on the NOAA nautical charts. See Appendix A for the full potential discovery report.

October 25, 2010
24 hour mapping operations continued.

Data quality remains high. Observed swath coverage over an acoustically reflective seabed was at times greater than7 km across in 4900 meters of water.

An internal drydock meeting with ship department heads was held onboard. Mapping department items include: transducer cleaning (with hull), relocation of scientific seawater pump, and possible Digibar installation. Questions regarding transducer cleaning best practice were sent to Kongsberg and the answers will be provided to the shipyard.

During the transit to the west coast, the ship underwent three time changes to adjust for the time zone change from Hawaii to California. This evening was the second time change, when 2200 became 2300. Ship time is now UTC minus 8 hours.

October 26, 2010
24 hour mapping operations continued.

Today was the first cloudy day of the cruise, and the wind has started to pick up. Bubble sweepdown events are starting to be observed in the data. Prior to today, the skies have been generally clear, and the winds generally 15 kts or less.

Everyday around 1830 and 2130 GMT, the POS/MV has been exceeding the position (latitude / longitude) accuracy tolerance alarms, which are set to 2.5 meters, for approximately 30 to 60 minutes each day. It is unclear why this is happening and the mapping department continues to monitor the daily event.

The EM302 computer was restarted to re-establish its connection to the time server with Symmtime. The time was only 53 ms off after we restarted but before we resynched. The TRU did not lose time sync, just the EM302 computer, so multibeam data file integrity was not compromised.

October 27, 2010
24 hour mapping operations continued.

The midnight XBT failed (Oct 27 0030). Three attempts were made, and each time the copper wire connecting the probe to the launcher/deck unit was blown onto the hull or other obstruction, which interrupts the signal. After the third try, the XBT operation was postponed until the 0630

XBT. The yellow warning lights in SIS came on around 0330, indicating the sound velocity profile had strayed more than 3 meters from what the surface sound speed from the hull mounted temperature gauge had reported.

The ship conducted a man overboard drill in the afternoon.

October 28, 2010
24 hour mapping operations continued.

At 1215, the ship slowed for the daily mid-day Manta deployment at 36° 34' 11" N, 126° 9' 55" W. The deployment location coincidentally was over a volcanic feature, and after the Manta was recovered, the feature was mapped further using the "box" exploration method. The extra surveying took approximately one hour, and the feature was mapped almost in its entirety. The results are shown in the figure below.

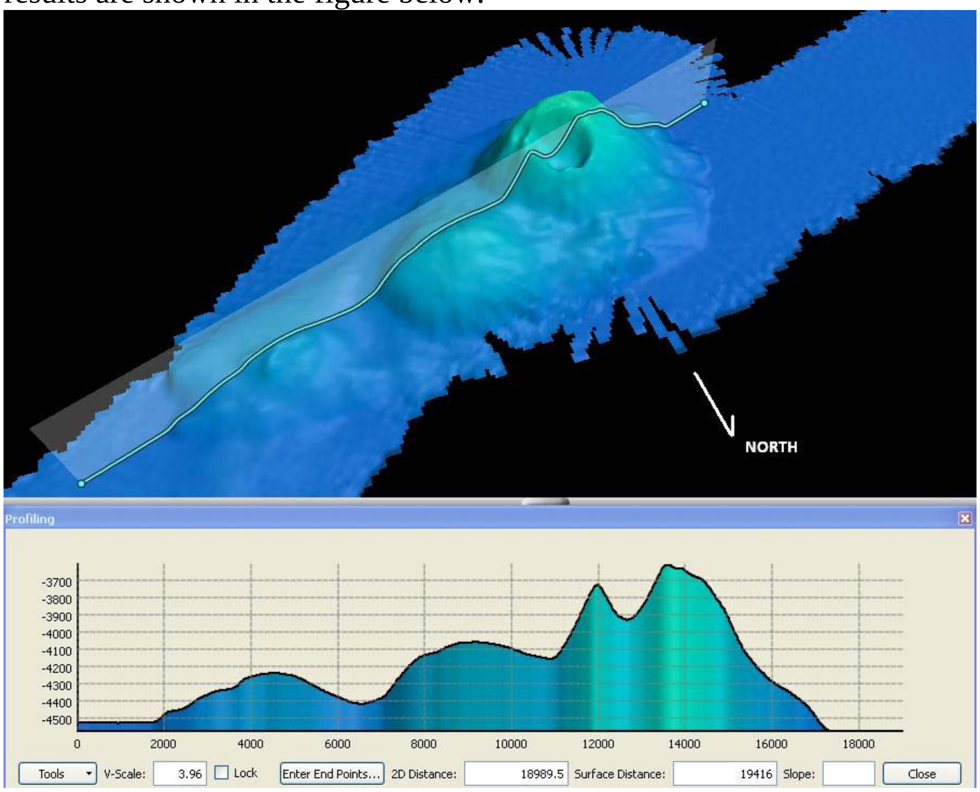


Figure 14. Screengrab created in Fledermaus of volcanic feature explored on Oct. 28. Vertical exaggeration 3. Profile showing depth and distance in meters.

During the transit to the west coast, the ship underwent three time changes to adjust for the time zones we are crossing. This morning was the third and final time change, when 0200 became 0300. Ship time is now UTC minus 7 hours.

The mapping department conducted sound level testing around the ship interior spaces while operating the subbottom profiler. The full results are included in Appendix A.

The engineering department conducted a 15 minute test of the emergency generator. The multibeam was monitored during the test, since during EX1003 shortly after the same testing, it was discovered that EM302 transmit board 16 had failed again. The emergency generator had been ruled out as the source of the transmit board failure, and the monitoring that occurred today was to confirm this. No effect was seen in the multibeam data, and subsequent BISTs indicated that board 16 still had one working high voltage bridge, and no additional boards had failed.

October 29, 2010

Continued mapping operations while in transit towards San Francisco Bay.

The transit line in was planned to go over the wreck of the Puerto Rican, which sank on October 25, 1984 in approximately 450 meters of water at 37° 30.3 N, 123° 00.3W. The wreck was not observed to be at the specified location.

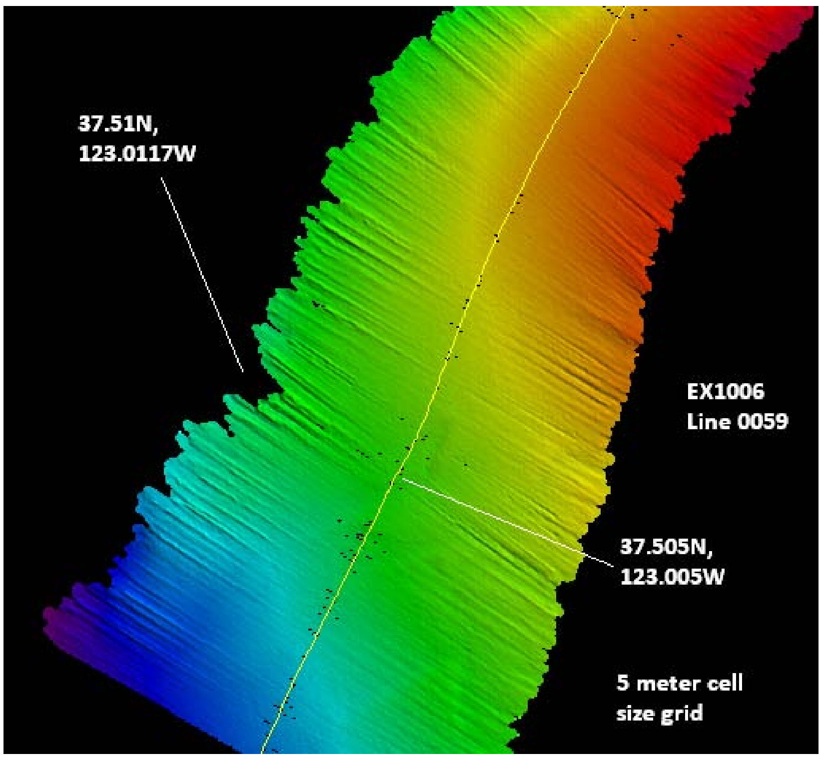


Figure 15. Screengrab of Line 0059 bathymetry data gridded at 5 meter cell size over expected Puerto Rican wreck location. Wreck not observed. Image created in CARIS.

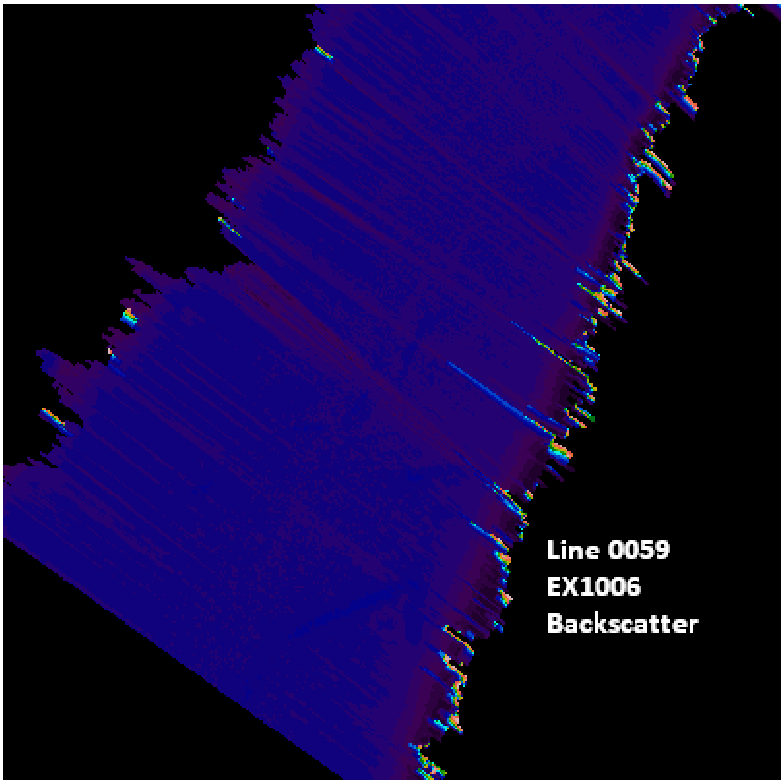


Figure 16. Screengrab of Line 0059 backscatter data gridded at 2m cell size over expected Puerto Rican wreck location. Wreck not observed. Image created in CARIS.

At 0820, the EM302 transducer was secured and mapping operations ceased. The wrap up science meeting was held in the afternoon in port, and field mapping products were presented. All are included in Appendix A.

11. Appendices

Appendix A: Field Products

DISCO-P 10/22/10 #1

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NOAA OFFICE OF OCEAN EXPLORATION AND RESEARCH
NOAA SHIP OKEANOS EXPLORER
POTENTIAL DISCOVERY (DISCO-P) REPORT – SEAMOUNT #1 10/22/10

PREPARED BY:
NOAA Ship Okeanos Explorer
Mapping Team
Team Lead: Meme Lobecker

SUBMITTED TO:
NOAA Office of Ocean Exploration (OER)
Craig Russell, Okeanos Explorer Program Manager
Steve Hammond, Okeanos Explorer Program Chief Scientist

==

CRUISE: EX1006
Transit: Honolulu, HI to San Francisco Bay, CA

DATE/TIME FILED:
10/25/10

VESSEL:
NOAA Ship *Okeanos Explorer*

LOCATION OF POTENTIAL DISCOVERY:
North Pacific Ocean
27.63 N, 147.12 W

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SUMMARY:

Two structures on the seafloor were detected around 2100 on 22 October 2010 during the transit from Honolulu, HI to San Francisco Bay, CA. This DISCO-P describes the first, slightly more southern, of the two structures. The structure appears to be an underwater seamount with shallowest depth of ~ 3880 meters below the sea surface. The adjacent seafloor to the northeast of the structure lies at ~5275 meters, and to the southwest lies at ~5275 meters, making the feature at least ~1395 meters high. No existing data other than Sandwell and Smith satellite-derived bathymetry and NOAA nautical chart #530 are available onboard to verify if this is a new discovery.

==

DISCUSSION:

The underwater seamount was found while during the exploration transit from Honolulu, HI to San Francisco Bay, CA, where the ship will spend the 2010/2011 winter repair period. See Figure 1. The potential discovery was found using the Kongsberg EM 302 multibeam sonar. The data were processed in CARIS HIPS 6.1 and brought into Fledermaus for visualization and measurements.

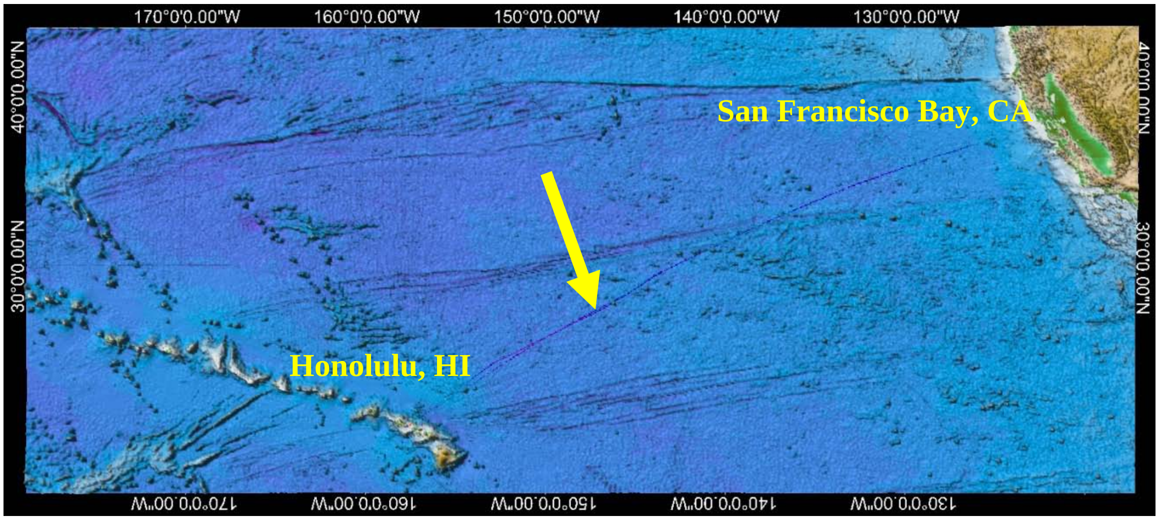

Figure1. Location map of the potential seamount (yellow arrow) Background bathymetry from Sandwell and Smith seafloor topography overlaid with the multibeam data collected during EX1006 and EX0908. Hawaiian island chain shown to the west, California coastline to the east. Image created in Fledermaus v7. Image credit: NOAA.

Existing data available onboard for potential discovery investigation included Sandwell and Smith global bathymetry and NOAA nautical charts. The Sandwell and Smith data showed this structure as approximately 600 meters high. See Figure 2.

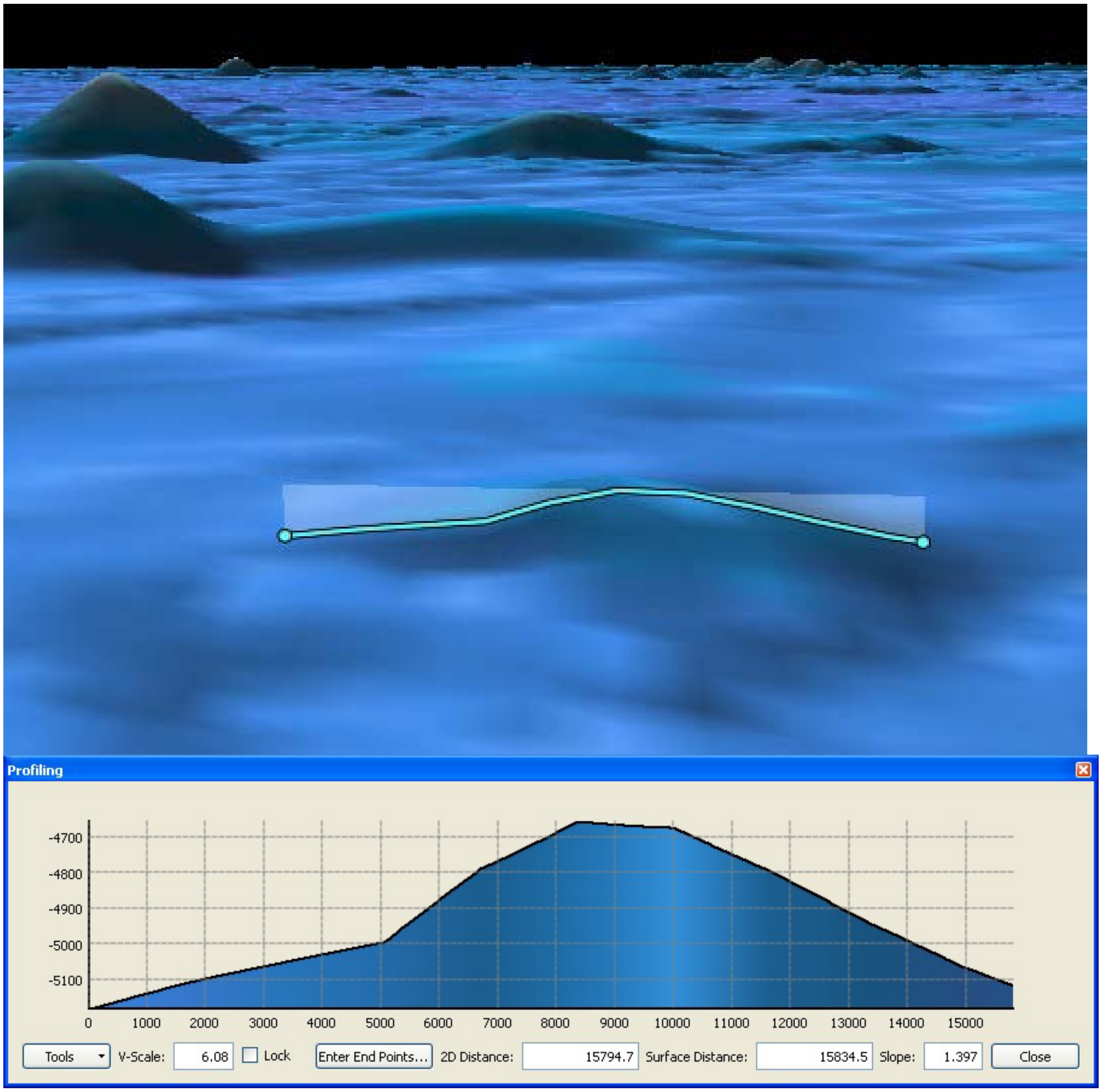

Figure 2. Oblique view looking north of Sandwell and Smith satellite-derived data indicating the feature to be ~ 600 meters high. Profile drawn west to east (left to right) with depths shown in meters. Image created in Fledermaus v7. Vertical exaggeration 3. Image credit: NOAA.

The EM302 data collected during EX1006 showed the feature as at least 1395 meters high. See Figure 3.

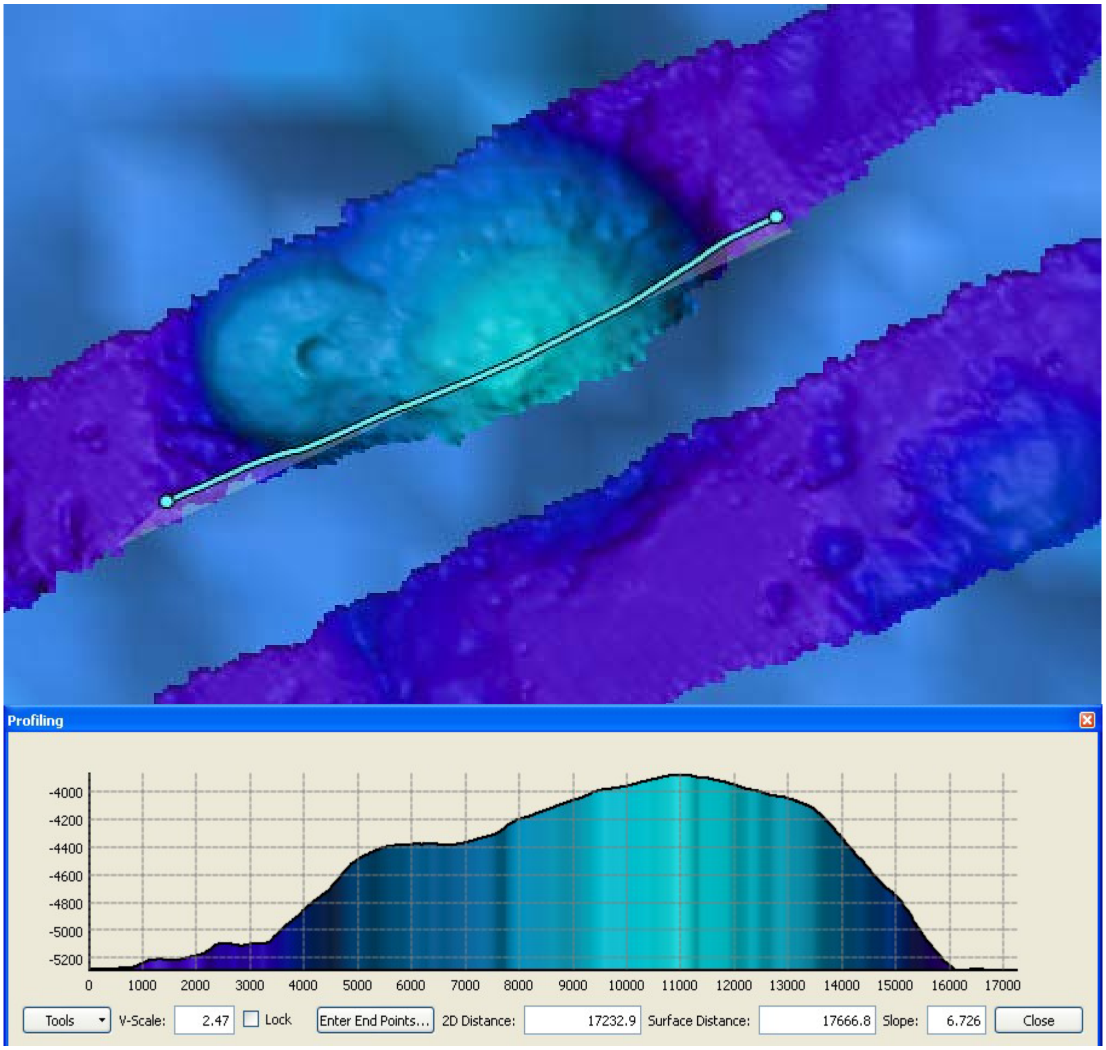

Figure 3. Oblique view (north up) of EM302 data overlain on Sandwell and Smith satellite-derived data indicating the feature to be ~1395 meters high. Profile drawn west to east (left to right) with depths shown in meters. Image created in Fledermaus v7. Vertical exaggeration 3. Image credit: NOAA.

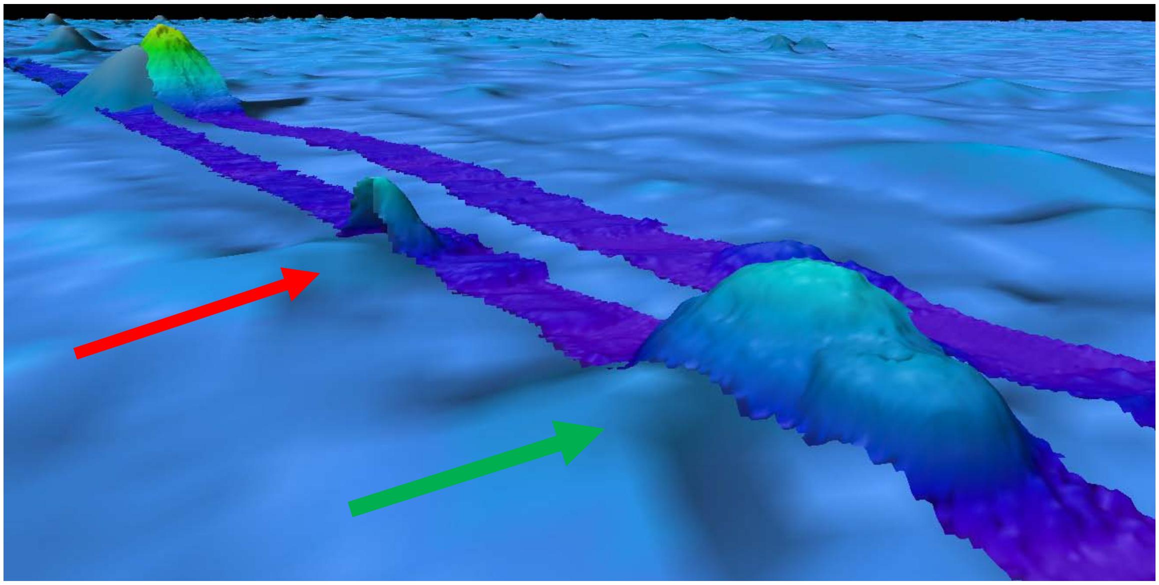

Figure 4. Oblique view looking southeast showing potential seamount / potential discovery described in this report in the foreground and indicated by the green arrow. The red arrow indicates the seamount / potential discovery described in the DISCO-P 10/22/10 #2. Huddell Seamount shown in the distance. Image created in Fledermaus v7 with Sandwell and Smith satellite-derived bathymetry in as a background layer. Vertical exaggeration 3. Image credit: NOAA.

NOAA chart # 530 showed a 2,000 fathom contour line in the vicinity of the seamount, but it does not appear that the contour indicates the presence of a seamount. Huddell Seamount, indicated with a blue arrow, is accurately and clearly shown on the chart. See Figure 5.

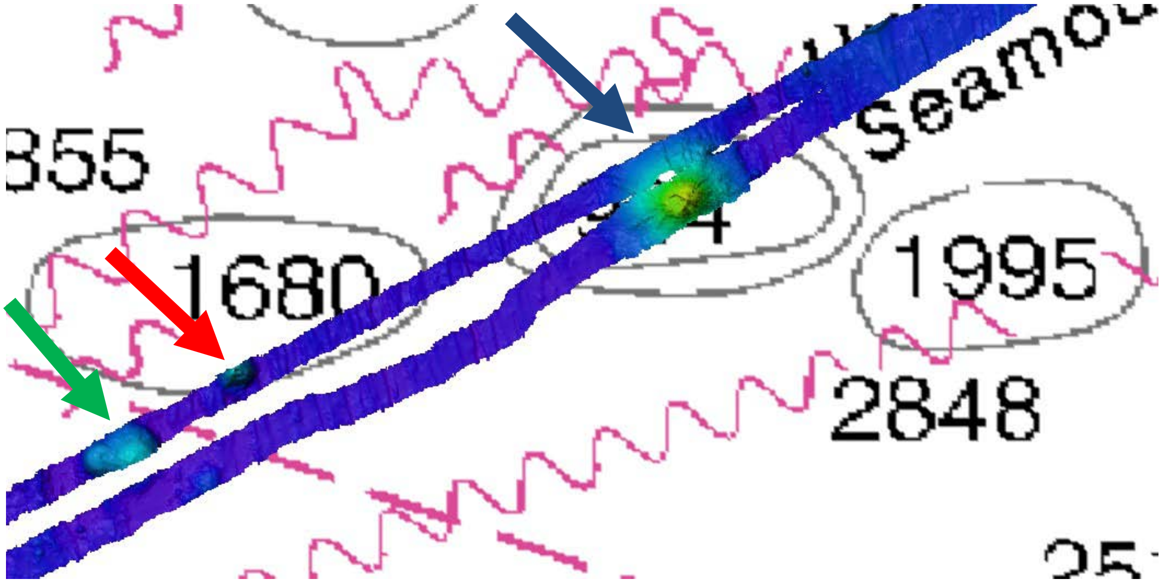

Figure 5. EM302 bathymetry overlaid over NOAA nautical chart # 530. Seamount / potential discovery described in this report is indicated by the green arrow. The red arrow indicates the seamount / potential discovery described in the DISCO-P 10/22/10 #2. Data shown north up. Northern transect is EX1006 data, southern transect is EX0908 data. Image created in Fledermaus v7. Image credit: NOAA.

More detailed scientific vetting is required before this find can be declared a discovery.

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FURTHER WORK BEING PLANNED:

At the time of writing of this report there are no plans to collected further data at the site.
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COMMENTS:

Discoveries are a corner stone of the *Okeanos Explorer* program. Protocols still need to be designated for presenting the news of discoveries, soliciting pertinent help from shore based scientists, communicating the results to public / scientists and determining individual responsibilities within OER and onboard the EX. The ship based mapping team has taken the initiative to compile a preliminary report describing a new find which has discovery potential (DISCO-P). It is hoped that this report will initialize the chain of events that are required to handle new discoveries.

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==============END OF DISCOVERY POTENTIAL REPORT===============
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DISCO-P 10/22/10 #2

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NOAA OFFICE OF OCEAN EXPLORATION AND RESEARCH
NOAA SHIP OKEANOS EXPLORER
POTENTIAL DISCOVERY (DISCO-P) REPORT - SEAMOUNT 10/22/10

PREPARED BY:
NOAA Ship Okeanos Explorer
Mapping Team
Team Lead: Meme Lobecker

SUBMITTED TO:
NOAA Office of Ocean Exploration (OER)
Craig Russell, Okeanos Explorer Program Manager
Steve Hammond, Okeanos Explorer Program Chief Scientist

==

CRUISE: EX1006
Transit: Honolulu, HI to San Francisco Bay, CA

DATE/TIME FILED:
10/24/10

VESSEL:
NOAA Ship *Okeanos Explorer*

LOCATION OF POTENTIAL DISCOVERY:
North Pacific Ocean
27.764 N, 149.945 W

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SUMMARY:

Two structures on the seafloor were detected around 2300 on 22 October 2010 during the transit from Honolulu, HI to San Francisco Bay, CA. This DISCO-P describes the second, slightly more northern, of the two structures. The structure appears to be an underwater seamount with shallowest depth of ~ 3855 meters below the sea surface. The adjacent seafloor to the northeast of the structure lies at 5200 meters, and to the southwest lies at 5000 meters, making the feature at least 1145meters high. No existing data other than Sandwell and Smith satellite-derived bathymetry and NOAA nautical chart #530 are available onboard to verify if this is a new discovery.

==

DISCUSSION:

The underwater seamount was found during the exploration transit from Honolulu, HI to San Francisco Bay, CA, where the ship will spend the 2010/2011 winter repair period. See Figure 1. The potential discovery was found using the Kongsberg EM 302 multibeam sonar. The data were processed in CARIS HIPS 6.1 and brought into Fledermaus for visualization and measurements.

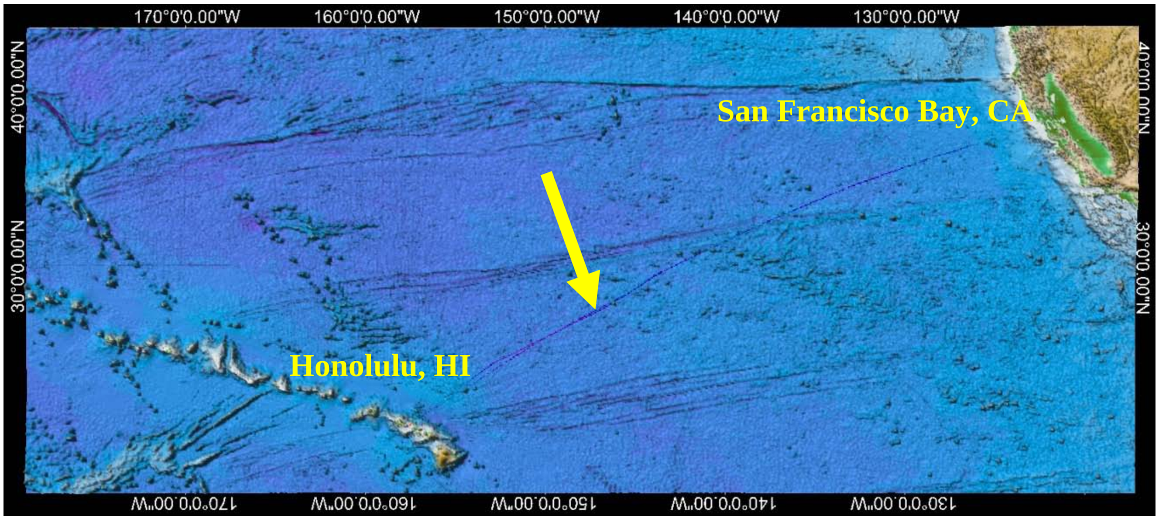

Figure1. Location map of the potential seamount (yellow arrow) Background bathymetry from Sandwell and Smith seafloor topography overlaid with the multibeam data collected during EX1006 and EX0908. Hawaiian island chain shown to the west, California coastline to the east. Image created in Fledermaus v7. Image credit: NOAA.

Existing data available onboard for potential discovery investigation included Sandwell and Smith global bathymetry and NOAA nautical charts. The Sandwell and Smith data showed this structure as approximately 300 meters high. See Figure 2.

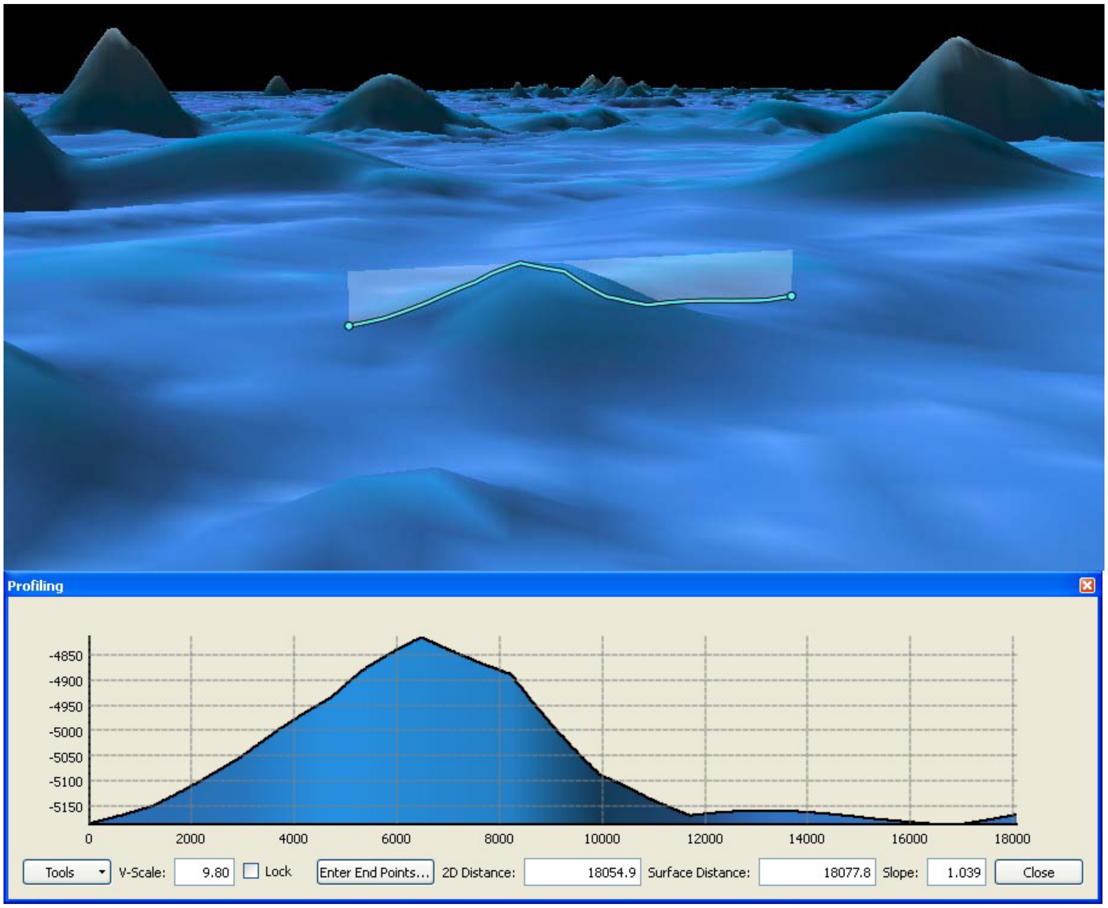

Figure 2. Oblique view looking north-north east of Sandwell and Smith satellite-derived data indicating the feature to be ~ 350 meters high. Profile drawn west to east (left to right) with depths shown in meters. Image created in Fledermaus v7. Vertical exaggeration 3. Image credit: NOAA.

The EM302 data collected during EX1006 showed the feature as at least 1145 meters high. See Figure 3.

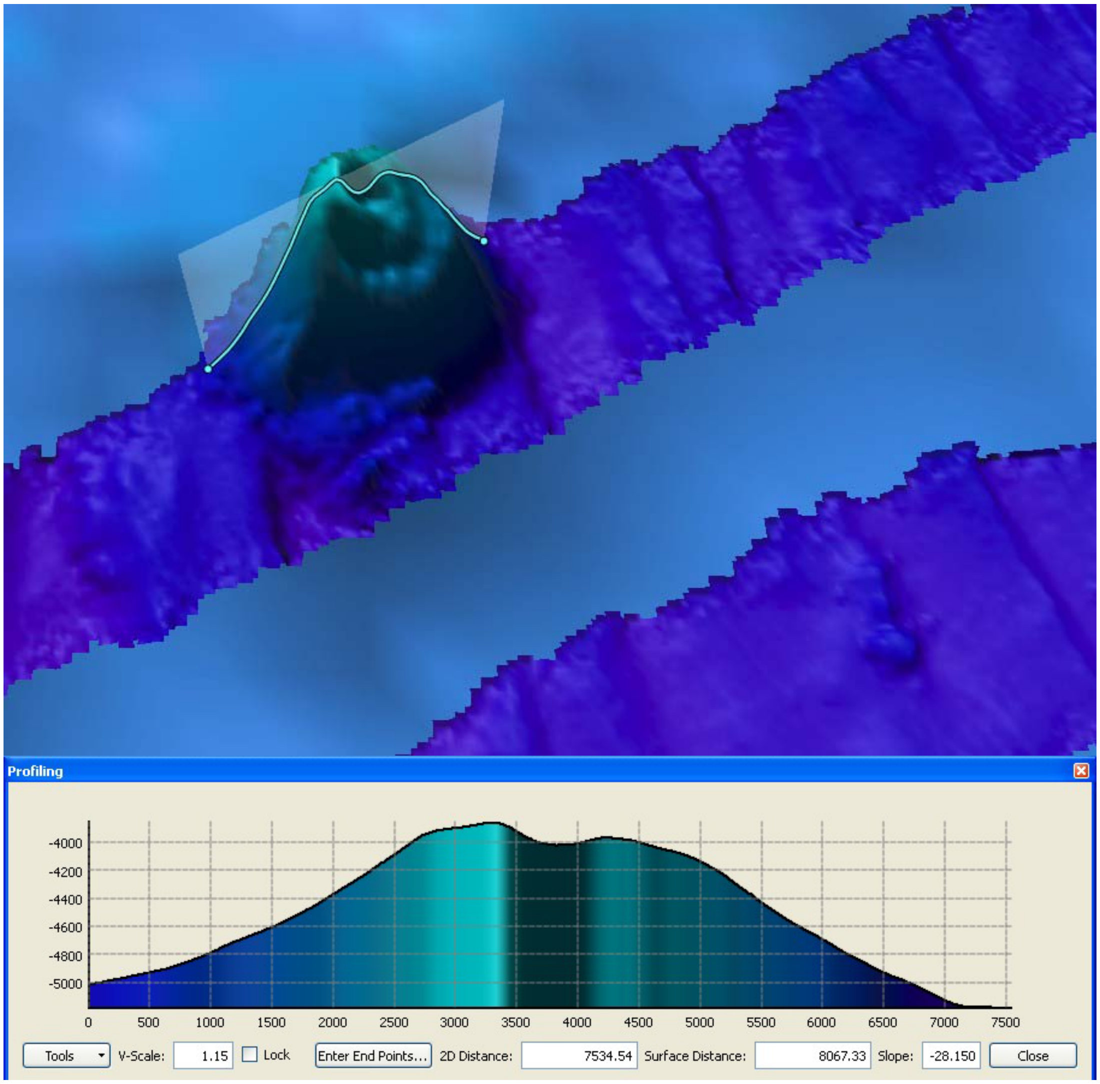

Figure 3. Oblique view (north up) of EM302 data overlain on Sandwell and Smith satellite-derived data indicating the feature to be ~1145 meters high. Profile drawn west to east (left to right) with depths shown in meters. Image created in Fledermaus v7. Vertical exaggeration 3. Image credit: NOAA.

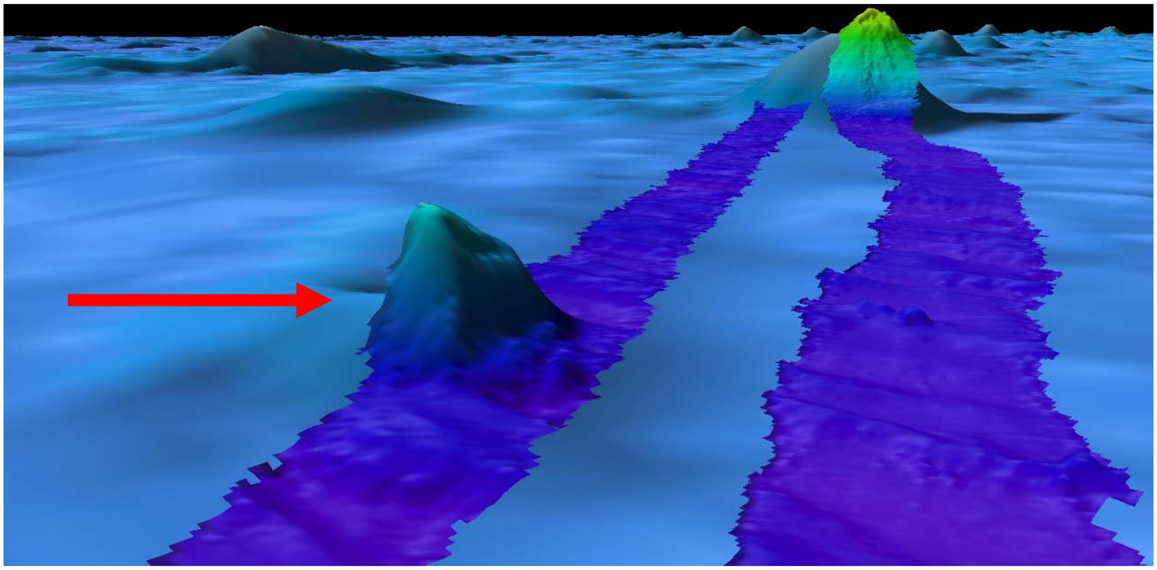

Figure 4. Oblique view looking northeast showing potential discovery in the foreground. Huddell Seamount shown in the distance. Image created in Fledermaus v7 with Sandwell and Smith satellite-derived bathymetry in as a background layer. Vertical exaggeration 3. Image credit: NOAA.

NOAA chart # 530 showed a 2000 fathom contour line in the vicinity of the seamount, but it does not appear that the contour indicates the presence of a seamount. Huddell Seamount, indicated with a blue arrow, is accurately and clearly shown on the chart. See Figure 5.

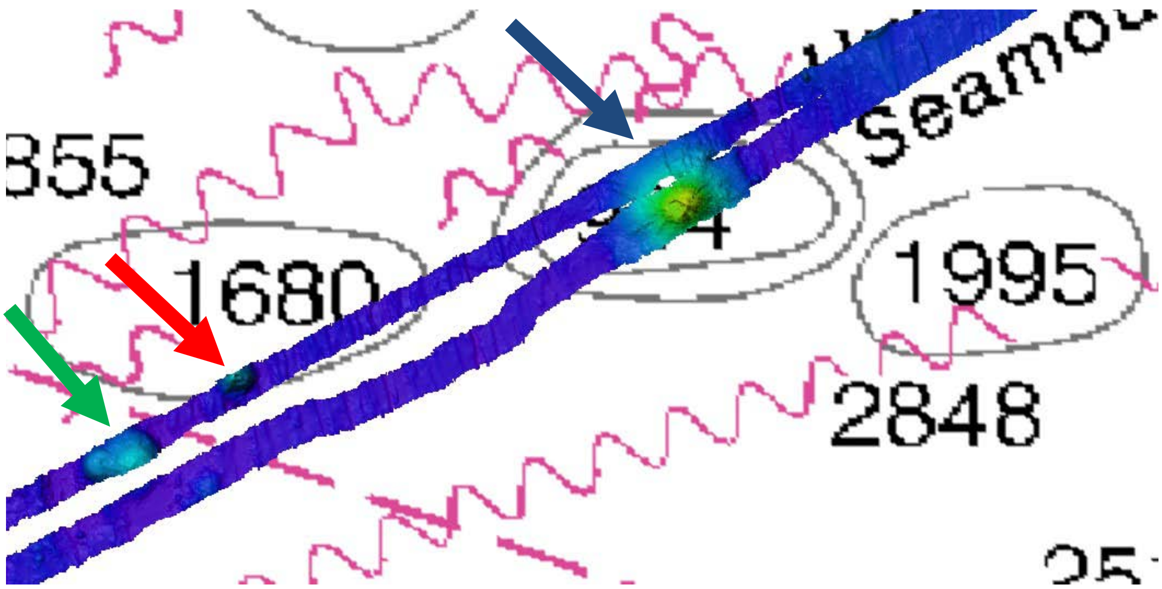

Figure 5. EM302 bathymetry overlaid over NOAA nautical chart # 530. Seamount / potential discovery described in this report is indicated by the red arrow. The green arrow indicates the seamount / potential discovery described in the DISCO-P 10/22/10 #1. Data shown north up. Northern transect is EX1006 data, southern transect is EX0908 data. Image created in Fledermaus v7. Image credit: NOAA.

More detailed scientific vetting is required before this find can be declared a discovery.

==
FURTHER WORK BEING PLANNED:

At the time of writing of this report there are no plans to collected further data at the site.
==
COMMENTS:

Discoveries are a corner stone of the *Okeanos Explorer* program. Protocols still need to be designated for presenting the news of discoveries, soliciting pertinent help from shore based scientists, communicating the results to public / scientists, and determining individual responsibilities within OER and onboard the EX. The ship-based mapping team has taken the initiative to compile a preliminary report describing a new find which has discovery potential (DISCO-P). It is hoped that this report will initialize the chain of events that are required to handle new discoveries.

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==============END OF DISCOVERY POTENTIAL REPORT===============
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DISCO-P 10/24/10

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NOAA OFFICE OF OCEAN EXPLORATION AND RESEARCH
NOAA SHIP OKEANOS EXPLORER POTENTIAL DISCOVERY (DISCO-P) REPORT - SEAMOUNT 10/24/10

PREPARED BY:
NOAA Ship Okeanos Explorer
Mapping Team
Team Lead: Meme Lobecker

SUBMITTED TO:
NOAA Office of Ocean Exploration (OER)
Craig Russell, Okeanos Explorer Program Manager
Steve Hammond, Okeanos Explorer Program Chief Scientist

==

CRUISE: EX1006
Transit: Honolulu, HI to San Francisco Bay, CA

DATE/TIME FILED:
10/24/10

VESSEL:
NOAA Ship *Okeanos Explorer*

LOCATION OF POTENTIAL DISCOVERY:
North Pacific Ocean
30.191 N, 142.331 W

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SUMMARY:

A structure on the seafloor were detected on 24 October 2010 during the transit from Honolulu, HI to San Francisco Bay, CA. The structure appears to be an underwater seamount with shallowest depth of ~ 3920 meters below the sea surface. The adjacent seafloor to the northeast of the structure lies at 5200 meters, and to the southwest lies at 5050 meters, making the feature ~ 1130 meters high. No existing data other than Sandwell and Smith satellite-derived bathymetry and NOAA nautical chart #530 are available onboard to verify if this is a new discovery.

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DISCUSSION:

The potential discovery was mapped during the exploration transit from Honolulu, HI to San Francisco Bay, CA, where the ship will spend the 2010/2011 winter repair period. See Figure 1. The potential discovery was found using the Kongsberg EM 302 multibeam sonar. The data were processed in CARIS HIPS 6.1 and brought into Fledermaus for visualization and measurements.

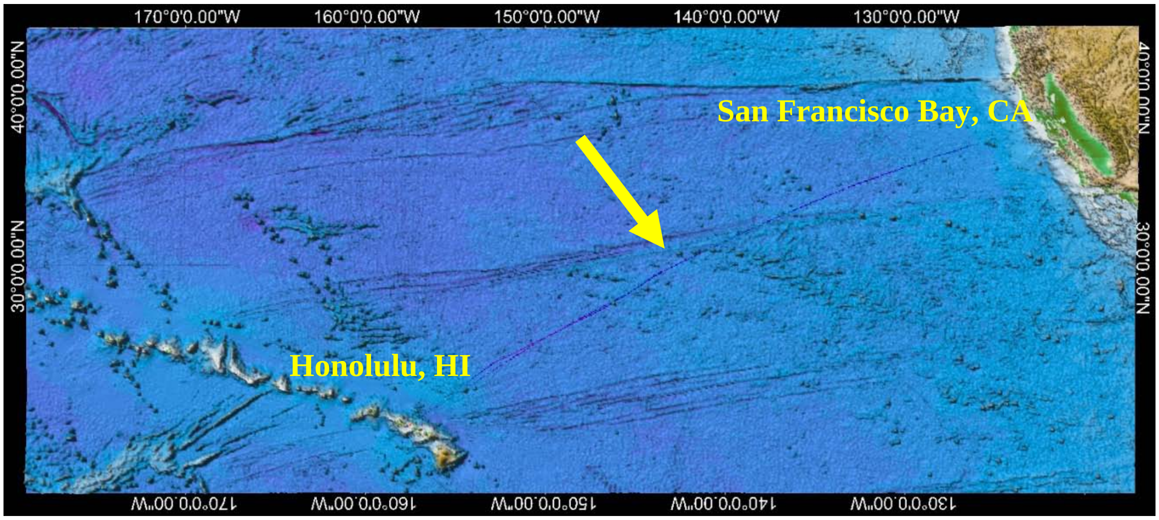

Figure1. Location map of the potential seamount (yellow arrow) Background bathymetry from Sandwell and Smith seafloor topography overlaid with the multibeam data collected during EX1006 and EX0908. Hawaiian island chain shown to the west, California coastline to the east. Image created in Fledermaus v7. Image credit: NOAA.

Existing data available onboard for potential discovery investigation included Sandwell and Smith global bathymetry and NOAA nautical charts. The Sandwell and Smith data showed this structure as less than 150 meters high. See Figure 2.

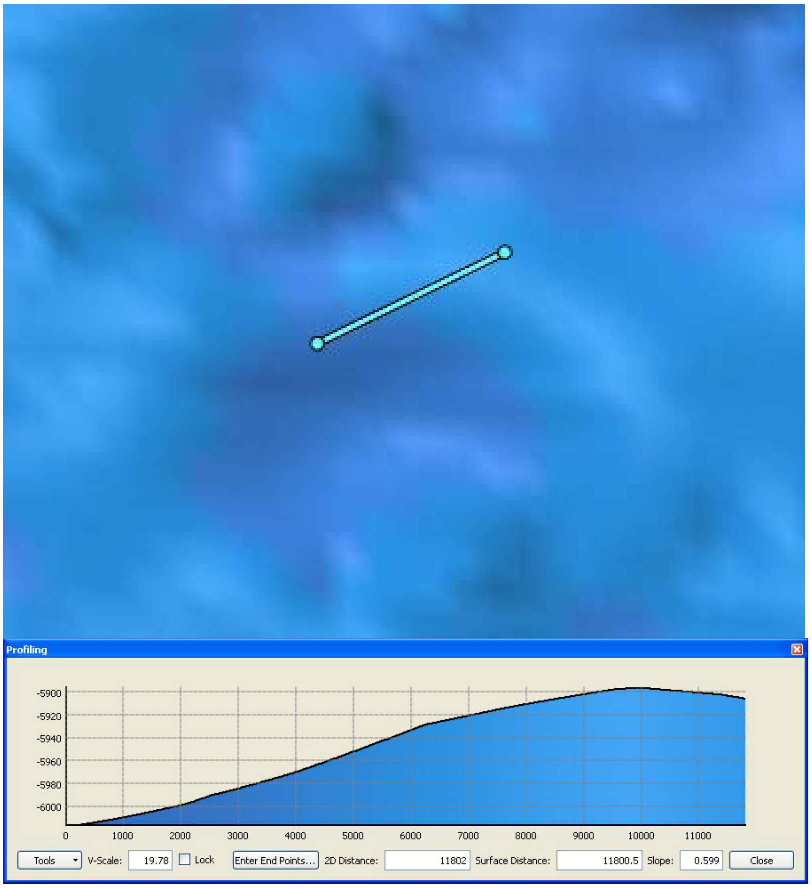

Figure 2. Plan view looking north-north east of Sandwell and Smith satellite-derived data indicating a slightly sloping seafloor, with less than 150 meters of relief. Profile drawn west to east (left to right) with depths shown in meters. Image created in Fledermaus v7. Image credit: NOAA.

The EM302 data collected during EX1006 showed the feature as at least 1130 meters high. See Figure 3.

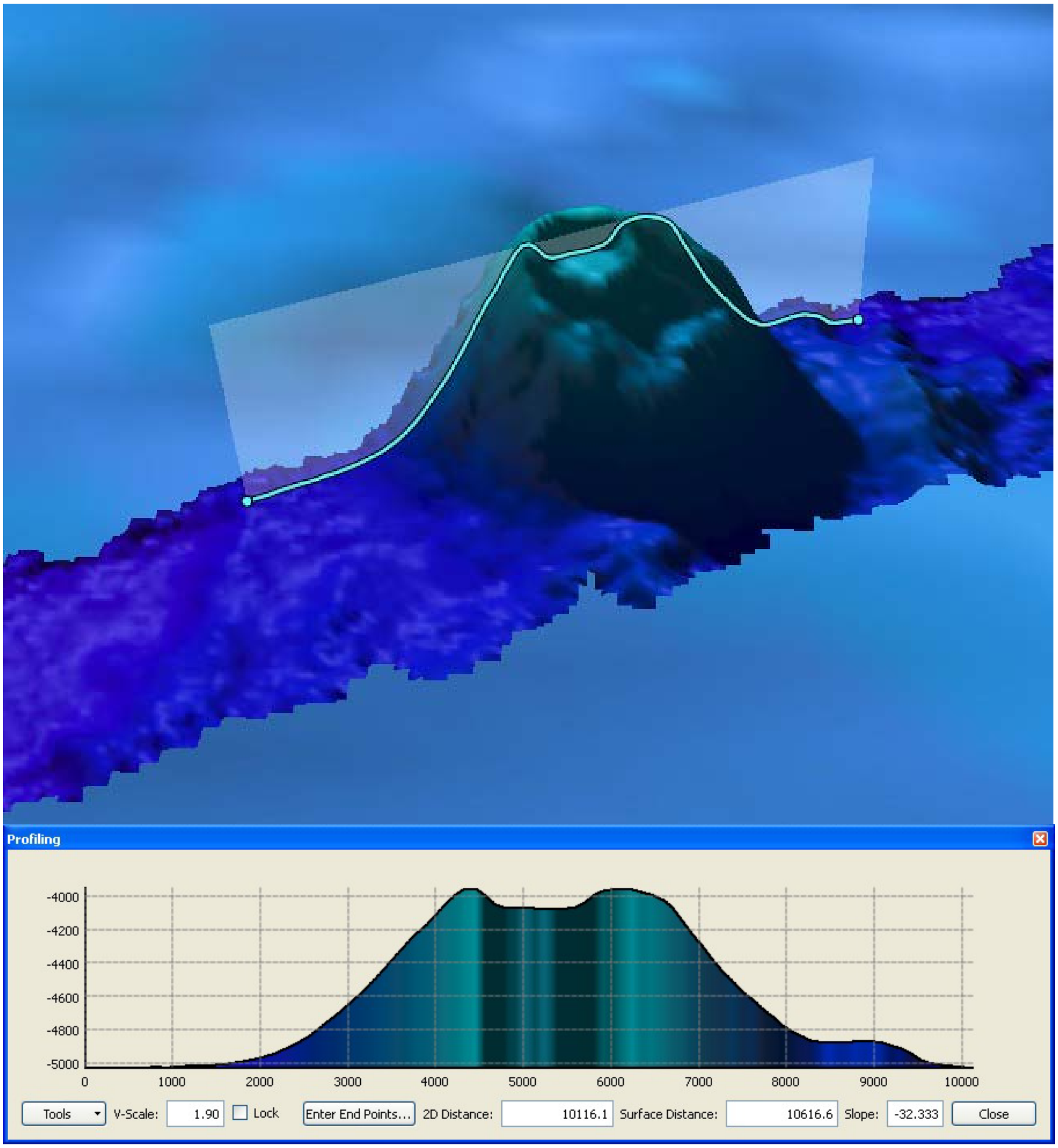

Figure 3. Oblique view (north up) of EM302 data overlain on Sandwell and Smith satellite-derived data indicating the feature to be ~1130 meters high. Profile drawn west to east (left to right) with depths shown in meters. Image created in Fledermaus v7. Vertical exaggeration 3. Image credit: NOAA.

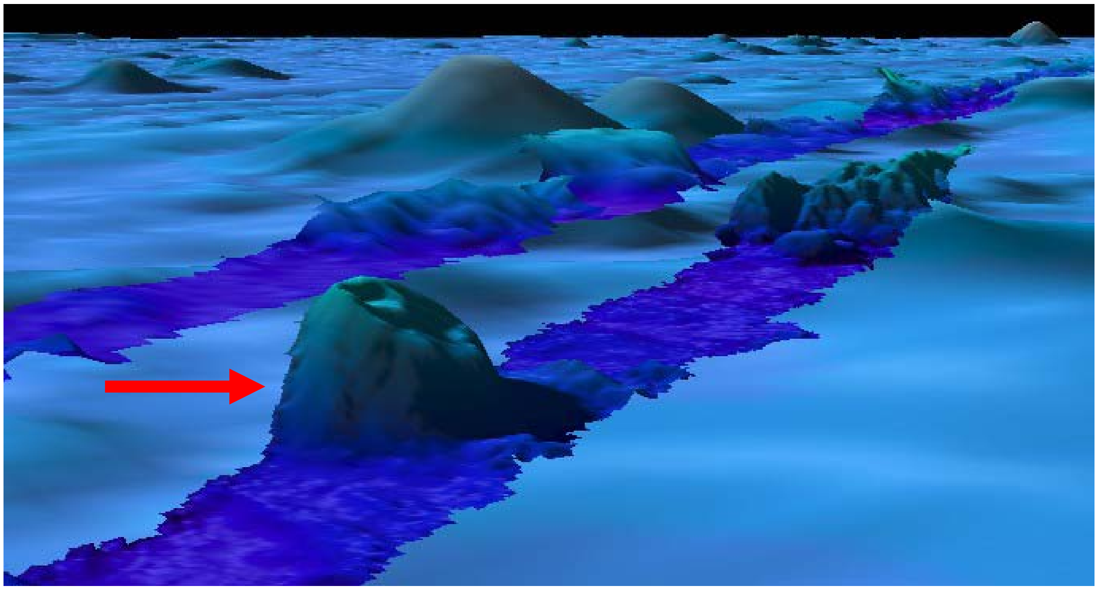

Figure 4. Oblique view looking northeast showing potential discovery in the foreground. Adjacent transect to north is EX0908 transit data from San Francisco to Honolulu. The image was created in Fledermaus v7 with Sandwell and Smith satellite-derived bathymetry in as a background layer. Vertical exaggeration 3. Image credit: NOAA.

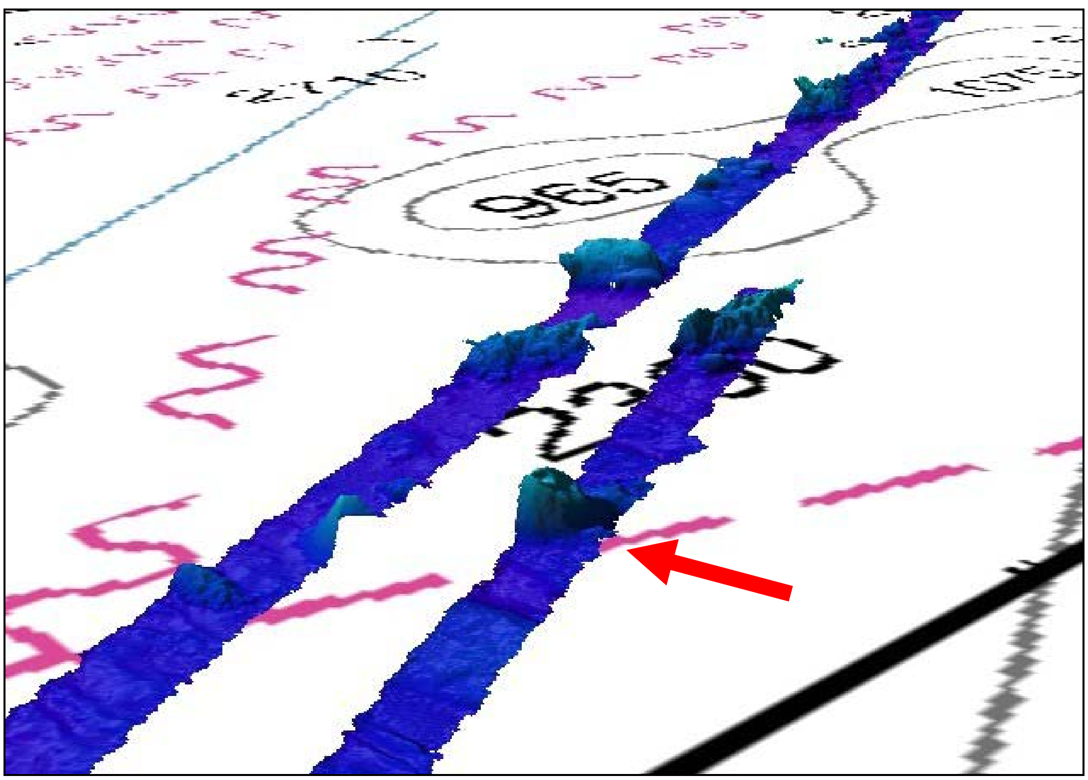

Figure 5. Oblique view looking northeast of EM302 bathymetry overlaid on NOAA nautical chart # 530. Seamount / potential discovery described in this report is indicated by the red arrow. Southern transect is EX1006 data, northern transect is EX0908 data. Image created in Fledermaus v7. Image credit: NOAA.

More detailed scientific vetting is required before this find can be declared a discovery.

===
FURTHER WORK BEING PLANNED:

At the time of writing of this report there are no plans to collected further data at the site.
===
COMMENTS:

Discoveries are a corner stone of the *Okeanos Explorer* program. Protocols still need to be designated for presenting the news of discoveries, soliciting pertinent help from shore based scientists, communicating the results to public / scientists, and determining individual responsibilities within OER and onboard the EX. The ship-based mapping team has taken the initiative to compile a preliminary report describing a new find which has discovery potential (DISCO-P). It is hoped that this report will initialize the chain of events that are required to handle new discoveries.

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==============END OF DISCOVERY POTENTIAL REPORT===============
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Subbottom Profiler Interior Sound Level Test

NOAA Ship *Okeanos Explorer*
October 2010

Introduction
The purpose of the test described in this report was to build on the results of a similar test conducted during EX1001, the complete results of which can be found in the Mapping Data Report for EX1001. In general, the only difference between the tests conducted during EX1001 and EX1006 was one setting on the sound level meter. The Response Setting was set to "Max Hold", to capture the highest sound level reading observed during each test. During EX1001, the Response setting used may not have been capturing the highest level.

The test described in this report was conducted by Physical Scientist Meme Lobecker (NOAA OER) and Chief Electronics Technician Eric Thompson (NOAA EEB).

Test Description

1. The Sper Scientific Digital Sound Level Meter 840029 was calibrated according to the instructions in the manual.
2. The Response setting was set to "Max Hold" to capture the highest sound level observed during each test.
3. To provide perspective to the reader of this report who may not have heard a subbottom profiler in operation, the following information is given:
    a. A "finger snap" was conducted directly at the sound meter's microphone under average ambient noise conditions. The finger snap resulted in readings of approximately 91 - 93 dB.
    b. While in operation, anecdotal evidence states that the equipment sounds like:
        i. Two billiard balls hitting each other
        ii. A frog noise-maker toy
4. All readings were taken around the ship at the same locations as previous sound surveys.
5. A "control" reading was taken of the ambient noise level in each location under the same test conditions as when the subbottom profiler was running.
6. A reading was taken in each location with the subbottom running using typical subbottom data collection settings for the water depth and seabed type present during the test (~4500 meters, non-bedrock bottom).
7. The results were tabulated (Table 1) and compared to the EX1001 results.

Test Conditions

1. While the readings were taken with the Knudsen subbottom profiler running, the following test conditions were in place:
    a. Environmental conditions:
        i. Approximate water depth: 4500 meters

ii. Ship's speed 9 – 10 knots
iii. Ship's heading: 45°
iv. Weather:

b. Knudsen 3260 Subbottom Profiler settings:
    i. Power level: 3
    ii. TX Pulse: 8
c. Sper Scientific Sound Level Meter settings:
    i. Response: Max Hold – this setting reports the largest sound level observed until the meter is reset
    ii. dB : the medium range (50-100) was chosen, which encompassed expected dB levels.
    iii. Weighting: readings were taken with both A and C weighting, since the manual for the equipment was not clear about the difference between these options.
d. Any major equipment or sources of other sound detected by the sound level meter in a particular space, such as fans or rattling metal, are indicated in the NOTES column of Table 1.
e. In general, doors slamming around the ship were audible throughout the test, but were not detected above ambient noise by the Sper Scientific Sound Level Meter.
f. If the subbottom profiler was not audibly heard above the ambient noise, "not heard" appears in the notes column of Table 1.

Results

Table 3. EX1006 Subbottom Profiler Sound Level Test Results

TEST LOCATION	**AMBIENT NOISE LEVEL (dB) (conducted from 1730 - 1750 ship time 10/28/10)**		**NOISE LEVEL Db (conducted from 1620 - 1640 ship time on 10/28/10)**		**NOTES**
	WEIGHTING "A"	**WEIGHTING "C"**	**WEIGHTING "A"**	**WEIGHTING "C"**	
Bridge	62.1	74.5	66	81.8	
02-23-10 (XO's Office)	56.3	77.1	55.1	79.8	
02-34-2-L (ET Berthing)	65	86.9	62.6	84.6	
Ladderway -O2 to O1 decks	61.6	76.4	62.2	79.5	SBP heard above ambient loud fan noise
01-24-L (Exped. Coord. Berth Outside/Inside)	63.2	78.6	57.8/56	76.3/76.3	
O1-6-0-E (EDG Room)	NOT TAKEN	NOT TAKEN	NOT TAKEN	NOT TAKEN	
O1-14-3-L(Outside/Inside)	71.2	74.8	63.1/52.9	72.5/69.8	

Bosun's Stores	67.5	78.7	70.3	81.1	not heard
O1-48-0 (Fire Station 5)	61.5	80.8	63.5	81.6	
ET Workspace	57.8	79	59.9	74.9	not heard
Mission control space	67	82.3	67	79.2	not heard
Dry lab	62.6	77.6	63.6	78.2	not heard
Wet lab	86.1	87	69.8	77	not heard, fume hood running during ambient test
ROV hangar	66.8	84.3	69	93	not heard, fan running
1-61-0-A (Mn Dk P-Way) DC Locker	83.4	81.2	67.3	81.1	not heard
Mess deck	64	78.8	71	80	not heard
Library	82.1	80.6	63.5	81.3	
1-9-0-L (P-way exposed frame) Outside ship's store	60.4	74.1	62.3	77	
Hospital	DOOR LOCKED	DOOR LOCKED	71.5	82.6	Other loud rattles due to metal cabinetry in room
Forward lounge	OCCUPIED	OCCUPIED	58.9	75	
Gym	60.5	74.7	64.9	79.8	
Ladderway O-1 to Mn Dk	67.8	86.2	72.3	74.6	
Laundry	80.9	82.1	81.1	81.5	
1-52-4-L (CR SR berth)	NOT TAKEN	NOT TAKEN	61	80.6	

Conclusions

As compared to EX1001, the test results indicate generally elevated maximum noise levels. It is possible that this is due to:

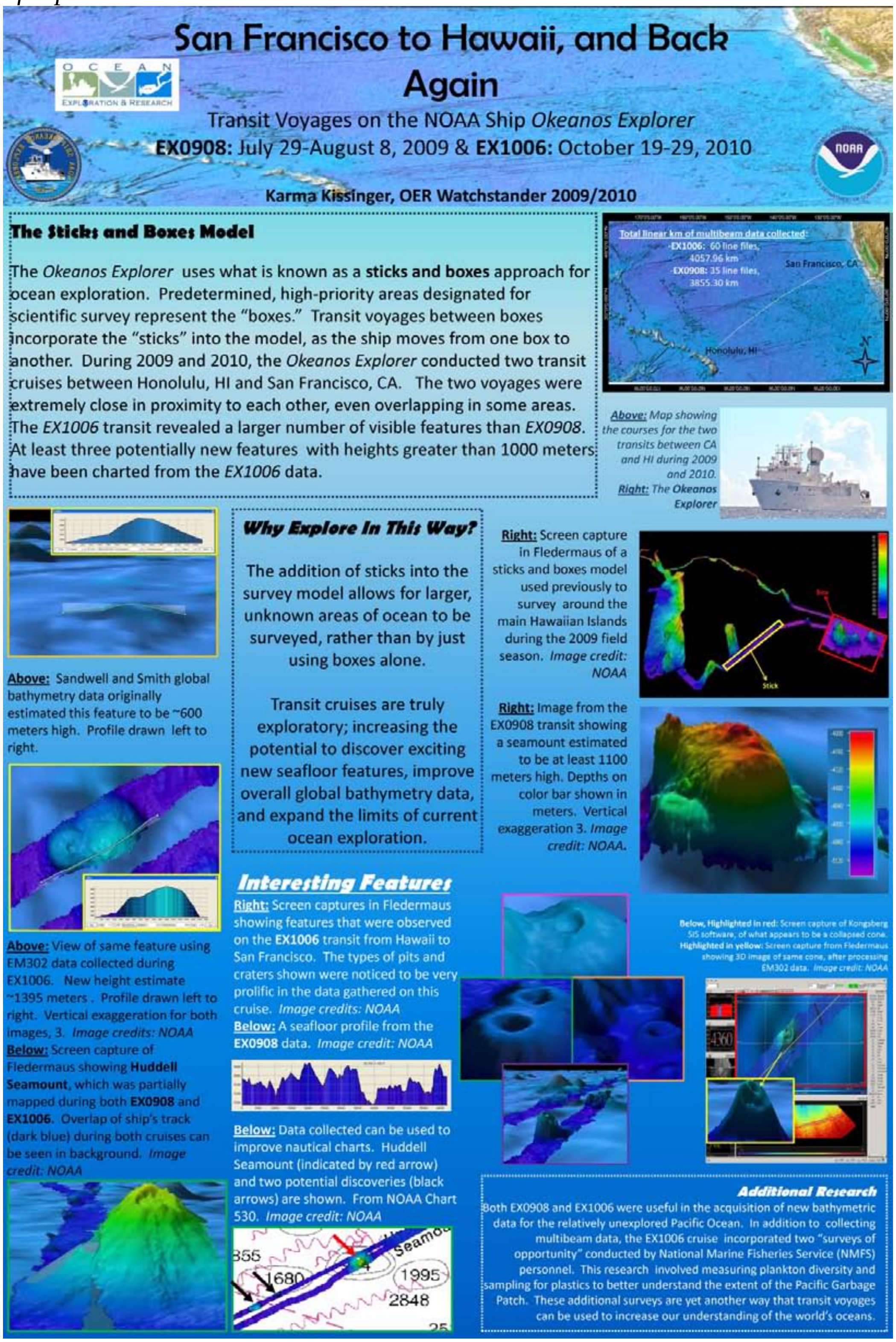
- the subbottom was operating in deeper water during the EX1006 test (4500 meters as opposed to <2000 meters during EX1001 test)
- the Sper sound meter Response setting was set to "Max Hold" during the EX1006 test, where as it was set to "Fast" during the EX1001 test. This may account for the maximum noise level not being captured.
- During EX1001, the ship was transiting at 3-4 knots, whereas during EX1006 it was transiting at 9-10 knots. This could cause an increase in the ambient noise levels around the ship.

The results of the EX1001 sound level test should be considered in light of these possibilities, in particular, the Response setting difference.

It is important to note that there are numerous other test scenarios, for example different weather conditions, different water depths, and different seafloor types requiring different subbottom profiler settings, that were not able to be tested. The purpose of this test was to increase the baseline understanding of interior sound levels under normal subbottom profiler operational conditions.

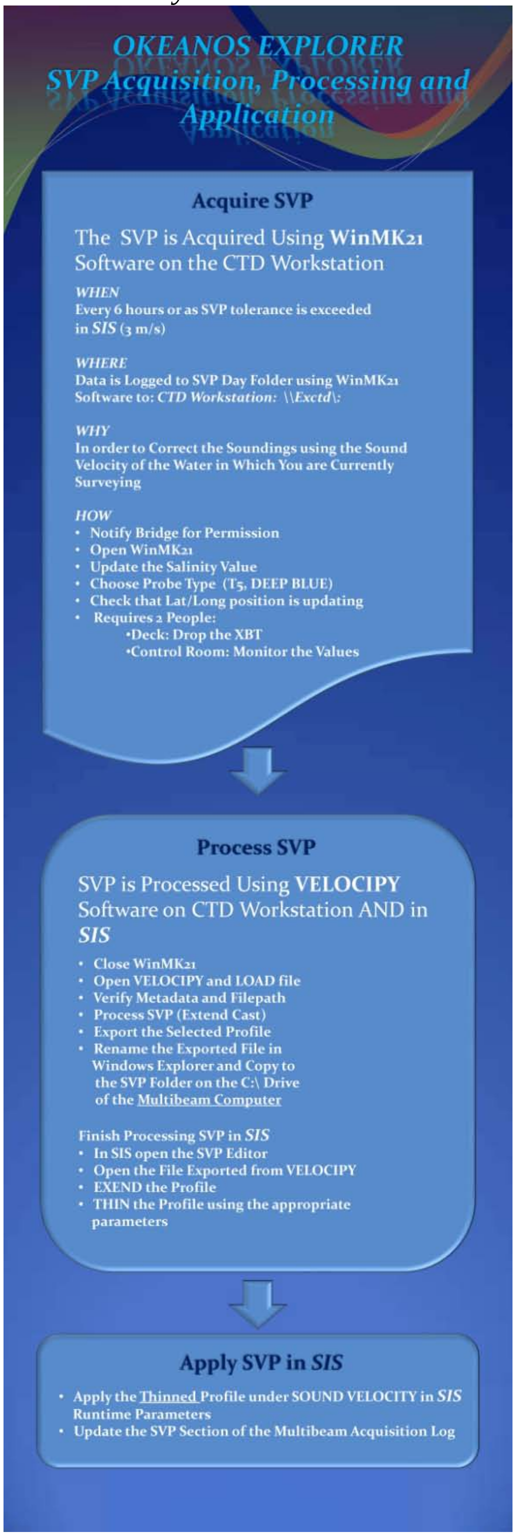
Figure 17. Sper Scientific Sound Meter 840029.

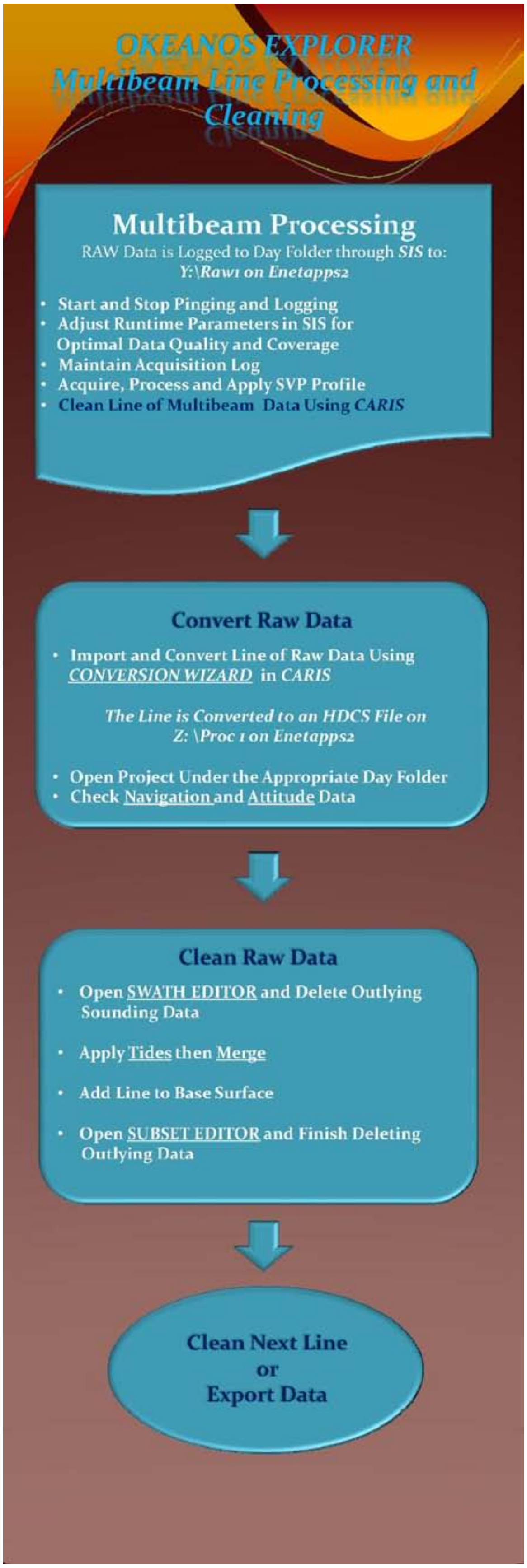
Poster created by Mapping Watchstander Karma Kissinger describing sticks and boxes method of exploration



Poster created by Intern Tessi Standfast describing EX1006 surveys of opportunity

Two posters created by Mapping Watchstander Ash Harris briefly describing multibeam and sound velocity data collection




OKEANOS EXPLORER
Multibeam Line Processing and Cleaning
Multibeam Processing
RAW Data is Logged to Day Folder through SIS to:
Y:\Raw1 on Enetapps2
Start and Stop Pinging and Logging
Adjust Runtime Parameters in SIS for Optimal Data Quality and Coverage
Maintain Acquisition Log
Acquire, Process and Apply SVP Profile
Clean Line of Multibeam Data Using CARIS
Convert Raw Data
Import and Convert Line of Raw Data Using CONVERSION WIZARD in CARIS
The Line is Converted to an HDCS File on Z: \Proc 1 on Enetapps2
Open Project Under the Appropriate Day Folder
Check Navigation and Attitude Data
Clean Raw Data
Open SWATH EDITOR and Delete Outlying Sounding Data
Apply Tides then Merge
Add Line to Base Surface
Open SUBSET EDITOR and Finish Deleting Outlying Data
Clean Next Line or Export Data

Fledermaus movies created by Mapping Watchstander Donny Brouiliette

Eight fly-through movies in mpg format were created by Donny Brouiliette in Fledermaus v6. The movies were created using INDEX-SATAL 2010 data of key ROV dive sites and can be obtained by contacting the NOAA Office of Ocean Exploration and Research.

Appendix B: Tables of Data Files Collected

EX1006 Multibeam Log

EX1006 Multibeam Log					
MB Line Filename	**SVP File Applied**	**Julian Day**	**Date (GMT)**	**SOG**	**Hdg**
0000_20101019_224714_EX.all	EX1006_XBT_01	292	10/19/10	8.5	60
0001_20101020_000002_EX.all	EX1006_XBT_01/02	293	10/20/10	9	55
0002_20101020_060008_EX.all	EX1006_XBT_02	293	10/20/10	9.5	57
0003_20101020_102126_EX.all	EX1006_XBT_02/03	293	10/20/10	9.9	64
0004_20101020_162131_EX.all	EX1006_XBT_03/04	293	10/20/10	9.9	55
0005_20101020_202800_EX.all	EX1006_XBT_04/05	293	10/20/10	9	55
0006_20101021_000013_EX.all	EX1006_XBT_05	294	10/21/10	9	55
0007_20101021_042435_EX.all	EX1006_XBT_06	294	10/21/10	9	55
0008_20101021_102429_EX.all	EX1006_XBT_06	294	10/21/10	9	55
0009_20101021_103923_EX.all	EX1006_XBT_06	294	10/21/10	9	55
0010_20101021_105540_EX.all	EX1006_XBT_06	294	10/21/10	9	55
0011_20101021_113006_EX.all	EX1006_XBT_06	294	10/21/10	9	55
0012_20101021_114017_EX.all	EX1006_XBT_07/08	294	10/21/10	10	55
0013_20101021_174020_EX.all	EX1006_XBT_08	294	10/21/10	9.9	58
0014_20101021_202804_EX.all	EX1006_XBT_08/09	294	10/21/10	9	55
0015_20101022_000001_EX.all	EX1006_XBT_09/10	295	10/22/10	9.5	55
0016_20101022_060008_EX.all	EX1006_XBT_10/11	295	10/22/10	10	5
0017_20101022_120002_EX.all	EX1006_XBT_11/12	295	10/22/10	10	60
0018_20101022_180008_EX.all	EX1006_XBT_12/13	295	10/22/10	10	60
0019_20101022_221000_EX.all	EX1006_XBT_13	295	10/22/10	10	60
0020_20101023_000006_EX.all	EX1006_XBT_13/14	296	10/23/10	10	60
0021_20101023_060008_EX.all	EX1006_XBT_14/15	296	10/23/10	9	60
0022_20101023_120002_EX.all	EX1006_XBT_15/16	296	10/23/10	9	60
0023_20101023_180008_EX.all	EX1006_XBT_16	296	10/23/10	9.5	59
0024_20101023_221854_EX.all	EX1006_XBT_17	296	10/23/10	10	59
0025_20101024_000016_EX.all	EX1006_XBT_17/18	297	10/24/10	10	59
0026_20101024_060012_EX.all	EX1006_XBT_18/19	297	10/24/10	10	59
0027_20101024_120008_EX.all	EX1006_XBT_19/20	297	10/24/10	9.8	59
0028_20101024_180013_EX.all	EX1006_XBT_20	297	10/24/10	9.5	59
0029_20101024_221331_EX.all	EX1006_XBT_21	297	10/24/10	9.5	59

0030_20101025_000110_EX.all	EX1006_XBT_21/22	298	10/25/10	9.5	59
0031_20101025_060128_EX.all	EX1006_XBT_22/23	298	10/25/10	9.5	59
0032_20101025_120108_EX.all	EX1006_XBT_23/24	298	10/25/10	10	53
0033_20101025_173032_EX.all	EX1006_XBT_24/26	298	10/25/10	10	65
0034_20101025_221844_EX.all	EX1006_XBT_26	298	10/25/10	10	65
0035_20101026_000100_EX.all	EX1006_XBT_26	299	10/26/10	10	65
0036_20101026_011513_EX.all	EX1006_XBT_26/27	299	10/26/10	10	65
0037_20101026_071518_EX.all	EX1006_XBT_27/28	299	10/26/10	10	65
0038_20101026_131514_EX.all	EX1006_XBT_28/29	299	10/26/10	10	69
0039_20101026_191514_EX.all	EX1006_XBT_29	299	10/26/10	10	65
0040_20101026_203856_EX.all	EX1006_XBT_29/30	299	10/27/10	10	65
0041_20101027_000826.EX.all	EX1006_XBT_30/31	300	10/27/10	10	65
0042_20101027_060826.EX.all	EX1006_XT_31	300	10/27/10	10	65
0043_20101027_120823_EX.all	EX1006_XT_31/35	300	10/27/10	10	47
0044_20101027_180824_EX.all	EX1006_XT_35	300	10/27/10	10	65
0045_20101027_211226_EX.all	EX1006_XT_35	300	10/27/10	10	65
0046_20101028_000010_EX.all	EX1006_XT_35/37/38	301	10/28/10	10	65
0047_20101028_060012_EX.all	EX1006_XBT_38/39	301	10/28/10	10	65
0048_20101028_120012_EX.all	EX1006_XBT_39/40	301	10/28/10	10	65
0049_20101028_180007_EX.all	EX1006_XBT_40	301	10/28/10	10	65
0050_20101028_200124_EX.all	EX1006_XBT_41	301	10/28/10	7	220
0051_20101028_201820_EX.all	EX1006_XBT_41	301	10/28/10	10	65
0052_20101028_210742_EX.all	EX1006_XBT_41	301	10/28/10	5	130
0053_20101028_211430_EX.all	EX1006_XBT_41	301	10/28/10	7	55
0054_20101028_211718_EX.all	EX1006_XBT_41	301	10/28/10	10	65
0055_20101029_000006_EX.all	EX1006_XBT_42/43	302	10/29/10	5-10	75
0056_20101029_060017_EX.ll	EX1006_XBT_43/44	302	10/29/10	10	34
0057_20101029_12001_EX.all	EX1006_XBT_45	302	10/29/10	10	57
0058_20101029_130320_EX.all	EX1006_XBT_45	302	10/29/10	10	57
0059_20101029_314359_EX.all	EX1006_XBT_45	302	10/29/10	10	57
0060_20101029_140924_EX.all	EX1006_XBT_45	302	10/29/10	10	57

EX1006 Sound Velocity Profile Log

EX1006 SVP LOG					
DATE (GMT)	**TIME (GMT)**	**XBT/CTD FILE NAME**	**LAT/LONG (WGS84)**	**PROBE TYPE**	**NOTES**
10/19/2010	2212	EX1006_XBT_01	21 12.091N 157 48.120W	Deep Blue probe	
10/20/2010	0443	EX1006_XBT_02	21 37.950N 157 0.549W	Deep Blue probe	

10/20/2010	1051	EX1006_XBT_03	22 10.923N 156 9.0W	Deep Blue probe	
10/20/2010	1610	EX1006_XBT_04	22 42.01318N 155 21.78418W	T5 probe	
10/20/2010	1230	EX1006_XBT_05	23 12.95532N 154 33.08496W	T5 probe	
10/21/2010	0444	EX1006_XBT_06	23 35.849N 153 58.91W	T5 probe	
10/21/2010	1030	EX1006_XBT_07	24 5.72363N 153 10.44434W	Deep Blue probe	
10/21/2010	1634	EX1006_XBT_08	24 37.55249N 152 20.58008W	T5 probe	
10/21/2010	2230	EX1006_XBT_09	25 8.14282N 151 31.79395W	T5 probe	
10/22/2010	0424	EX1006_XBT_10	25 34.091N 150 51.810W	T5 probe	
10/22/2010	1026	EX1006_XBT_11	26 5.37915N 150 1.4541W	Deep Blue probe	
10/22/2010	1527	EX1006_XBT_12	26 29.75391N 149 15.79883W	T5 probe	
10/22/2010	1230	EX1006_XBT_13	26.977905N 148.353711W	T5 probe	
10/23/2010	0330	EX1006_XBT_14	27 25.19873N 147 32.4248W	T5 probe	
10/23/2010	0925	EX1006_XBT_15	27 53.17456N 146 40.72754W	Deep Blue probe	
10/23/2010	1524	EX1006_XBT_16	28 21.00317N 145 47.8457W	T5 probe	
10/23/2010	1230	EX1006_XBT_17	28 48.411N 144 56.573W	T5 probe	
10/24/2010	0326	EX1006_XBT_18	29 13.861N 144 7.6084W	T5 probe	
10/24/2010	0930	EX1006_XBT_19	29 43.6272N 143 11.25586W	Deep Blue probe	
10/24/2010	1525	EX1006_XBT_20	30 14.25024N 142 12.17969W	T5 probe	
10/24/2010	2131	EX1006_XBT_21	30 38.997N 141 23.250W	T5 probe	
10/25/2010	0328	EX1006_XBT_22	31 4.294N 140 36.295W	T5 probe	
10/25/2010	0927	EX1006_XBT_23	31 28.44507N 139 46.2041W	Deep Blue probe	

10/25/2010	1541	EX1006_XBT_24	31 54.14258N 138 43.79004W	T5 probe	
10/25/2010	2130	EX1006_XBT_25 .asvp	32 15.806N 137 49.848W	T5 probe	Bad Probe
10/25/2010	2134	EX1006_XBT_26 .asvp	32 15.738N 137 49.921	T5 probe	
10/26/2010	0328	EX1006_XBT_27 .asvp	32 36.523N 137 1.1310W	T5 probe	
10/26/2010	0824	EX1006_XBT_28	32 55.72119N 136 13.15039W	Deep Blue probe	
10/26/2010	1428	EX1006_XBT_29	33 21.22607N 135 8.98438W	T5 probe	
10/26/2010	2031	EX1006_XBT_30	33 44.356N 134 11.644W	T5 probe	
10/27/2010	0226	EX1006_XBT_31	34 7.2100N 133 14.3930W	T5 probe	
10/27/2010	0829	EX1006_XBT_32	34 33.213N 132 10.930W	Deep Blue probe	Bad cast-weather
10/27/2010	0832	EX1006_XBT_33	34 33.411N 132 10.429W	Deep Blue probe	Bad cast-weather
10/27/2010	0839	EX1006_XBT_34	34 33.893N 132 9.218W	Deep Blue probe	Bad cast-weather
10/27/2010	1446	EX1006_XBT_35	34 59.34912N 131 3.57031W	Deep Blue probe	Accidentally processed cast as T-5 but was a deep blue probe
10/27/2010	2027	EX1006_XBT_36	35 20.03711N 130 11.70508W	T5 probe	
10/28/2010	0222	EX1006_XBT_37	35 37.404N 129 19.549W	T5 probe	
10/28/2010	0831	EX1006_XBT_38	35 43.828N 128 59.897W	Deep Blue probe	
10/28/2010	0826	EX1006_XBT_39	35 57.71411N 128 14.96582W	Deep Blue probe	
10/28/2010	1331	EX1006_XBT_40	36 15.1333N 127 17.02441W	T5 probe	
10/28/2010	1930	EX1006_XBT_41	36 35.73047N 126 9.52539W	T5 probe	
10/29/2010	0121	EX1006_XBT_42	36 48.667N 125 24.690W	T5 probe	
10/29/2010	0259	EX1006_XBT_43	36 53.38843N 125 8.05371W	Deep Blue probe	

10/29/2010	0727	EX1006_XBT_44	37 7.33643N 124 12.89258W	Deep Blue probe	
10/29/2010	1233	EX1006_XBT_45	37 22.91821N 123 11.11816W	Deep Blue probe	

EX1006 Built In System Test Log

EX1006 BIST LOG

FILE BIST NAME	DATE (LOCAL)	DATE (UTC)	TIME (LOCAL)	TIME (GMT)	BIST TYPE	SHIP HDG	LAT (N)/LONG (W) (WGS84)	VESSEL SPEED	Max RX Noise (dB)/Board/Channel	Avg RX Noise Board 1 (dB)	Avg RX Noise Board 2 (dB)	Avg RX Noise Board 3 (dB)	Avg RX Noise Board 4 (dB)	NOTES
EX1006_1	10/19/10	10/19/10	1126	2126	all	90	21.25/ 157.91	8	69.7/2/17	61.3	62.8	64	61.3	outside Pearl Harbor .start of transit.
EX1006_2	10/20/10	10/20/10	1016	2016	all	54	23.01/ 154.87	10	68.4/2/1	59.2	58.2	57.2	58.5	
EX1006_3	10/20/10	10/21/10	1815	1409	all	012	23.58/ 153.90	2	50.9/4/8	43.4	42.8	41.2	44.1	slowed down for manta tow
EX1006_4	10/20/10	10/21/10	1819	0419	RX Noise Level	012	23.58/ 153.90	2	53.7/4/8	40.6	40.5	42.4	47	slowed down for manta tow
EX1006_5	10/20/10	10/21/10	1821	0421	RX Noise Spectrum	012	23.58/ 153.90	2	n/a	39.8	40.3	42.1	47.9	slowed down for manta tow
EX1006_6	10/21/10	10/21/10	0042	1042	all	054	24.12/ 153.14	9	82.9/1/14	69.3	55.9	55.2	56.9	TRU froze up
EX1006_7	10/21/10	10/21/10	1104	1104	all	054	24.14/ 153.11	9	73.5/1/14	61.6	60.4	57.3	55.7	TRU froze up
EX1006_8	10/21/10	10/21/10	0138	1138	all	054	24.19/ 153.02	9	63.2/1/14	57.4	55.6	56.2	55.0	TRU froze up
EX1006_9	10/21/10	10/21/10	1025	2025	all	054	24.94/ 151.84	10	64.1/1/23	60.1	55.2	54.8	56.8	
EX1006_10	10/22/10	10/22/10	1225	2125	all	162	26.983 /148.359	1.5	59.9/4/8	41.8	42.7	46	51.5	slowed down for manta tow
EX1006_11	10/23/10	10/23/10	1219	2119	all	221	28.809 /144.942	1.5	57.9/4/8	39.2	39.4	41.9	47.7	slowed down for manta tow
EX1006_12	10/24/10	10/24/10	1224	2124	all	220	30.652 /141.387	1.5	59.9/4/8	41.8	42.9	46.2	51.7	slowed down for manta tow
EX1006_13	10/25/10	10/25/10	1215	2115	all	29	32.270 /137.821	7.5	56.7/4/8	39.2	39.2	40.9	46.6	
EX1006_14	10/25/10	10/26/10	1606	0106	all	63	32.467 /137.352	10	65.4/1/23	59.2	51.0	51.9	52.9	
EX1006_15	10/26/10	10/26/10	1218	2018	all	150	33.742 /134.198	1.5	53.0/4/8	39.1	39.4	41.1	46.0	slowed down for manta tow
EX1006_16	10/27/10	10/27/10	1218	2018	all	219	35.336 /130.194	1.5	46.3/1/23	40.7	40.7	41.9	43.7	slowed down for manta tow
EX1006_17	10/28/10	10/28/10	1224	1924	all	182	36.596 /126.1	1.5	55.0//8	41.5	41.4	42.6	46.7	slowed down for manta tow

							59							
EX1006_18	10/29/10	10/29/10	0811	1511	all	45	37.2/122.8	9	72.9/3/15	71.4	71.5	71.9	72	final BIST of cruise

EX1006 Weather Log

Weather Log							
Local Date	**Local Time**	**UTC Time**	**Wind Direction (deg)**	**Wind Speed (kts)**	**Swell Height (ft)**	**Swell Direction (deg)**	**Wave Height (ft)**
10/19/2010	1118	2118	206	7	0-1	20	0
	1330	2330	31	16	1-2	210	0
	1630	0230	309	14	3-5	050	0
	2008	0508	090	13	4-6	070	0
	2310	1110	080	10	4-6	070	0
10/20/2010	0326	1326	084	10	3-5	070	0
	0705	1705	72	8	3-5	70	0
	1016	2016	15	10	3-5	070	0
	1330	2330	080	8.2	2-3	070	0
	1642	0242	070	7	5-7	340	0
	1918	0518	065	8	6-8	340	0
	2200	0800	120	12	7-8	330	0
10/21/2010	0415	1414	168	11	7-8	70	0
	0700	1700	163	11	6-9	350	0
	1025	2025	178	7	6-9	350	0
	1400	0000	210	6	5-8	350	0
	1715	0310	220	5	6-8	340	1-2
	2132	0732	200	8	5-8	340	0
10/22/2010	0015	1014	236	9	4-6	340	0
	0500	1359	224	11	4-6	340	0
	0800	1700	230	13	4	340	1
	1215	2120	230	14	5-7	340	2-3
	1515	0020	250	10	5-7	340	2-3
	2030	0535	250	11	4-6	280	0
10/23/2010	0105	1007	230	11	4-6	280	0
	0400	1248	240	15	4-6	280	0
	700	1600	238	11	4-6	280	0
	1100	1900	252	12	4	240	1
	1400	2200	250	12	5-7	290	3-4
	1700	0200	260	11	5-7	290	1-3
	2100	0600	270	10	4-6	300	1-2
10/24/2010	120	1021	264	9	0	0	0
	445	1345	241	10	0	0	0

	745	1645	245	10	6-8	310	1-2
	1100	2000	260	11	5-7	310	1-2
	1400	2200	250	10	5-7	300	1-3
	1700	2300	290	11	5-7	300	1-2
	2000	0500	320	6	5-7	30	0-1
10/25/2010	0041	941	291	5	5-7	35	0
	0335	1235	283	8	5-7	305	0
	0655	1553	307	9	5-7	305	1-2
	0930	1830	290	6	5-7	300	1-2
	1100	2000	270	6	5-7	310	1-2
	1400	2200	280	10	6-8	285	2-3
	1700	0200	280	11	5-7	300	2-3
	2000	0500	120	11	7-9	310	1-2
10/26/2010	0324	1124	168	12	7-9	310	1-2
	0635	1435	185	8	7-9	310	1-2
	0800	1600	170	9	6-8	310	1-2
	1100	1900	180	20	6-8	320	1-3
	1400	2200	210	14	7-9	330	2-3
	1700	0100	190	17	5-8	345	2-3
	2000	0400	190	24	6-8	340	2-3
	2300	0700	190	24	6-8	340	3-4
10/27/2010	0100	9000	200	25	10	330	0
	0330	1130	201	27	10	330	0
	0755	1555	271	16	5-8	200	3-4
	1100	1900	250	13	5-7	200	3-4
	1400	2200	230	14	5-7	200	2-4
	1700	0100	280	14	5-7	210	2-4
	2000	0400	260	13	5-7	210	2-4
	2300	0700	240	9	5-7	210	2-4
10/28/2010	0400	1100	211	15	5-7	210	2-4
	0647	1347	195	12	5-7	210	2-4
	1000	1700	210	13	4-6	290	2-3
	1300	2000	190	14	4-6	300	2-3
	1600	2300	210	13	4-6	290	2-3
	1900	0200	190	9	4-6	290	2-3
	2200	0500	160	7	4-6	290	2-3
10/29/2010	0315	1115	181	2	4-6	290	2-3
	0650	1350	127	20	4-6	290	2-3

Appendix C: List of acronyms

POP – persisting organic pollutants

BIST – Built In System Test
CDR - Commander
CO – Commanding Officer
CPR – Continuous Plankton Recorder
CTD – conductivity temperature and depth (equipment)
CW – continuous wave
dB – decibels
DDT - dichlorodiphenyltrichloroethane
DGPS –Differential Global Positioning System
EEB – Electronics Engineering Branch
EEZ –Exclusive Economic Zone
ERT – Earth Resources Technology, Inc.
ET – Electronics Technician
EX – NOAA Ship *Okeanos Explorer*
FM – frequency modulation
FOO – Field Operations Officer
GMT – Greenwich Mean Time
Km – kilometers
KM – Kongsberg Maritime AS
Kt(s) – knots
LT – lieutenant
MB / MBES – multibeam
ms – millisecond
NGDC – National Geophysical Data Center
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
OAR – NOAA Office of Oceanic and Atmospheric Research
OARS – Offshore Analysis and Research Solutions
OER – NOAA Office of Ocean Exploration and Research
OMAO – NOAA Office of Marine and Aviation Operations
PCB - Polychlorinated Biphenyls
SIS – Seafloor Information System – Kongsberg proprietary software
SST – Senior Survey Technician
TRU – transmit and receive unit
UNH-CCOM/JHC – University of New Hampshire Center for Coastal and Ocean Mapping / Joint Hydrographic Center
UPS – uninterruptable power supply
XBT – expendable bathythermograph
XO – Executive Officer
WD – water depth

Appendix D: EM302 description and operational specs

EM 302 : Ideal for Ocean Exploration

There are several features of the Okeanos Explorer's 30 kHz multibeam that make it an excellent tool for ocean exploration. The following is a brief description of these features.

Depth Range

The system is designed to map the seafloor in water depths of 10 to 7000 meters. This leaves only the deepest parts of the deeper ocean trenches out of the EM 302's reach. Moreover, operational experience on the *Okeanos Explorer* has shown consistent EM 302 bottom detection at depth ranges in excess of 8000m.

High Density Data

In multibeam data, the denser the data, the finer resolution maps you can produce. The system can operate in dual swath, or multiping mode, which results in increased along track data density. This is achieved by detecting two swaths per ping cycle, resulting in up to 864 beams per ping.

The Okeanos Explorer mapping team typically operates the multibeam in high density equidistant ping mode, which results in up to 864 soundings on the seafloor per ping.

Full Suite of Data Types Collected

The system collects seafloor backscatter data, which provides information about the character of the seafloor in terms of bottom type.

The system also collects water column backscatter data, which has the ability to detect gaseous plumes in the water column. The full value of this feature is still being realized.

FM chirp mode is utilized in water depths greater than 1000 meters, and allows for the detection of the bottom further out from nadir than with previous 30 kHz systems.

Multibeam Primer

The area of the seafloor covered, or ensonified, by a single beam within a pulse of sound, or ping, is called the beam footprint. This beam footprint is defined in terms of the across track and along track values. Both of these values are dependent on water depth and the beam width at which the sound pulse is transmitted and received. The across track beam width value is also dependent on the receive angle, or "listening" angle, of the system, and the angle from nadir which it is received from. The receive angle for the receive transducer on the Okeanos Explorer EM302 is 1°, which is the smallest possible angle currently available for the EM302 system. The further out from nadir a sounding occurs, the larger the footprint will be. For example, as seen in Table 1 below, in 2000 meters of water, a beam footprint will have a radius of 18 meters at nadir but 25 meters by the time it hits the seafloor at an angle 140 degrees out from nadir.

Calculated acrosstrack acoustic beam footprint for EM 302 (high density ping mode, 432 soundings/profile)				
Water depth (m)	**Angle from nadir**			
50	1 deg RX center	90 deg	120 deg	140 deg
100	1	0.5	1	1
200	2	1	2	3
400	4	2	3	5
1000	7	4	6	10

2000	18	9	16	25
4000	35	19	32	-
6000	70	37	-	-
7000	105	56	-	-

Table 4. Calculated across track EM 302 beam footprint. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 17.

Calculated acrosstrack sounding density for EM 302 (high density ping mode, 432 soundings/profile)			
Water depth (m)	**Swath Width**		
50	90 deg	120 deg	140 deg
100	0.2	0.4	0.9
200	0.5	0.8	1.7
400	0.9	1.6	3.5
1000	1.9	3.2	6.9
2000	4.6	8.1	17.4
4000	9.3	16.2	-

Table 5. Calculated across track EM 302 sounding density. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 17.

Acrosstrack sounding density describes the spacing between individual soundings on the seafloor in the acrosstrack direction. The maximum swath of the EM 302 is 150 degrees. At this swath, the sounding density will be the least dense, since the beams will be spread out over a larger horizontal distance over the seafloor. As the swath angle (width) is decreased, the sounding density will increase, as the same number of beams are now spread out over a smaller horizontal distance over the seafloor.

Calculated ping rate and alongtrack resolution for EM 302					
140 deg swath, one profile per ping					
			Alongtrack distance between profiles (m)		
Water depth (m)	**Swath Width (m)**	**Ping Rate (pings/second)**	**@4 kts**	**@8 kts**	**@12 kts**
50	275	3.2	0.7	1.2	1.9
100	550	1.8	1.1	2.2	3.3
200	1100	1	2.1	4.2	6.3
400	2200	0.5	4.1	8.2	12.2
1000	5500	0.2	10	20	30
2000	8000	0.1	15.2	30.5	45.7
4000	8000	0.06	19.2	38.5	57.7
6000	8000	0.04	24.5	49	73.4

Table 6. Calculated ping rate and along track EM 302 sounding density, one profile per ping. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 15.

Calculated ping rate and alongtrack resolution for EM 302					
140 deg swath, two profiles per ping					
Water depth (m)	Swath Width (m)	Ping Rate	Alongtrack distance between profiles (m)		
			@4 kts	@8 kts	@12 kts
50	275	3.2	0.3	0.6	0.9
100	550	1.8	0.6	1.1	1.7
200	1100	1	1.1	2.1	3.2
400	2200	0.5	2	4.1	6.1
1000	5500	0.2	5	10	15
2000	8000	0.1	7.6	15.2	22.8

Table 7. Calculated ping rate and along track EM 302 sounding density, two profiles per ping. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 15.

Reference: Kongsberg Product Description: EM 302 multibeam echosounder

Appendix E: EM302 PU Parameters in use during cruise

#// Database Parameters

#// Seafloor Information System
#// Kongsberg Maritime AS
#// Saved: 2010.10.20 12:21:10

#// Build info:
#* SIS: [Version: 3.6.4, Build: 174 , DBVersion 16.0 CD generated: Mon Mar 30 2009 14:00:00]
[Fox ver = 1.6.29]
[db ver = 16, proc = 16.0]
[OTL = 4.0.-95]
[ACE ver = 5.5]
[Coin ver = 2.4.4]
[Simage ver = 1.6.2a]
[Dime ver = DIME v0.9]
[STLPort ver = 513]
[FreeType ver = 2.1.9]
[TIFF ver = 3.8.2]
[GeoTIFF ver = 1230]
[GridEngine ver = 2.3.0]

#* Language [3] #// Current language, 1-Norwegian, 2-German,3-English, 4-Spanish

#* Type [302]
#* Serial no. [101]
#* Number of heads [2]

#* System descriptor [50331648] #// 03000000

#// **

#// Installation parameters

#{ Input Setup #// All Input setup parameters

#{ COM1 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [9600]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [1] [0]
#* GGK [1] [0]
#* GGA [1] [1]
#* GGA_RTK [1] [0]
#* SIMRAD90 [1] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [1] [1]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} COM1

#{ COM2 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [19200]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [1]

```
      #* GGK              [0] [0]
      #* GGA              [0] [0]
      #* GGA_RTK          [0] [0]
      #* SIMRAD90         [0] [0]
    #} Position

    #{ Input Formats #// Format input settings.
      #* Attitude          [1] [1]
      #* MK39 Mod2 Attitude,  [0] [0]
      #* ZDA Clock         [0] [0]
      #* HDT Heading       [0] [0]
      #* SKR82 Heading     [0] [0]
      #* DBS Depth         [0] [0]
      #* DBT Depth         [0] [0]
      #* EA500 Depth       [0] [0]
      #* ROV. depth        [0] [0]
      #* Height, special purp [0] [0]
      #* Ethernet AttVel   [0] [0]
    #} Input Formats

  #} COM2

  #{ COM3 #// Link settings.

    #{ Com. settings #// Serial line parameter settings.
      #* Baud rate:        [4800]
      #* Data bits         [8]
      #* Stop bits:        [1]
      #* Parity:           [NONE]
    #} Com. settings

    #{ Position #// Position input settings.
      #* None             [1] [1]
      #* GGK              [1] [0]
      #* GGA              [1] [0]
      #* GGA_RTK          [1] [0]
      #* SIMRAD90         [1] [0]
    #} Position

    #{ Input Formats #// Format input settings.
      #* Attitude          [0] [0]
      #* MK39 Mod2 Attitude,  [0] [0]
      #* ZDA Clock         [0] [0]
      #* HDT Heading       [1] [1]
      #* SKR82 Heading     [0] [0]
      #* DBS Depth         [1] [0]
      #* DBT Depth         [1] [0]
      #* EA500 Depth       [0] [0]
      #* ROV. depth        [1] [0]
      #* Height, special purp [1] [0]
      #* Ethernet AttVel   [0] [0]
    #} Input Formats

  #} COM3

  #{ COM4 #// Link settings.

    #{ Com. settings #// Serial line parameter settings.
      #* Baud rate:        [9600]
      #* Data bits         [8]
      #* Stop bits:        [1]
      #* Parity:           [NONE]
    #} Com. settings

    #{ Position #// Position input settings.
      #* None             [1] [1]
      #* GGK              [1] [0]
      #* GGA              [1] [0]
      #* GGA_RTK          [1] [0]
      #* SIMRAD90         [1] [0]
    #} Position

    #{ Input Formats #// Format input settings.
      #* Attitude          [0] [0]
      #* MK39 Mod2 Attitude,  [0] [0]
      #* ZDA Clock         [0] [0]
      #* HDT Heading       [0] [0]
      #* SKR82 Heading     [0] [0]
      #* DBS Depth         [1] [0]
      #* DBT Depth         [1] [0]
      #* EA500 Depth       [0] [0]
      #* ROV. depth        [1] [0]
      #* Height, special purp [1] [0]
      #* Ethernet AttVel   [0] [0]
    #} Input Formats

  #} COM4

  #{ UDP2 #// Link settings.

    #{ Com. settings #// Serial line parameter settings.
      #// N/A
    #} Com. settings

    #{ Position #// Position input settings.
      #* None             [1] [1]
      #* GGK              [1] [0]
      #* GGA              [1] [0]
      #* GGA_RTK          [1] [0]
      #* SIMRAD90         [1] [0]
    #} Position

    #{ Input Formats #// Format input settings.
      #* Attitude          [0] [0]
      #* MK39 Mod2 Attitude,  [0] [0]
      #* ZDA Clock         [0] [0]
      #* HDT Heading       [0] [0]
      #* SKR82 Heading     [0] [0]
      #* DBS Depth         [0] [0]
      #* DBT Depth         [0] [0]
      #* EA500 Depth       [1] [0]
      #* ROV. depth        [0] [0]
      #* Height, special purp [0] [0]
      #* Ethernet AttVel   [0] [0]
    #} Input Formats

  #} UDP2

  #{ UDP3 #// Link settings.

    #{ Com. settings #// Serial line parameter settings.
      #// N/A
    #} Com. settings

    #{ Position #// Position input settings.
      #* None             [0] [1]
      #* GGK              [0] [0]
      #* GGA              [0] [0]
      #* GGA_RTK          [0] [0]
      #* SIMRAD90         [0] [0]
    #} Position

    #{ Input Formats #// Format input settings.
      #* Attitude          [0] [0]
      #* MK39 Mod2 Attitude,  [0] [0]
      #* ZDA Clock         [0] [0]
      #* HDT Heading       [1] [0]
      #* SKR82 Heading     [0] [0]
      #* DBS Depth         [1] [0]
      #* DBT Depth         [1] [0]
      #* EA500 Depth       [0] [0]
      #* ROV. depth        [1] [0]
      #* Height, special purp [1] [0]
      #* Ethernet AttVel   [0] [0]
    #} Input Formats

  #} UDP3

  #{ UDP4 #// Link settings.

    #{ Com. settings #// Serial line parameter settings.
      #// N/A
    #} Com. settings

    #{ Position #// Position input settings.
      #* None             [0] [1]
      #* GGK              [0] [0]
      #* GGA              [0] [0]
      #* GGA_RTK          [0] [0]
      #* SIMRAD90         [0] [0]
    #} Position

    #{ Input Formats #// Format input settings.
      #* Attitude          [1] [0]
      #* MK39 Mod2 Attitude,  [0] [0]
      #* ZDA Clock         [0] [0]
      #* HDT Heading       [1] [0]
      #* SKR82 Heading     [0] [0]
      #* DBS Depth         [1] [0]
      #* DBT Depth         [1] [0]
      #* EA500 Depth       [0] [0]
      #* ROV. depth        [1] [0]
      #* Height, special purp [1] [0]
      #* Ethernet AttVel   [0] [0]
    #} Input Formats

  #} UDP4

  #{ UDP5 #// Link settings.

    #{ Com. settings #// Serial line parameter settings.
```

#// N/A
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [0]
#* GGK [0] [0]
#* GGA [0] [0]
#* GGA_RTK [0] [0]
#* SIMRAD90 [0] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [0] [0]
#* DBT Depth [0] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [0] [0]
#* Height, special purp [0] [0]
#* Ethernet AttVel [1] [1]
#} Input Formats

#{ Attitude Velocity settings #// Only relevant for UDP5 on EM122, EM302 and EM710, currently
#* Attitude 1 [1] [1]
#* Attitude 2 [1] [0]
#* Use Ethernet 2 [1] [1]
#* Port: [5602]
#* IP addr.: [192.168.2.20]
#* Net mask: [255.255.255.0]
#} Attitude Velocity settings

#} UDP5

#{ Misc. #// Misc. input settings.
#* External Trigger [1] [0]
#} Misc.

#} Input Setup

#{ Output Setup #// All Output setup parameters

#* PU broadcast enable [1] [1]
#* Log watercolumn to s [1] [1]

#{ Host UDP1 #// Host UDP1 Port: 16100

#{ Datagram subscription #//
#* Depth [0] [0]
#* Raw range and beam a [0] [0]
#* Seabed Image [0] [0]
#* Central Beams [0] [0]
#* Position [0] [0]
#* Attitude [0] [0]
#* Heading [0] [0]
#* Height [0] [0]
#* Clock [0] [0]
#* Single beam echosoun [0] [0]
#* Sound Speed Profile [0] [1]
#* Runtime Parameters [0] [1]
#* Installation Paramet [0] [1]
#* BIST Reply [0] [1]
#* Status parameters [0] [1]
#* PU Broadcast [0] [0]
#* Stave Display [0] [0]
#* Water Column [0] [0]
#* Internal, Range Data [0] [0]
#* Internal, Scope Data [0] [0]
#} Datagram subscription

#} Host UDP1

#{ Host UDP2 #// Host UDP2 Port: 16101

#{ Datagram subscription #//
#* Depth [1] [1]
#* Raw range and beam a [1] [1]
#* Seabed Image [1] [1]
#* Central Beams [1] [0]
#* Position [1] [1]
#* Attitude [1] [1]
#* Heading [1] [1]
#* Height [1] [1]
#* Clock [1] [1]
#* Single beam echosoun [1] [1]
#* Sound Speed Profile [0] [1]
#* Runtime Parameters [0] [1]
#* Installation Paramet [0] [1]
#* BIST Reply [1] [1]
#* Status parameters [0] [1]
#* PU Broadcast [1] [0]
#* Stave Display [0] [1]
#* Water Column [0] [1]
#* Internal, Range Data [1] [0]
#* Internal, Scope Data [1] [0]
#} Datagram subscription

#} Host UDP2

#{ Host UDP3 #// Host UDP3 Port: 16102

#{ Datagram subscription #//
#* Depth [0] [1]
#* Raw range and beam a [0] [0]
#* Seabed Image [0] [0]
#* Central Beams [0] [0]
#* Position [0] [0]
#* Attitude [0] [1]
#* Heading [0] [0]
#* Height [0] [1]
#* Clock [0] [0]
#* Single beam echosoun [0] [1]
#* Sound Speed Profile [0] [1]
#* Runtime Parameters [0] [0]
#* Installation Paramet [0] [1]
#* BIST Reply [0] [0]
#* Status parameters [0] [0]
#* PU Broadcast [0] [0]
#* Stave Display [0] [0]
#* Water Column [0] [0]
#* Internal, Range Data [0] [0]
#* Internal, Scope Data [0] [1]
#} Datagram subscription

#} Host UDP3

#{ Host UDP4 #// Host UDP4 Port 16103

#{ Datagram subscription #//
#* Depth [1] [1]
#* Raw range and beam a [1] [0]
#* Seabed Image [1] [0]
#* Central Beams [1] [0]
#* Position [1] [0]
#* Attitude [1] [0]
#* Heading [1] [0]
#* Height [1] [0]
#* Clock [1] [0]
#* Single beam echosoun [1] [0]
#* Sound Speed Profile [1] [0]
#* Runtime Parameters [1] [0]
#* Installation Paramet [1] [0]
#* BIST Reply [1] [0]
#* Status parameters [1] [0]
#* PU Broadcast [1] [0]
#* Stave Display [1] [0]
#* Water Column [1] [0]
#* Internal, Range Data [1] [0]
#* Internal, Scope Data [1] [0]
#} Datagram subscription

#} Host UDP4

#{ Watercolumn #// Host UDP4 Port 16103

#{ Datagram subscription #//
#* Depth [1] [1]
#* Raw range and beam a [1] [1]
#* Seabed Image [1] [1]
#* Central Beams [1] [0]
#* Position [1] [1]
#* Attitude [1] [1]
#* Heading [1] [1]
#* Height [1] [1]
#* Clock [1] [1]
#* Single beam echosoun [1] [1]
#* Sound Speed Profile [1] [1]
#* Runtime Parameters [1] [1]
#* Installation Paramet [1] [1]
#* BIST Reply [1] [1]
#* Status parameters [1] [1]
#* PU Broadcast [1] [0]
#* Stave Display [1] [0]
#* Water Column [1] [1]
#* Internal, Range Data [1] [0]
#* Internal, Scope Data [1] [0]
#} Datagram subscription

#} Watercolumn

#} Output Setup

#{ Clock Setup #// All Clock setup parameters

#{ Clock #// All clock settings.
#* Source: [1] #// External ZDA Clock
#* 1PPS Clock Synch. [1] [1]
#* Offset (sec.): [0]
#} Clock

#} Clock Setup

#{ Settings #// Sensor setup parameters

#{ Positioning System Settings #// Position related settings.

#{ COM1 #// Positioning System Ports:
#* P1T [0] #// System
#* P1M [0] #// Enable position motion correction
#* P1D [0.000] #// Position delay (sec.):
#* P1G [WGS84] #// Datum:
#* P1Q [1] #// Enable
#* Pos. qual. indicator [] #//
#} COM1

#} Positioning System Settings

#{ Motion Sensor Settings #// Motion related settings.

#{ COM2 #// Motion Sensor Ports:
#* MRP [RP] #// Rotation (POSMV/MRU)
#* MSD [0] #// Motion Delay (msec.):
#* MAS [1.00] #// Motion Sensor Roll Scaling:
#} COM2

#} Motion Sensor Settings

#{ Active Sensors #//
#* APS [0] [COM1] #// Position:
#* ARO [2] [COM2] #// Motion:
#* AHE [2] [COM2] #// Motion:
#* AHS [3] [COM3] #// Heading:
#} Active Sensors

#} Settings

#{ Locations #// All location parameters

#{ Location offset (m) #//

#{ Pos, COM1: #//
#* P1X [0.00] #// Forward (X)
#* P1Y [0.00] #// Starboard (Y)
#* P1Z [0.00] #// Downward (Z)
#} Pos, COM1:

#{ Pos, COM3: #//
#* P2X [0.00] #// Forward (X)
#* P2Y [0.00] #// Starboard (Y)
#* P2Z [0.00] #// Downward (Z)
#} Pos, COM3:

#{ Pos, COM4/UDP2: #//
#* P3X [0.00] #// Forward (X)
#* P3Y [0.00] #// Starboard (Y)
#* P3Z [0.00] #// Downward (Z)
#} Pos, COM4/UDP2:

#{ TX Transducer: #//
#* S1X [6.147] #// Forward (X)
#* S1Y [1.822] #// Starboard (Y)
#* S1Z [6.796] #// Downward (Z)
#} TX Transducer:

#{ RX Transducer: #//
#* S2X [2.497] #// Forward (X)
#* S2Y [2.481] #// Starboard (Y)
#* S2Z [6.790] #// Downward (Z)
#} RX Transducer:

#{ Attitude 1, COM2: #//
#* MSX [0.00] #// Forward (X)
#* MSY [0.00] #// Starboard (Y)
#* MSZ [0.00] #// Downward (Z)
#} Attitude 1, COM2:

#{ Attitude 2, COM3: #//
#* NSX [0.00] #// Forward (X)
#* NSY [0.00] #// Starboard (Y)
#* NSZ [0.00] #// Downward (Z)
#} Attitude 2, COM3:

#{ Waterline: #//
#* WLZ [1.838] #// Downward (Z)
#} Waterline:

#} Location offset (m)

#} Locations

#{ Angular Offsets #// All angular offset parameters

#{ Offset angles (deg.) #//

#{ TX Transducer: #//
#* S1R [0.00] #// Roll
#* S1P [0.00] #// Pitch
#* S1H [359.98] #// Heading
#} TX Transducer:

#{ RX Transducer: #//
#* S2R [0.00] #// Roll
#* S2P [0.00] #// Pitch
#* S2H [0.03] #// Heading
#} RX Transducer:

#{ Attitude 1, COM2: #//
#* MSR [0.00] #// Roll
#* MSP [-0.80] #// Pitch
#* MSG [0.00] #// Heading
#} Attitude 1, COM2:

#{ Attitude 2, COM3: #//
#* NSR [0.00] #// Roll
#* NSP [0.00] #// Pitch
#* NSG [0.00] #// Heading
#} Attitude 2, COM3:

#{ Stand-alone Heading: #//
#* GCG [0.00] #// Heading
#} Stand-alone Heading:

#} Offset angles (deg.)

#} Angular Offsets

#{ ROV. Specific #// All ROV specific parameters

#{ Depth/Pressure Sensor #//
#* DSF [1.00] #// Scaling:
#* DSO [0.00] #// Offset:
#* DSD [0.00] #// Delay:
#* DSH [NI] #// Disable Heave Sensor
#} Depth/Pressure Sensor

#} ROV. Specific

#{ System Parameters #// All system parameters

#{ System Gain Offset #//
#* GO1 [0.0] #// BS Offset (dB)
#} System Gain Offset

#{ Opening angles #//
#* S1S [0] #// TX Opening angle:
#* S2S [1] #// RX Opening angle:
#} Opening angles

#} System Parameters

#// ***
#// Runtime parameters

#{ Sounder Main #//

#{ Sector Coverage #//

#{ Max. angle (deg.): #//
#* MPA [30] #// Port
#* MSA [30] #// Starboard
#} Max. angle (deg.):

#{ Max. Coverage (m): #//
#* MPC [5000] #// Port
#* MSC [5000] #// Starboard
#} Max. Coverage (m):

#* ACM [1] #// Angular Coverage mode: AUTO
#* BSP [2] #// Beam Spacing: HIDENS EQDIST

#} Sector Coverage

#{ Depth Settings #//
#* FDE [5200] #// Force Depth (m)
#* MID [4400] #// Min. Depth (m):
#* MAD [5400] #// Max. Depth (m):
#* DSM [0] #// Dual swath mode: OFF
#* PMO [6] #// Ping Mode: EXTRA DEEP
#* FME [1] #// FM enable
#} Depth Settings

#{ Stabilization #//
#* YPS [1] #// Pitch stabilization
#* TXA [1] #// Along Direction (deg.):

#{ Yaw Stabilization #//
#* YSM [2] #// Mode: REL. MEAN HEADING
#* YMA [300] #// Heading:
#* HFI [1] #// Heading filter: MEDIUM
#} Yaw Stabilization

#} Stabilization
#} Sounder Main

#{ Sound Speed #//

#{ Sound Speed at Transducer #//
#* SHS [0] #// Source SENSOR
#* SST [15000] #// Sound Speed (dm/sec.):
#* Sensor Offset (m/sec [0] #//
#* Filter (sec.): [5] #//
#} Sound Speed at Transducer

#} Sound Speed

#{ Filter and Gains #//

#{ Filtering #//
#* SFS [2] #// Spike Filter Strength: MEDIUM
#* PEF [0] #// Penetration Filter Strength: OFF
#* RGS [1] #// Range Gate: NORMAL
#* SLF [1] #// Slope
#* AEF [1] #// Aeration
#* STF [1] #// Sector Tracking
#* IFF [1] #// Interference
#} Filtering

#{ Absorption Coefficient #//
#* ABC [5.858] #// 31.5 kHz
#} Absorption Coefficient

#{ Normal incidence sector #//
#* TCA [6] #// Angle from nadir (deg.):
#} Normal incidence sector

#{ Mammal protection #//
#* TXP [0] #// TX power level (dB): Max.
#* SSR [0] #// Soft startup ramp time (min.):
#} Mammal protection
#} Filter and Gains

#{ Data Cleaning #//
#* Active rule: [STANDARD] #//
#{ STANDARD #//
#* PingProc.maxPingCountRadius [10]
#* PingProc.radiusFactor [0.050000]
#* PingProc.medianFactor [1.500000]
#* PingProc.beamNumberRadius [3]
#* PingProc.sufficientPointCount [40]
#* PingProc.neighborhoodType [Elliptical]
#* PingProc.timeRule.use [false]
#* PingProc.overhangRule.use [false]
#* PingProc.medianRule.use [false]
#* PingProc.medianRule.depthFactor [0.050000]
#* PingProc.medianRule.minPointCount [6]
#* PingProc.quantileRule.use [false]
#* PingProc.quantileRule.quantile [0.100000]
#* PingProc.quantileRule.scaleFactor [6.000000]
#* PingProc.quantileRule.minPointCount [40]
#* GridProc.minPoints [8]
#* GridProc.depthFactor [0.200000]
#* GridProc.removeTooFewPoints [false]
#* GridProc.surfaceFitting.surfaceDegree [1]
#* GridProc.surfaceFitting.tukeyConstant [6.000000]
#* GridProc.surfaceFitting.maxIteration [10]
#* GridProc.surfaceFitting.convCriterion [0.010000]
#* GridProc.surfaceDistanceDepthRule.use [false]
#* GridProc.surfaceDistanceDepthRule.depthFactor [0.050000]
#* GridProc.surfaceDistancePointRule.use [false]
#* GridProc.surfaceDistancePointRule.scaleFactor [1.000000]
#* GridProc.surfaceDistanceUnitRule.use [false]
#* GridProc.surfaceDistanceUnitRule.scaleFactor [1.000000]
#* GridProc.surfaceDistanceStDevRule.use [false]
#* GridProc.surfaceDistanceStDevRule.scaleFactor [2.000000]

#* GridProc.surfaceAngleRule.use [false]
#* GridProc.surfaceAngleRule.minAngle [20.000000]
#* SonarProc.use [false]
#* SonarProc.gridSizeFactor [4]
#* SonarProc.mergerType [Average]
#* SonarProc.interpolatorType [TopHat]
#* SonarProc.interpolatorRadius [1]
#* SonarProc.fillInOnly [true]
#} STANDARD
#{ Seabed Image Processing #//
#* Seabed Image Process [1] [0]
#} Seabed Image Processing
#} Data Cleaning

#{ Advanced param. #//
#} Advanced param.

Appendix F: Software versions in use during cruise

Software	Version	Purpose
CARIS HIPS and SIPS	6.1 Service Pack 2	Multibeam processing
ECDIS		Ship line keeping
Fledermaus	6.7.0h Build 419 Professional	Multibeam QC
Fledermaus	7.2 Professional	Multibeam QC
Hypack	9.0.0.22	Survey planning
Hypack	9.0.4.0	Realtime monitoring
Kongsberg SIS (through 2/11/10)	3.6.1	EM302 data acquisition
Kongsberg SIS (installed 2/12/10)	3.6.4 build 174	EM302 data acquisition
Velocipy (NOAA)	10.7 (r2982)	XBT processing