NOAA *Okeanos Explorer* Program

MAPPING REPORT

CRUISE EX1103 Leg 2

Galapagos Rift Expedition, 2011 (GALREX, 2011)

July 7, 2011 to July 28, 2011

Puntarenas, Costa Rica To Balboa, Panama

Report Contributors:
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July 29, 2011

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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 unique combination of scientific and technological tools positions it to systematically explore new areas of our largely unknown ocean. These explorations will generate scientific questions leading to further scientific inquiries.

Using a high-definition multibeam sonar with water column capabilities, a deep water remotely operated vehicle, and telepresence technology, *Okeanos Explorer* provides NOAA the ability to foster scientific developments by identifying new targets in real time, diving on those targets shortly after initial detection, then sending this information back k 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 better understanding.

Through the *Okeanos Explorer* Program, NOAA's Office of Ocean Exploration and Research provides the nation with important capabilities to discover and investigate new ocean areas 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

NOAA Ship *Okeanos Explorer* 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. NOAA's Office of Ocean Exploration and Research is responsible for operating the cutting-edge ocean exploration systems on the vessel. It is the only federal ship dedicated to systematic 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 data acquisition and processing of EM 302 multibeam sonar system during EX1103 Leg 2 cruise (July 7-July 28, 2011). For details about setup of the various mapping equipment / sensors please refer to 'NOAA Ship *Okeanos Explorer* Mapping Readiness Report 2011' which can be obtained from the ship. Also, please note that this report covers only the EM 302 multibeam mapping activities conducted during this cruise. Considerable other activities including Conductivity Temperature Depth (CTD) measurements, Remotely Operated Vehicle (ROV) dives, as well as education and outreach activities were conducted which may be referred to in this report but details will not be provided here.

Crew of the NOAA Ship *Okeanos Explorer* is greatly appreciated for their efforts in helping make the cruise a success.

3. Cruise Objectives

Leg 1: Mapping and CTD (June 8 – July 2, 2011)

The GALREX 2011 expedition consisted of two legs. Leg 1primarily focused on conducting mapping operations on Galapagos Rift along with collecting Light Scattering Sensor (LSS) and Oxygen Reduction Potential (ORP) measurements using the onboard CTD (Conductivity, Temperature, Depth) package. The CTD package was towed using Ship's A-Frame and data were collected with CTD sampling a depth range of 50 – 300 m above the seafloor. With this configuration of 'Tow-Yo', several anomalies in LSS and ORP signals were detected, that were expected to provide precise locations of the ongoing venting along the main axis of Galapagos Rift.

Leg 2: ROV, Mapping and CTD (July 07 – 28, 2011)

Primary objectives for the Leg 2 included utilization of the full suite of *Okeanos Explorer* capabilities (i.e., ROV, mapping, CTD, and telepresence). Daytime operations largely focused on ROV dives to explore targets identified using bathymetry and CTD data collected during Leg 1. Night time operations consisted of CTD operations and multibeam data collection.

Remote Science: A new paradigm

Equipped with a high speed internet connection, NOAA Ship *Okeanos Explorer* is capable of streaming live video and data to shore. This capability, along with shore based Exploration Command Centers (ECCs) where scientists can talk directly with ship-board personnel, enables this exploration vessel to bring shore based expertise live to the ship to guide the ship to focus her efforts on areas and targets identified by the shore based scientists. This was the first cruise during 2011 where, through telepresence, onboard scientists collaborated with shore based scientists at participating ECCs established at various science centers on the US mainland. This participation occurred in real time, enhancing the *Okeanos Explorer* multibeam mapping and ROV operations.

Dr. Tim Shank of Woods Hole Oceanographic Institution (WHOI) participated in this cruise as senior scientist onboard. Several scientists based in Seattle, WA, Newport, OR and Woods Hole, MA ECCs participated remotely through telepresence. As such, scientists onboard and ashore worked closely together via satellite intercom utilizing data and information that were made available to shore via satellite high speed internet. A host of collaboration tools were implemented during this cruise, including dedicated FTP servers, live broadcast of ROV video and data acquisition computer monitors. Daily data products provided to shore based scientists included: geotiff images, Fledermaus IVS SD objects, ASCII gridded text files, ship and ROV tracklines, and Google Earth KMZ's for bathymetry and backscatter. These data products were provided to the ECC's through the dedicated ftp site to keep ECC's up to date with EM302 mapping results.

4. Ship board participating personnel (Mapping related activities only)

Robert Kamphaus, CDR	Commanding Officer
Jeremy Potter	Expedition coordinator
Tim Shank (WHOI)	Senior Scientist onboard the ship
Megan Nadeau	Field Operations Officer
Miguel Calderon (INOCAR)	Ecuador onboard observer
Mashkoor Malik	Mapping Lead
Elaine Stuart	Senior survey technician
Colleen Peters	Senior survey technician
Christopher Pinero (OER/UCAR)	Mapping watch stander
Thomas Kok (OER/UCAR)	Mapping watch stander
Nicholas Kraus (OER/UCAR)	Mapping watch stander
Vincent Howard (OER/UCAR	Mapping watch stander
Karl McKletchie (OER/UCAR)	Mapping watch stander

5. Mapping Sonar Setup

NOAA ship *Okeanos Explorer* (EX) is equipped with a 30 kHz Kongsberg EM 302 multibeam sonar, a 3.5 kHz Knudsen SBP 3260 sub-bottom profiler, and an 18 kHz Kongsberg EK 60 single-beam sonar. During this cruise EM 302 seabed bathymetry and backscatter data were collected. Additionally, EK 60 and EM 302 water column data were continuously monitored by mapping watch standers and the water column data were logged if anomalies of interest were observed in the water column data.

The ship used the onboard Applanix POS/MV (ver. 4) to record and correct multibeam data for any ship's motion before being logged by SIS software. The C-NAV GPS satellite service system provided DGPS correctors to the POS/MV with positional accuracy expected to be better than 2.0m.

All the corrections (motion, sound speed profile, sound speed at sonar head, draft, sensor offsets) were applied during real time data acquisition in Kongsberg data acquisition software Seafloor Information System (SIS) ver. 3.6.4 build 176. Sippican XBT casts (Deep Blue, max depth 760 m) were taken every 6 hours and more frequently if needed. XBT cast data were converted to SIS-compliant format using the NOAA in-house tool for XBT processing: Velocipy. Please consult Appendix A for details about parameters and settings used for EM 302 data acquisition.

Onboard processing of bathymetric data was performed using CARIS HIPS ver. 6.1. The data was cleaned using the CARIS 'Swath Editor' and 'Subset Editor' tools. A nominal grid cell size of 50 m was chosen for the bathymetric grids. Onboard processing of seabed and water column backscatter data was conducted using IVS Fledermaus ver. 7.3.

Daily mapping products made available to the shore scientists through the FTP server included bathymetry grids (in ASCII Latitude, Longitude and Depth), Fledermaus ver. 7 SD object, Geotiff image of gridded Bathymetric data, Geotiff image of gridded Backscatter data, Google Earth KMZ – Bathymetric, Google Earth KMZ – Backscatter, Bathymetric grid in ArcView Grid format and backscatter mosaic Latitude Longitude Backscatter in dB.

2011 Patch test results

Angular offsets (based on patch test conducted in May 2011) are tabulated as below. For complete processing unit setup (PU Setup) utilized for the cruise, please refer to Appendix A.

	Roll	Pitch	Heading
Tx Transducer	0.0	0.0	359.98
Rx Transducer	0.0	0.0	0.03
Attitude	0	-0.80	0.0

Table 2: Angular offsets for Transmit (TX) and Receive (RX) transducer as determined during a patch test conducted in May 2011.

6. Data Acquisition Summary

The primary purpose of the multibeam data during this expedition was to provide baseline maps for further exploration using CTD and ROV adding on to the coverage of the mapping data collected during EX1103 Leg 1. The cruise instructions (Ref 1) had to be modified during this cruise to adapt to the changes in operational priorities and loss of time at Puntarenas, Costa Rica due to trouble shooting VSAT failure. To maximize the use of all the resources available onboard, it was decided that the ship will conduct her mapping operations and CTD operations during the night time and ROV operations will be conducted during day time.

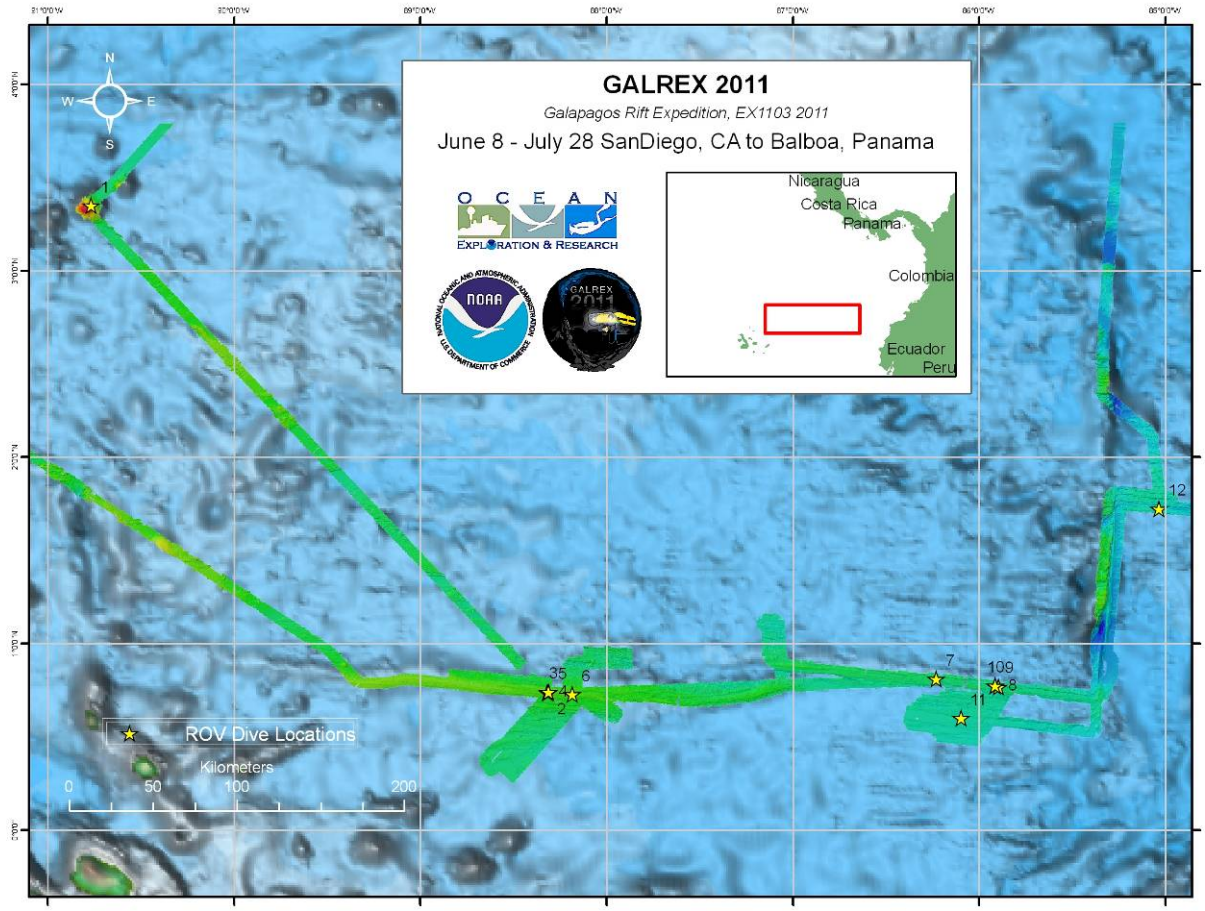


Figure 1: Overview of the multibeam bathymetric results during EX1103 expedition. ROV dive locations are also shown.

The mapping operations were limited only to the transits between the ROV dive locations and also during the night times adding coverage to the existing multibeam bathymetry in the area.

Important areas that were mapped included a portion of Paramount seamounts, eastern portion of Galapagos rift, Inca fracture zone and Ecuador fracture zone. Coverage was added to the south of Galapagos rift covering portions of known mounds field.

For major results of mapping operations, please see the comparatively detailed cruise report where mapping data are discussed along with results from CTD and ROV observations (cruise report in development at this time).

The overall operating box was the area approved by the Costa Rica, Ecuador and Panama EEZs. No data were acquired in the Colombia EEZ.

As the CTD data were primarily used to locate positions of the hydrothermal vents–Multibeam sonar and EK 60 water column data when available on these locations were analyzed further to infer if the plume structure is visible in the MB water column data. However, no water column targets were detected in locations of CTD casts. The locations of the CTD casts are provided in this report as Table 8c. For detailed reports about CTD casts and ROV dive sites, reader is requested to consult relevant data reports.

8. Data processing and statistics

Dates	07/07/11-07/28/11
Weather delays	0 days
Number of partial mapping days	12 days
Total transit mapping days	days
Line kilometers of survey	3908.6 km
Square kilometers mapped	26207 Sq km
Number of bathymetric multibeam files	111
Data volume of raw multibeam data files	17.46 GB
Number of water column multibeam files	1
Data volume of water column multibeam files	31 MB
Number of XBT casts	30
Number of CTD casts	8
Beginning draft	14 Ft 6 Inch
Ending draft	14 Ft 4 Inch
Number of ROV dives	12
Number of soundings accepted	64663178

EM 302 Multibeam sonar performed well throughout the cruise with no major problems.

The bathymetric data were processed in CARIS HIPS/SIPS ver. 6.2. The edited data were then brought into IVS Fledermaus and ESRI ARCMAP for visualization and rendering with existing data sets for day to day planning. Day to day observation of the mapping operations are outlined in the daily logs.

All the mapping data was submitted to National Coastal Data Development Center (NCDDC) for Preparing the data for submission to National Geophysical Data Center (NGDC) for archival. For details about the data archival process, please refer to cruise instructions [1]

11. Cruise Calandar

July 2011						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
			7 Sailing delayed due to ongoing VSAT repairs	8 Sailing delayed due to ongoing VSAT repairs	9 Sailing delayed due to ongoing VSAT repairs	10 Sailing delayed due to ongoing VSAT repairs
11 Left Puntarenas 1200, heading to Paramount seamount	12 In transit to Paramount Seamount	13 Arrived Paramount seamount 2110. Commenced mapping	14 Conducted Dive # 1 and commenced transit to Site location 2a	15 Conducted Dive # 2 at location 2a.	16 Conducted dive#3 at location 2a. CTD Tow yo operations conducted in the evening.	17 Conducted dive # 4 at location 2a. Conducted CTD tow-yo operations
18 Conducted dive # 5 at location 2a. Conducted CTD operations	19 Conducted dive #6 at location 2c. Transited over to location Rose Bud	20 Conducted dive # 7 at location Rose bud. EK 60 and EM 302 operations continued overnight	21 Conducted dive #8 at location 4a East. Conducted tow-yo and mapping operations overnight	22 Conducted dive #9 at location 4a West. Conducted tow-yo and mapping operations overnight	23 Conducted dive #10 at dive location 4a West. Conducted tow-yo and mapping operations overnight	24 Conducted dive #11 at dive location Off-Axis Mounts. Conducted mapping operations overnight
25 Conducted dive #12 at Ecuador Rift. Conducted mapping operations overnight	26 In transit to Panama. Conducted mapping operations	27 In transit to Panama. Conducted mapping operations until 2312. Multibeam secured.	28 Arrived Panama. 1200 secured all sensors.			

11. Daily Cruise Log

(ALL TIMES LOCAL – UTC -6 HRS)

July 7 -10, 2011

Ship delayed getting underway because of critical failure in the VSAT that shipboard ET's cannot fix. MTN reps flown in to Costa Rica to repair the system. Science and ROV personnel onboard and awaiting ship's departure once the VSAT is fixed.

July 11, 2011

0800 - Low speed internet back up and running, but high speed still down. The rest of the repairs can be monitored and done from shore by MTN. Left Puntarenas at 1200 and are heading toward the Paramount Seamount Chain for the first ROV dive – instructed not to turn on any sensors until we were 12 miles out of the area. 1558 started up the multibeam, conducted our first XBT, and began acquiring data with SCS. System having a little trouble keeping the bottom because of weather.

July 12, 2011

Continued mapping operations for the transit to the Paramount Seamounts. Weather continues to deteriorate – system having more trouble keeping the bottom consistently. Swells at 5-7ft with added wind waves at 4-6ft. 1230 ET's got permission to stop the ship so they can work on the VSAT high speed. The ship drifted until 1530 and was back on the transit track line and survey speed by 1602.

July 13, 2011

Continued mapping operations enroute to the Paramount dive site. System still having trouble keeping the bottom as ship is heading directly into the seas, causing bubble sweep down problems. The MK21 XBT software stopped updating position information to acquisition files for some unknown reason. Testing revealed that the position information coming into the computer is not the problem. CET Conway will contact Sippican for their input. Position information will be put in manually until the problem is fixed. The Paramount Seamount Chain consists of several individual seamounts observable in Sandwell and Smith. A line plan with ~ 1500 m line spacing was overlaid on one of the northern seamounts where it was planned for the ROV dive. Arrived at Paramount Seamount Chain and started mapping the ROV dive site around 2100.

July 14, 2011

0130 Conducted the first ROV dive. The Hypack machine was setup to broadcast the ship's position on the network where a script was used (written by Brian Bingham, ROV navigator) to continuously update a KML file. The screen grab below shows the real time ship's tracking in Google Earth.

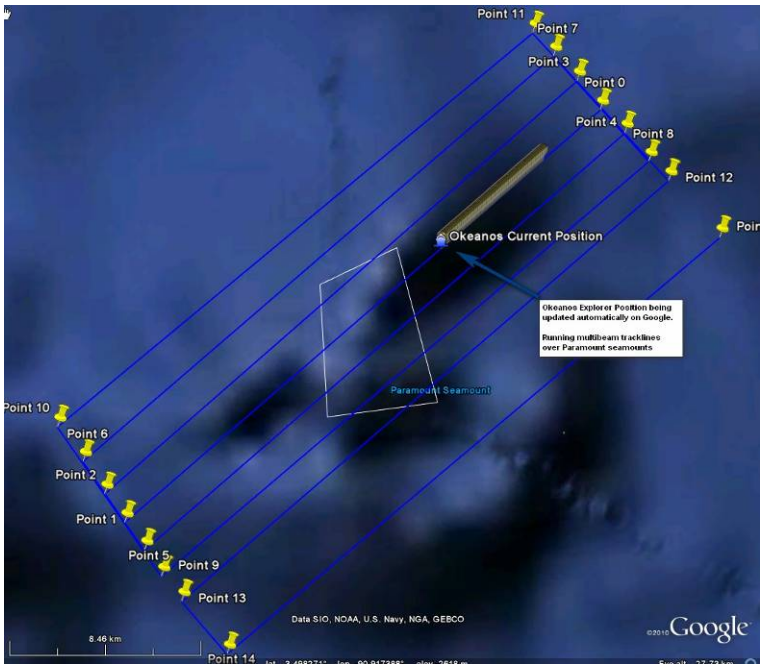
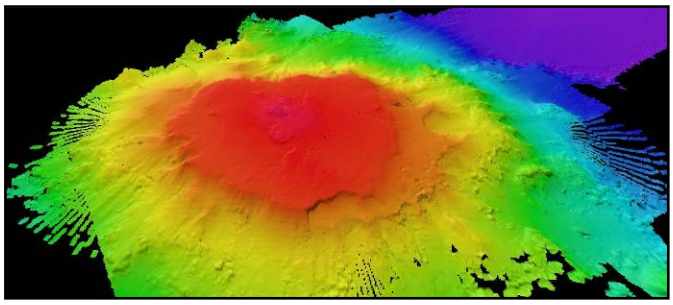


Figure 2: The line plan over the Paramount Seamount was brought into Google Earth. The white box shows the priority area to be mapped first. The real time ship track is also visible.



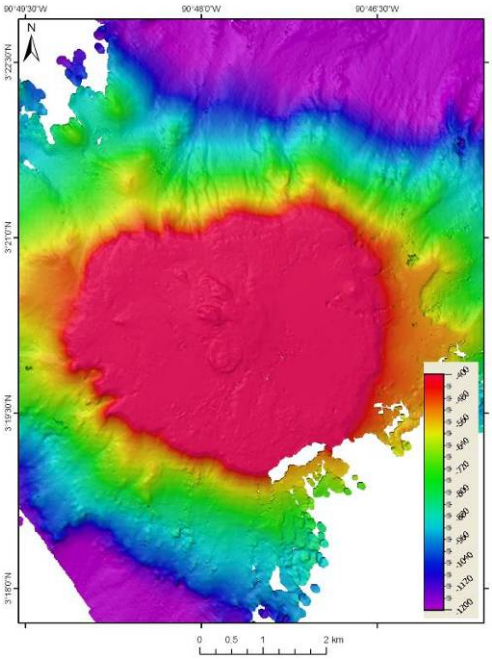


Figure 3: (Above and right) EM302 data 10m Caris grid over the top of the seamount. The feature rose up to ~ 200 m—three hundred meters more than what was shown on the Sandwell and Smith. Images compiled in Fledermaus 7.3 and ArcMap.

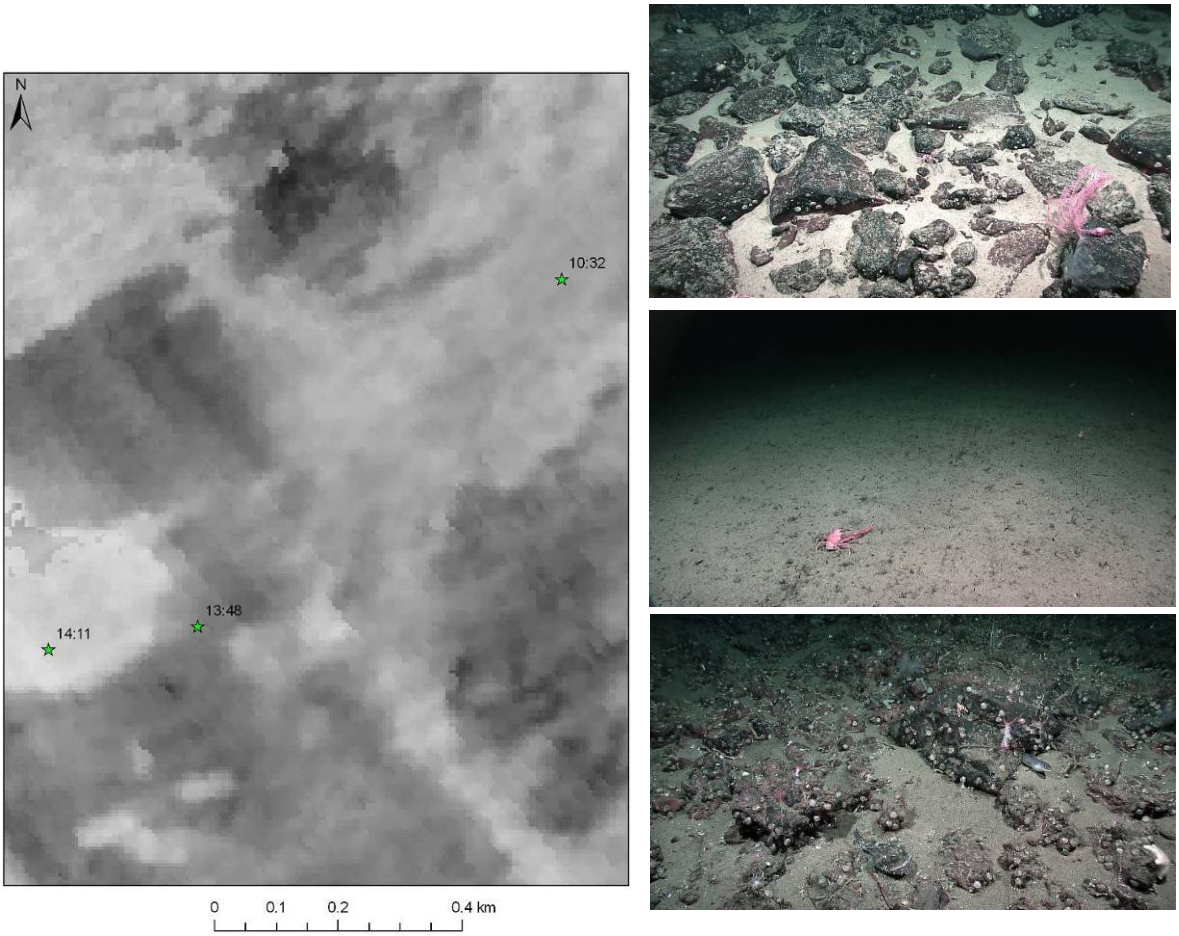


Figure 4: (left) Backscatter of the seamount where the three stars are representations of the three major bottom types seen (soft, hard, and in-between) along the ROV dive track. Each star corresponds to a time which is associated with a ROV image. 10:32 corresponds to the top image, 13:48 the middle, and 14:11 the bottom. The EM302 backscatter matches up well with what was recorded with the ROV and provided excellent ground truthing for the system. Backscatter image compiled in Fledermaus 7.3 and ArcMap.

July 15, 2011

0630 All operations were halted because fishing gear was found tangled in the ship's propellers and divers were put in the water to clear the fishing gear. All sonar systems were secured until the divers were done. 0930 mapping operations resumed until reaching ROV dive target #2 (site 2a) at 1053. EK60 operations conducted after the ROV dive. Observed interference between EK60 and EM302. Kongsberg was contacted about the interference. Gregg Jurgens (Kongbserg engineer) is recommending running a serial cable between terminal junction box (remote on and off) and EK60 processing computer to synchronize EK60 and EM302. CET Conway is working on the problem.

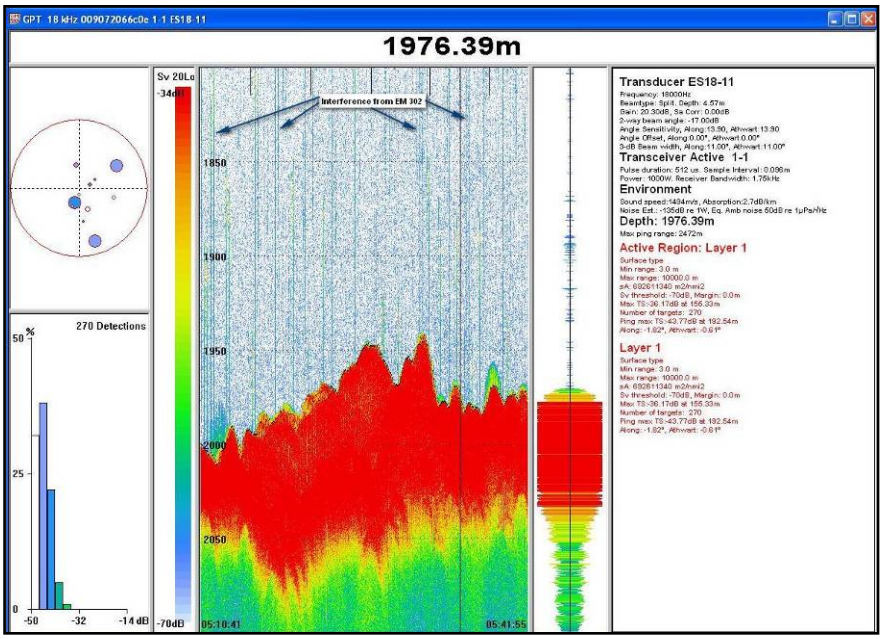


Figure 5: A screen grab of EK60 acquisition screen showing interference between EK60 and EM302. Although interference was observable in both EM302 and EK60, the bottom detections of both systems were not adversely affected by the interference besides more processing time of EM302 data.

July 16, 2011

ROV dive #3 was conducted at site 2a. CTD tow-yo operations commenced after the ROV dive with start and end points -88.3100 0.7370 and -88.2900 0.7360. ROV spare USBL transponder was put on the CTD for precise positioning. ORP failed at 1000 m. Testing and replacement of the ORP to be done the following day.

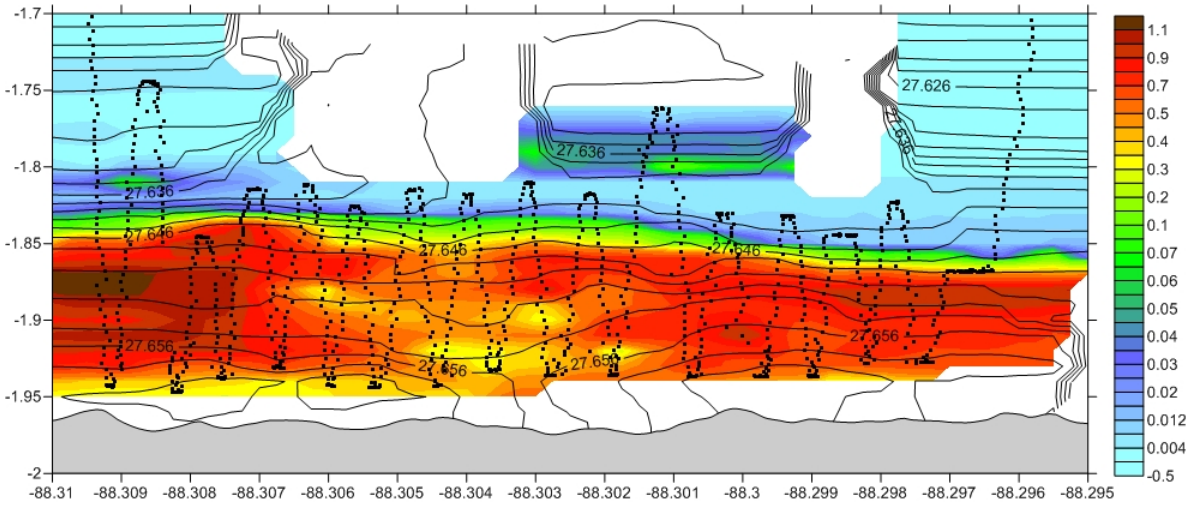


Figure 6: Image above provided by Sharon L Walker (NOAA PMEL) based on the data collected by the CTD LSS Sensors.

July 17, 2011

ROV dive # 4 was conducted on location 2a. ORP sensor was replaced with the spare ORP and cable which was tested and found to not work either. Both were then tested on another auxiliary port, replacing one of the two LSS's, and the sensor started giving correct readings. Concluded that 9 Plus had a bad auxiliary port—CET Conway looking into the problem. CTD tow-yo operations were conducted in the evening after the ROV dive was completed followed by mapping operations in area south east from the spreading center.

July 18, 2011

ROV dive #5 was conducted on location 2a. CTD tow-yo operations were conducted in the evening after the ROV dive was completed followed by mapping operations.

July 19, 2011

ROV dive # 6 conducted on location 2c. The ship in transit to site Rose Bud. Mapping operations were conducted.

July 20, 2011

ROV dive #7 conducted at location Rosebud. CTD tow-yo operations conducted in the evening after the ROV dive. Conducted EK60 operations after tow-yo was on deck from 2315 to 0100 to see if system could pick up vent sites. EM302 secured to ensure it was not interfering with EK60. Multibeam operations conducted after EK60 was secured.

July 21, 2011

ROV dive #8 conducted at location 4a East. Conducted tow-yo operations after ROV dive. Collected EK60 data after tow-yo until midnight. Found an interesting feature that looked like a promising vent target—will try and conduct EK60 lines perpendicular to target to confirm the following evening (see Figure). Conducted multibeam operations for the remainder of the night. Figure 7: Left – screen grab showing the possible vent seen in the EK60 data. Right – screen grab of EK60 data running perpendicular to line to the right showing that the possible vent turned out to be a feature on the seafloor.

July 22, 2011

ROV dive #9 conducted at location 4a West. Conducted tow-yo operations after dive, followed by EK60 lines run at 50m line spacing perpendicular to the previous line with possible vent target. No evidence of vent target in these lines—appears to be an actual feature of the ridge nearby (See Figure 7). No other possible vent sites were seen in the EK60 data throughout these tests. It is still unclear whether or not the EK60 can pick up vents in the water column since there has been no vents found with the ROV large enough to ground truth against EK 60 data. Secured EK60 at 0010 and conducted multibeam operations for the remainder of the night.

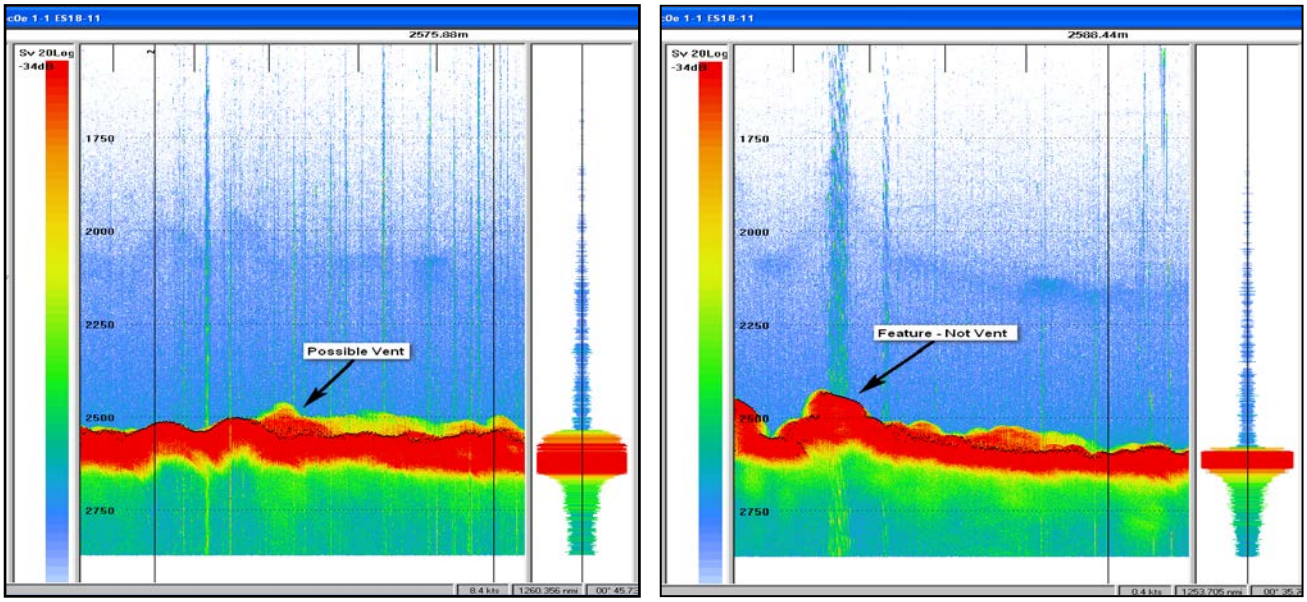


Figure 7: (Left) EK 60 data showing a possible water column target which appears to have structure of a vent. (Right) The same target as shown in left was mapped with a different survey direction and does not show any water column targets.

July 23, 2011

ROV dive #10 conducted at location 4a West. Conducted CTD tow operations 30m off the bottom for 1NM. Conducted multibeam operations for the remainder of the night.

July 24, 2011

ROV dive #11 conducted at the Off-Axis Mounts location. Brought ROV up early to begin transit to next ROV site. Ran Sub-bottom Profiler tests for one hour while leaving ROV site. Conducted mapping operations for the rest of the evening.

July 25, 2011

ROV dive #12 conducted at the Ecuador Rift, which is the final ROV dive of the cruise. Begin transit to Panama. Conducting small mapping survey for scientists on shore around the Ecuador Rift before resuming mapping transit line to Panama.

July 26, 2011

Continued transit to Panama. Collecting multibeam data and XBT's until the ship reaches Panama. Conducted weekly ship's drills from 1415 to 1530.

July 27, 2011

Continued mapping operations on the transit to Panama. 1600 Recorded some test data with the Knudsen Sub-bottom Profiler to see if the data could be processed. PS Malik will send .segY test data to UNH. Also found that synchronization between EM302 and Sub-bottom continues to

work when the External Trigger is checked on the Knudsen. Secured multibeam at 2312. Performed final BIST, everything green.

July 28, 2011

0725 Secured flow through sensors and TSG. 0800 The ship waits at anchor for Panama Customs Officials, a Pilot, and Panama Canal representatives to clear the ship for our stay in Panama and the transit through the Canal the following Tuesday. One copy of the data will be packaged up and put on a hard drive and taken back to Silver Springs, another will be taken to UNH at the end of EX1104, along with the data from that cruise.

12. References

1. Project Instructions, EX 11-03, NOAA Ship *Okeanos Explorer*, May 2011.

13. Appendices

Appendix A: Field products generated during cruise

Nil

Appendix B. Tables of data files collected

Table 1. XBT and CTD data collected during the cruise for the Multibeam Sound Speeed computation.

EX1103 Leg 2 SVP LOG				
DATE (GMT)	TIME (GMT)	XBT/CTD FILE NAME	LAT/LONG (WGS84)	NOTES
7/11/2011	22:01:32	EX1103L2_XBT01_071111	9 28.67175N/84 52.30371W	DeepBlue
7/12/2011	00:28:30	EX1103L2_XBT02_071211	9 10.6604N/85 9.86133W	DeepBlue
7/12/2011	06:55:48	EX1103L2_XBT03_071211	8 25.28619N/85 54.03516W	DeepBlue
7/12/2011	12:26:49	EX1103L2_XBT04_071211	7 46.55841N/86 31.65625W	DeepBlue
7/12/2011	18:32:44	EX1103L2_XBT05_071212	7 4.4668N/87 12.53125W	DeepBlue
7/13/2011	00:28:32	EX1103L2_XBT06_071311	6 43.52124N/87 33.0127W	DeepBlue
7/13/2011	06:26:54	EX1103L2_XBT07_071311	6 3.69983N/88 11.61816W	DeepBlue
7/13/2011	12:33:00	EX1103L2_XBT08_071311	5.315517N/ 88.916835W	DeepBlue
7/13/2011	18:40:50	EX1103L2_XBT09_071311	4 34.85565N/89 37.5791W	DeepBlue
7/14/2011	00:38:38	EX1103L2_XBT10_071411	4 34.90482N/89 37.53223W	DeepBlue
7/14/2011	17:32:20	EX1103L2_XBT11_071411	4 17.52300N/90 45.10500W	DeepBlue
7/15/2011	00:28:28	EX1103L2_XBT12_071412	2 26.48991N/89 56.52049W	DeepBlue
7/15/2011	06:21:56	EX1103L2_XBT13_071511	1 42.138N/89 14.190W	DeepBlue
7/15/2011	12:43:00	EX1103L2_XBT14_071511	0 54.06923N/88 28.42186W	DeepBlue
7/16/2011	02:41:31	EX1103L2_XBT15_071611	0 43.4292N/88 18.1854W	DeepBlue
7/16/2011	06:24:39	EX1103L2_XBT16_071611	0 45.4913N/88 32.8339W	DeepBlue

7/17/2011	02:38:01	EX1103L2_TOW01_110716	00 44.21 N/088 18.55 W	CTD
7/18/2011	00:08:13	EX1103L2_TOW02_110717	00 43.66 N/088 11.51 W	CTD
7/19/2011	00:35:17	EX1103L2_XBT17_071911	0 43.4292N/88 18.1854W	DeepBlue
7/20/2011	06:23:52	EX1103L2_XBT18_072011	0 45.92891N/87 15.047W	DeepBlue
7/21/2011	00:26:52	EX1103L2_TOW04_110720	00 47.36 N/086 05.76 W	CTD
7/22/2011	00:51:13	EX1103L2_TOW05_110721	00 46.19 N/085 53.48 W	CTD
7/25/2011	00:11:07	EX1103L2_XBT19_072511	0 34.4413N/85 50.2771W	DeepBlue
7/25/2011	06:24:49	EX1103L2_XBT20_072511	1 9.66603N/85 21.13477W	DeepBlue
7/26/2011	00:08:25	EX1103L2_XBT21_072611	01 43.1175N/84 52.2055W	DeepBlue
7/26/2011	06:28:08	EX1103L2_XBT22_072611	2 20.2893N/84 37.2055W	DeepBlue
7/26/2011	12:48:28	EX1103L2_XBT24_072611	3 24.9839N/84 45.0809W	DeepBlue
7/26/2011	18:21:03	EX1103L2_XBT25_072611	4 22.1845N/84 33.9378W	DeepBlue
7/27/2011	00:43:38	EX1103L2_XBT26_072711	5 15.0117N/84 0.1497W	DeepBlue
7/27/2011	11:33:26	EX1103L2_XBT28_072711	6 6.4451N/82 13.1913W	DeepBlue
7/27/2011	17:24:51	EX1103L2_XBT29_072711	6 31.909N/81 20.178W	DeepBlue
7/27/2011	23:37:54	EX1103L2_XBT30_072711	7 2.5232N/80 16.387W	DeepBlue

Table 2. Multibeam files collected during the cruise.

Survey Day	Date (GMT)	MB Line Filename	Location	SIS Survey Name
1	7/11/2011	0000_20110711_221435_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
2	7/12/2011	0001_20110712_004140_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
2	7/12/2011	0002_20110712_064134_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2

2	7/12/2011	0003_20110712_124137_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
2	7/12/2011	0004_20110712_184034_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
2	7/12/2011	0005_20110712_184420_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
2	7/12/2011	0006_20110712_194435_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
2	7/12/2011	0007_20110712_220250_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
3	7/13/2011	0008_20110713_003844_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
3	7/13/2011	0009_20110713_063850_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
3	7/13/2011	0010_20110713_123849_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
3	7/13/2011	0011_20110713_183844_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
3	7/13/2011	0012_20110713_214423_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0013_20110714_000347_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0014_20110714_031130_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0015_20110714_041334_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0016_20110714_041546_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0017_20110714_041854_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0018_20110714_042049_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0019_20110714_044548_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0020_20110714_050019_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0021_20110714_052758_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0022_20110714_053446_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0023_20110714_060621_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0024_20110714_061959_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0025_20110714_172634_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
4	7/14/2011	0026_20110714_232631_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
5	7/15/2011	0027_20110715_002207_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
5	7/15/2011	0028_20110715_062205_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
5	7/15/2011	0029_20110715_122204_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
5	7/15/2011	0030_20110715_153555_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
6	7/16/2011	0031_20110716_024652_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
6	7/16/2011	0032_20110716_034126_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
6	7/16/2011	0033_20110716_035250_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
6	7/16/2011	0034_20110716_083139_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
6	7/16/2011	0035_20110716_085331_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
6	7/16/2011	0036_20110716_124255_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
6	7/16/2011	0037_20110717_054930_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
7	7/17/2011	0038_20110717_055647_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
7	7/17/2011	0039_20110717_091008_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
7	7/17/2011	0040_20110717_094506_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
7	7/17/2011	0041_20110717_124655_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
8	7/18/2011	0042_20110718_035729_EX1103L2_MB.all	Ecuador EEZ	EX1103L2

8	7/18/2011	0043_20110718_073930_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
8	7/18/2011	0044_20110718_080223_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
8	7/18/2011	0045_20110718_114758_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
8	7/18/2011	0046_20110718_115349_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
8	7/18/2011	0047_20110718_125000_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
9	7/19/2011	0048_20110719_061753_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
9	7/19/2011	0049_20110719_071452_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
9	7/19/2011	0050_20110719_093100_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
9	7/19/2011	0051_20110719_095032_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
9	7/19/2011	0052_20110719_113030_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
9	7/19/2011	0053_20110719_113646_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
10	7/20/2011	0054_20110720_004719_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
10	7/20/2011	0055_20110720_064721_EX1103L2_MB.all	Ecuador EEZ	EX1103L2
10	7/20/2011	0056_20110720_231509_EX1103L2_MB.all	International Waters	EX1103L2
10	7/20/2011	0057_20110720_235040_EX1103L2_MB.all	International Waters	EX1103L2
11	7/21/2011	0058_20110721_040448_EX1103L2_MB.all	International Waters	EX1103L2
11	7/21/2011	0059_20110721_065704_EX1103L2_MB.all	International Waters	EX1103L2
11	7/21/2011	0060_20110721_080252_EX1103L2_MB.all	International Waters	EX1103L2
11	-	line 0061 does not exist	International Waters	-
11	7/21/2011	0062_20110721_080507_EX1103L2_MB.all	International Waters	EX1103L2
11	7/21/2011	0063_20110721_093750_EX1103L2_MB.all	International Waters	EX1103L2
11	7/21/2011	0064_20110721_100137_EX1103L2_MB.all	International Waters	EX1103L2
11	7/21/2011	0065_20110721_113445_EX1103L2_MB.all	International Waters	EX1103L2
11	7/21/2011	0066_20110721_114208_EX1103L2_MB.all	International Waters	EX1103L2
12	7/22/2011	0067_20110722_061155_EX1103L2_MB.all	International Waters	EX1103L2
12	7/22/2011	0068_20110722_071049_EX1103L2_MB.all	International Waters	EX1103L2
12	7/22/2011	0069_20110722_092654_EX1103L2_MB.all	International Waters	EX1103L2
12	7/22/2011	0070_20110722_093951_EX1103L2_MB.all	International Waters	EX1103L2
12	7/22/2011	0071_20110722_102756_EX1103L2_MB.all	International Waters	EX1103L2
12	7/22/2011	0072_20110722_110025_EX1103L2_MB.all	International Waters	EX1103L2
12	7/22/2011	0073_20110722_122351_EX1103L2_MB.all	International Waters	EX1103L2
13	7/23/2011	0074_20110723_075445_EX1103L2_MB.all	International Waters	EX1103L2
13	7/23/2011	0075_20110723_081419_EX1103L2_MB.all	International Waters	EX1103L2
13	7/23/2011	0076_20110723_095900_EX1103L2_MB.all	International Waters	EX1103L2
13	7/23/2011	0077_20110723_110123_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0078_20110724_060500_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0079_20110724_063012_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0080_20110724_080126_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0081_20110724_083705_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0082_20110724_090148_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0083_20110724_091734_EX1103L2_MB.all	International Waters	EX1103L2

14	7/24/2011	0084_20110724_100254_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0085_20110724_104332_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0086_20110724_121215_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0087_20110724_231538_EX1103L2_MB.all	International Waters	EX1103L2
14	7/24/2011	0088_20110724_233639_EX1103L2_MB.all	International Waters	EX1103L2
15	7/25/2011	0089_20110725_001623_EX1103L2_MB.all	International Waters	EX1103L2
15	7/25/2011	0090_20110725_030912_EX1103L2_MB.all	International Waters	EX1103L2
15	7/25/2011	0091_20110725_031118_EX1103L2_MB.all	International Waters	EX1103L2
15	7/25/2011	0092_20110725_091118_EX1103L2_MB.all	International Waters	EX1103L2
15	7/25/2011	0093_20110725_100207_EX1103L2_MB.all	International Waters	EX1103L2
15	7/25/2011	0094_20110725_122022_EX1103L2_MB.all	International Waters	EX1103L2
15	7/25/2011	0095_20110725_232122_EX1103L2_MB.all	International Waters	EX1103L2
16	7/26/2011	0096_20110726_014349_EX1103L2_MB.all	International Waters	EX1103L2
16	7/26/2011	0097_20110726_015159_EX1103L2_MB.all	International Waters	EX1103L2
16	7/26/2011	0098_20110726_020845_EX1103L2_MB.all	International Waters	EX1103L2
16	7/26/2011	0099_20110726_023917_EX1103L2_MB.all	International Waters	EX1103L2
16	7/26/2011	0100_20110726_030749_EX1103L2_MB.all	International Waters	EX1103L2
16	7/26/2011	0101_20110726_072735_EX1103L2_MB.all	International Waters	EX1103L2
16	7/26/2011	0102_20110726_104544_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
16	7/26/2011	0103_20110726_164543_EX1103L2_MB.all	Costa Rica EEZ	EX1103L2
16	7/26/2011	0104_20110726_220234_EX1103L2_MB.all	Panama EEZ	EX1103L2
16	7/26/2011	0105_20110726_222014_EX1103L2_MB.all	Panama EEZ	EX1103L2
17	7/27/2011	0106_20110727_001013_EX1103L2_MB.all	Panama EEZ	EX1103L2
17	7/27/2011	0107_20110727_061015_EX1103L2_MB.all	Panama EEZ	EX1103L2
17	7/27/2011	0108_20110727_121015_EX1103L2_MB.all	Panama EEZ	EX1103L2
17	7/27/2011	0109_20110727_181010_EX1103L2_MB.all	Panama EEZ	EX1103L2
18	7/28/2011	0110_20110728_001010_EX1103L2_MB.all	Panama EEZ	EX1103L2
18	7/28/2011	0111_20110728_024801_EX1103L2_MB.all	Panama EEZ	EX1103L2
18	7/28/2011	0112_20110728_034650_EX1103L2_MB.all	Panama EEZ	EX1103L2

Table 3. CTD Tow Yo files collected during the cruise.

CTD/Tow-yo Stations	Date	From (Position)	To (Position)	Speed	Sensors
EX1103L2_TOW01	07162011	-88.3100/0.7370	-88.2900/ 0.7360	0.5	LSS, Altimeter
EX1103L2_TOW02	07172011	-88.1919/0.7278	-88.1640/ 0.7274	0.5	LSS, ORP, Altimeter
EX1103L2_TOW03	07182011	-88.2100/0.7289	-88.1998/ 0.7285	0.5	LSS, ORP, Altimeter
EX1103L2_TOW04	07202011	86.09608/0.78947	86.071503/0 .786427	0.5	LSS, ORP, Altimeter
EX1103L2_TOW05	07212011	85.891387/0.769902	85.893092/0 .77102	0.5	LSS, ORP, Altimeter

EX1103L2_TOW06	07222011	85.91285/0.769553	85.888623/0.767567	0.5	LSS, ORP, Altimeter
EX1103L2_TOW07	07232011	86.09508/0.61127	86.081093/0.59726	0.5	LSS, ORP, Altimeter

Table 4. CTD vertical casts.

CTD station	Date	Position	Sensors	Water Samples Collected (Depth/m)
EX1103L2_CTD01	07182011	88.3089/0.7369	LSS, ORP, Altimeter	Yes (1933, 1884, 1874, 1872, 1851, 1831, 1832, 1788)

Table 5. ROV dives conducted during the cruise. Dive locations describe the launch position.

Dive Number #	Date (GMT)	Location	Latitude (N)	Longitude (W)
1	07142011	Paramount seamount	3.346733	-90.7658
2	07152011	Plume signal 2a	0.734917	-88.3159
3	07162011	Plume signal 2a	0.7387	-88.3121
4	07172011	Plume signal 2a	0.7355	-88.3103
5	07182011	Plume signal 2a	0.737167	-88.3103
6	07192011	Plume signal 2c	0.725367	-88.1829
7	07202011	Rose Bud	0.807117	-86.2292
8	07212011	4a East	0.765833	-85.8946
9	07222011	4a West	0.770167	-85.9131
10	07232011	4a West	0.771933	-85.9128
11	07242011	Off-Axis Mounts	0.597067	-86.096
12	07252011	Ecuador Rift	01.73132	85.03253

Table 5. EK 60 Single Beam files collected during the cruise.

Survey Day	Date (GMT)	MB Line Filename	Location	SIS Survey Name
1				

Appendix C: List of acronyms

BIST – Built In System Test
CTD – conductivity temperature and depth (equipment)
DNP – do not process
EEZ –Exclusive Economic Zone
ERT – Earth Resources Technology, Inc.
ET – Electronics Technician
EX – NOAA Ship *Okeanos Explorer*
GMT – Greenwich Mean Time
URI GSO – University of Rhode Island Graduate School of Oceanography
Km – kilometers
KM – Kongsberg Maritime AS
Kt(s) – knots
LSS – Light Scattering Sensor
LT – Lieutenant
MBES – multibeam echosounder
NCDDC – National Coastal Data Development Center
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
ORP – oxidation reduction potential
PHB – Pacific Hydro Branch
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
VSAT – very short aperture terminal
WD – water depth
XBT – eXpendable BathyThermograph

Appendix D: EM302 PU Parameters in use during cruise

```
#// Database Parameters

#// Seafloor Information System
#// Kongsberg Maritime AS
#// Saved:  2011.07.28 05:47:56

#// 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              [-0.725] #// 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              [75] #// Port
      #* MSA              [75] #// 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              [2800] #// Force Depth (m)
    #* MID              [100] #// Min. Depth (m):
    #* MAD              [4200] #// Max. Depth (m):
    #* DSM              [2] #// Dual swath mode: DYNAMIC
    #* PMO              [0] #// Ping Mode: AUTO
    #* FME              [1] #// FM enable
  #} Depth Settings

  #{ Stabilization #//
    #* YPS              [1] #// Pitch stabilization
    #* TXA              [0] #// 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              [0] #// Aeration
    #* STF              [1] #// Sector Tracking
    #* IFF              [1] #// Interference
  #} Filtering

  #{ Absorption Coefficient #//
    #* ABC              [4.872] #// 31.5 kHz
  #} Absorption Coefficient

  #{ Normal incidence sector #//
    #* TCA              [5] #// Angle from nadir (deg.):
  #} Normal incidence sector


  #{ Mammal protection #//
    #* TXP              [0] #// TX power level (dB): Max.
    #* SSR              [4] #// 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.