# NOAA *Okeanos Explorer* Program

# MAPPING DATA REPORT

**EX1004 Leg 2**

Exploration, Indonesia

June 24 to July 14, 2010

Bitung to Bitung

Report Contributors:

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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.

## Table of Contents



### 2. Report Purpose

The purpose of this report is to briefly describe the data acquisition and processing of the EM 302 multibeam system during EX1004 Leg 2 cruise (June 24 – July 14, 2010). For details about the setup of the various mapping equipment /sensors, please appendix D and the ship's readiness report, which can be obtained by contacting the ships operations officer (ops.explorer@noaa.gov). 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) casts, Remotely Operated Vehicle (ROV) dives, and education and outreach activities were conducted which may be referred to in this report. Details will be provided an overall cruise report (forthcoming).

The talented and patient crew of the NOAA Ship *Okeanos Explorer* (*EX*) is greatly appreciated for their efforts in helping make the INDEX-SATAL 2010 mission a success.

### 3. Cruise Objectives

This cruise was the first of the series of cruises conducted in cooperation between the US and Indonesian governments. INDEX-SATAL 2010 (Indonesia Exploration–Sangihe Talaud Region) expedition is aimed at exploration of an area approved by the Indonesian government north of Sulawesi Island, Indonesia (Figure 1). This area will be referred to in this report as the INDEX-SATAL 2010 exploration area. The INDEX-SATAL 2010 area extends from 2° N to 6° 24' N and 124° 45' E to 128° E covering an area of ~ 31,000 square miles. The coordinates of INDEX-SATAL exploration area are provided in Table 1.

Scientists from the US and Indonesia participated in the expedition onboard and through telepresence technology with Exploration Command Centers (ECCs) established in Seattle and Jakarta.

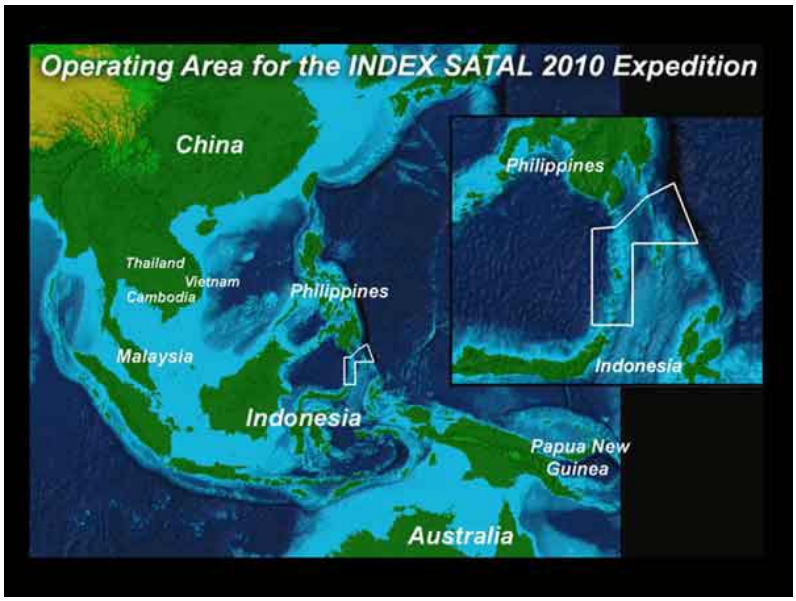


**Figure 1. Location of *INDEX-SATAL* 2010 exploration area outlined as white polygon in the above image. Image credit: NOAA.**

**Table 1. Coordinates of INDEX-SATAL 2010 exploration area as depicted in Figure 1.**

| Point ID | Longitude (E) | Latitude (N) |
|---|---|---|
| 1 | 126° 0’ 0” | 2° 0' 0" |
| 2 | 124° 45' 36" | 2° 0' 0" |
| 3 | 126° 0' 0" | 4° 30' 0" |
| 4 | 128° 0' 0" | 4° 30' 0" |
| 5 | 127° 17' 59.99" | 6° 24' 0" |
| 6 | 126° 24' 0" | 5° 54' 0" |
| 7 | 125° 30' 0" | 5° 0' 0" |
| 8 | 124° 45' 0" | 4° 57' 0" |

## Remote Science: A new paradigm

Equipped with a high speed internet connection, the NOAA Ship *Okeanos Explorer* is capable of streaming live video and data to shore, commonly referred to as telepresence. This capability, along with shore based ECCs, allow shorebased scientists to talk directly with shipboard personnel. This partnership allows for real-time collaboration between shore side and ship-based participants to make decisions on where the ship’s efforts would be focused i.e. on areas and targets of particular interest. EX1004 Leg 2 was the first cruise during which onboard scientists

collaborated with shore based scientists at ECCs in Seattle and Jakarta during real-time multibeam mapping and ROV operations.

John Sherrin (University of Victoria, Canada) and Xerandy (Indonesian Agency of Technology Assessment and Application-BPPT) participated in this cruise as the science representatives onboard. Dr. Jim Holden acted as designated chief scientist for this cruise based at the ECC in Jakarta. As such, scientists onboard and ashore worked closely based on the data and information that were made available through host of collaboration tools including designated FTP servers, and live broadcast of ROV video and computer screens. A Geotiff image, IVS SD object and a ASCII gridded text file were provided on a daily basis to the ECCs through the FTP site to keep the ECCs up to date about the EM302 mapping results.

## 4. Participating Personnel

| NAME | ROLE | AFFILIATION |
|---|---|---|
| CDR Joseph Pica | Commanding Officer | NOAA Corps |
| Jeremy Potter | Expedition Coordinator | NOAA OER |
| LT Nicola VerPlanck | Field Operations Officer | NOAA Corps |
| Jim Holden | Designated Chief Scientist (Jakarta ECC) | Jakarta (PMEL) |
| Elaine Stuart | Senior Survey Technician | NOAA OMAO |
| Colleen Peters | Senior Survey Technician | NOAA OMAO |
| Joel DeMello | Mapping Watchstander | NOAA OER/UCAR Intern |
| Tom Kok | Mapping Watchstander | NOAA OER/UCAR Intern |
| Karl McLetchie | Mapping Watchstander | NOAA OER/UCAR Intern |
| Mashkoor Malik | Mapping Team Lead | NOAA OER (ERT, Inc.) |
| John Sherrin | US Science Lead | University of Victoria, Canada |
| Xerandy | Indonesian Science Lead | Indonesian Agency of Technology Assessment and Application (BPPT) |
| Major Muddan Zayadi | Indonesian Navy Observer | Indonesian Navy (TNI) |

## 5. Mapping Statistics

| | |
|---|---|
| Dates | June 24 – July 14, 2010 |
| Linear km mapped | 4247 km |
| Square km mapped | 3157 $km^2$ |
| Number of bathymetric multibeam files | 158 |
| Number of water column backscatter files | 43 |
| Data volume of raw multibeam data files | 25.3 GB |
| Number of XBT casts | 37 |
| Number of CTD casts (not including ROV CTD) | 13 |

## 6. Mapping Sonar Setup

NOAA Ship *Okeanos Explorer* (EX) is equipped with a 30 kHz Kongsberg EM 302 multibeam sonar and a 3.5 kHz Knudsen sub-bottom profiler (SBP 3260). During this cruise EM 302 bottom bathymetric and backscatter data were collected. Additionally, EM 302 water column data were continuously monitored by mapping watch standers and the water column data were logged when the mapping watch standers observed water column targets in the water column data.

The ship used a POS MV ver. 4 to record and correct the multibeam data for any ship's motion. C-NAV GPS system provided DGPS correctors with position accuracy expected to be better than 2.0 m.

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. Expendable bathythermograph (XBT) casts (Deep Blue, max depth 760 m) were taken every six hours and in between when needed. The XBT cast data were converted to SIS compliant format using NOAA in house tool for XBT processing: Velocipy. Please consult Appendix A, for details about parameters and settings used for EM 302 data acquisition.

A Built in System Test (BIST) conducted before departure indicated a transmit board (#16) defective. The transmit board was replaced with an onboard spare board before departure on June 24, 2010. A BIST conducted after the transmit board replacement indicated that all the transmit boards were passing the BISTs, but the same board (#16) failed the BIST test conducted on the following day (25 June, 2010). The EM 302, in-spite of one defective transmit board, provided good quality data during the initial tests soon after arriving in the approved mapping area. Based on these initial tests it was decided that the ship would continue its mapping mission. The affects of the defective transmit board on the data quality were assessed throughout the cruise by comparing this cruise data with earlier cruises. However, no apparent loss of data quality was observed. Kongsbserg, Inc. was also contacted about recurring problems with the failed transmit board.

*May 2010 Patch test results*

Angular offsets (based on a patch test conducted in May 2010) are tabulated below. For complete processing unit setup (PU Setup) utilized for the cruise, please refer to Appendix A.

**Table 2. Angular offsets for Transmit (TX) and Receive (RX) transducer as determined during a patch test conducted in May 2010.**

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

## 7. Data Acquisition and Processing Summary

The primary purpose of the multibeam data during this expedition was to provide baseline maps for further exploration using the CTD and ROV. The cruise instructions (Ref. A) had to be

modified during this cruise to adapt to the changes in operational priorities and loss of time that had previously been dedicated to mapping during EX1004 Leg 1. As a consequence, the mapping plan was adjusted to first cover the area which is shown in the over view image (Figure 2) as the EX2 mapping box which was deemed of value for further ROV and CTD work. To maximize the use of all the resources available onboard, it was decided that the ship would conduct mapping operations during the night and ROV and CTD casts would be conducted during the day. As the cruise progressed, the targets for CTD casts and ROV dives were refined in collaboration with the Seattle and Jakarta ECCs with shifting focus of operations to the EX1 mapping box for a significant amount of time (July 4-10, 2010). The ship then resumed work in EX2 mapping box on July 11, 2010. .

As shown in Figure 2, the overall operating box was the area approved by the Indonesian government for this exploration cruise. No data were acquired outside this approved box.

Although several CTD casts were conducted during this cruise, this report will not provide details about data analysis of CTD casts. As the CTD data were primarily used to locate positions of the hydrothermal vents, multibeam sonar water column data, when available, were analyzed further on these locations to infer if the plume structure was visible in the MB water column data. However, no water column targets were detected in the locations of the CTD casts. The locations of the CTD casts are provided in Table 8c of this report.

Onboard processing of bathymetric data was done in CARIS HIPS ver. 6.1 where the data were cleaned in ‘Swath Editor’ and ‘Subset Editor’. No tidal corrections were applied during post processing; however, no appreciable differences were observed between different lines by not applying tidal corrections. A nominal grid cell size of 50 m was chosen for the bathymetric grids. Onboard processing of bottom and water column backscatter data was conducted using Geocoder and IVS Fledermaus respectively but was limited only to a few specific targets. Detailed processing of bottom and water column backscatter data for the whole cruise was not attempted onboard.

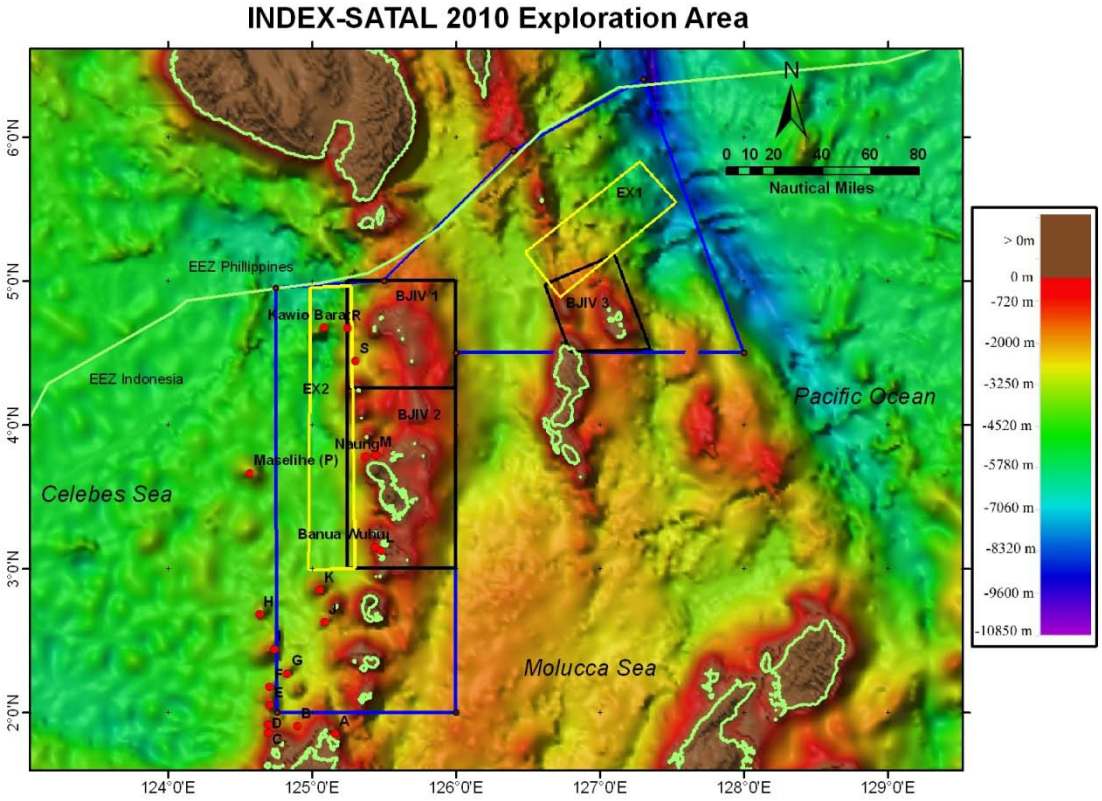


**Figure 2. The overall exploration area during EX1004 Leg II. Mapping areas indicated by the yellow outline were the primary focus for the mapping operations referred to as EX2 and EX1 mapping boxes respectively (Ref A). The targets described by Ref B in the vicinity of INDEX-SATAL 2010 operating area are shown also. Background bathymetric data is from satellite derived bathymetry (Ref D). R/V Baruna Jaya IV (BJIV) mapping priority areas are shown as BJIV 1-3.**

For detailed reports about CTD casts and ROV dive site, the reader is requested to consult those relevant data reports. The Indonesian research vessel Baruna Jaya IV (BJIV) will be operating in INDEX-SATAL 2010 exploration area later this year. The priority mapping areas for BJIV are shown in Figure 2 as BJIV 1-3 for reference. No mapping data from BJIV was available during this leg.

Several of the sites referred in this report are named as defined by McConachy et al, 2004. [Reference B]. For consistency, those same names of the sites were utilized for this report.

A total of 4247.14 linear km (2293.27 linear miles) were mapped during this cruise covering an area of 8178.9 $mi^2$ within the approved INDEX-SATAL 2010 exploration area. The exploration area was comprised of several islands around which very shallow water depths were observed. The seafloor away from the islands slowly deepens to water depths reaching ~ 5000 m (as observed in EX2 mapping area). The maximum water depth was observed in the eastern area o f EX1 mapping box where the maximum depth recorded was ~ 7000 m.

**Multibeam mapping results overview – bathymetric data**

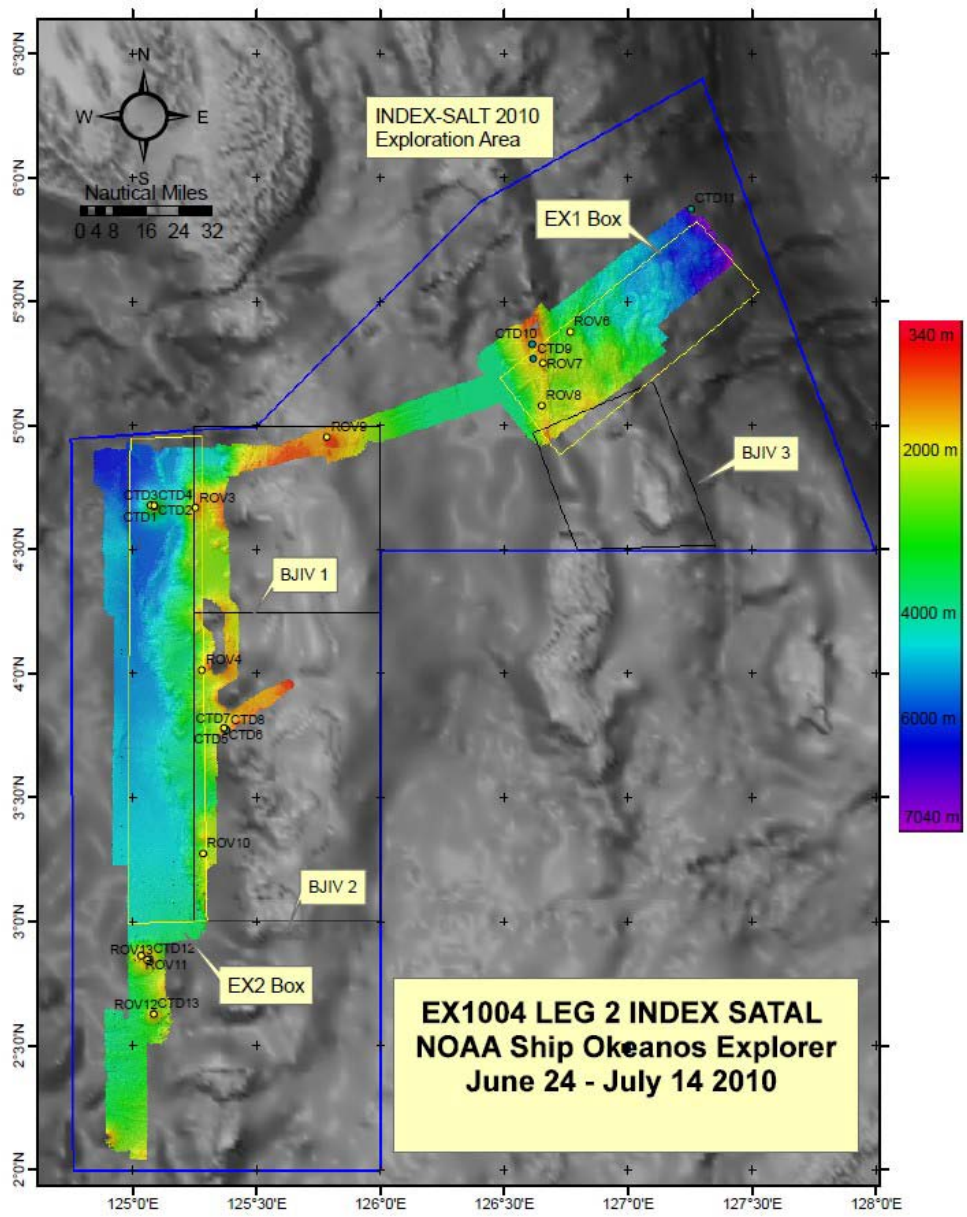


**Figure 3. Overview of the EM302 multibeam bathymetric results (50 m grid) during EX1004 Leg 2 cruise. EM302 data grid compiled in Fledermaus, background data is from satellite derived bathymetry. Figure compiled in ArcMap.**

## 8. Cruise Calendar

| **June 2010** | | | | | | |
|---|---|---|---|---|---|---|
| **Mon** | **Tue** | **Wed** | **Thu** | **Fri** | **Sat** | **Sun** |
| | | | 24 Departed Bitung. Arrived working grounds 1600 Started mapping | 25 Conducted mapping in the western boundary of the EX2 | 26 Continue mapping in the EX2 mapping area. Passed over Kawio | 27 Conducted CTD casts over Kawio-Barat from 0800-1700. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | operations 1630. | mapping area | Barat | Resumed mapping overnight |
| 28<br>Continued mapping in south eastern portion of EX2 mapping area | 29<br>0800-Conducted ROV dive over Kawio Barat (#1). Conducted CTD ops till 1900. Resumed Mapping in EX2 mapping area | 30<br>Conducted ROV dive (#2) over Kawio Barat. Resumed mapping west of EX2 mapping area during night | | | | |
| **July 2010** | | | | | | |
| | | | 1<br>Conducted ROV dive over target R.<br>(#3)<br>Resumed mapping in the shallow areas between the islands. | 2<br>Conducted ROV dive<br>(#4)<br><br>Conducted two cross lines over the bathymetric data collected so far. | 3<br>Conducted ROV dive over target Naung.<br>(#5)<br><br>At 1800 ship transited towards mapping area EX1 | 4<br>Conducted mapping operations in EX1 area. |
| 5<br>Conducted ROV dive.<br>#6 | 6<br>Conducted ROV dive #7<br>Resumed mapping.<br>Conducted CTD cast #10 | 7<br>Conducted mapping in the deeper areas of EX1 box | 8<br>Conducted ROV dive | 9<br>Conducted ROV dive<br>In the area transit from EX1 to EX2 box. Transited to EX1 box | 10<br>Conducted ROV dive in EX2 box | 11<br>Conducted ROV dive over target K |
| 12<br>Conducted ROV dive over target J. Overnight mapped in the south western area of approved exploration box | 13<br>Conducted ROV dive over target K again. Secured all sensors while outside the approved exploration area. | 14<br>Arrived Bitung, Indonesia | | | | |

## 9. Daily Cruise Log

(ALL TIMES LOCAL Guam Time)

**June 24, 2010**

Departed Bitung, Indonesia. Working towards northern boundary of EX2 box. Observed some interesting features on the seafloor which look like scours on the seafloor with depths of ~ 20 m and widths of 200 – 400 m. Shown below in Figure 4.

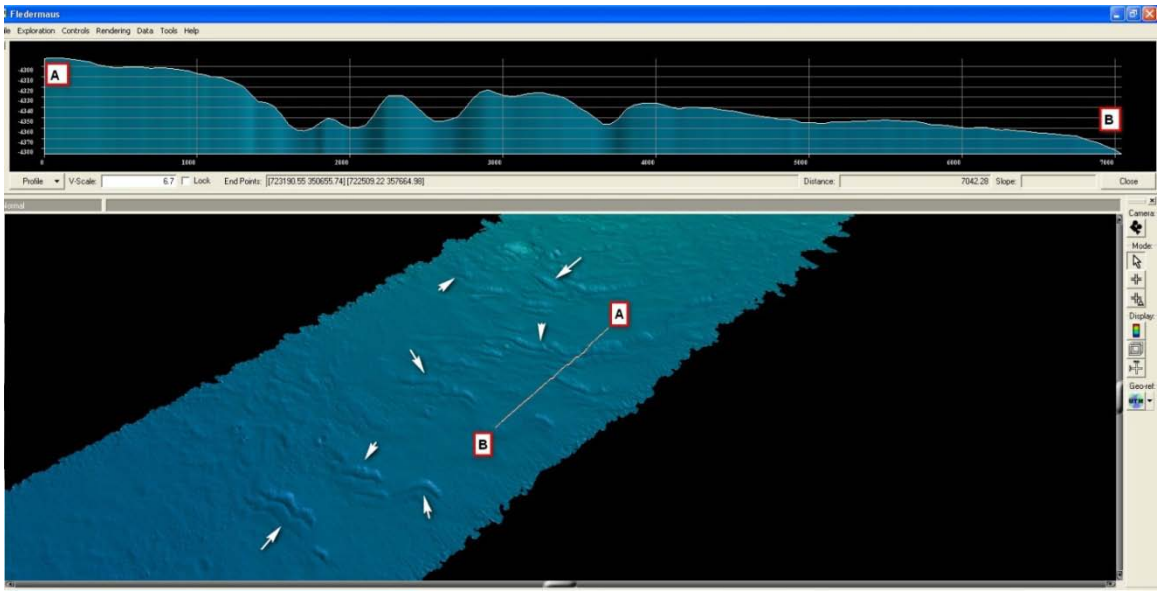


**Figure 4. Scour-like features observed in multibeam bathymetry on 24 June, 2010. Screengrab from Fledermaus. Image credit: NOAA.**

## June 25, 2010

Conducted first two passes over Kawio Barat. Water column data over Kawio Barat collected. No water column targets observed in the water column. The Jakarta ECC (Michael Purawdi) notified ship of a potential plume site in location 4.6370 N 125.0504 E. Upon further observation of the water column data no targets were located in the water column. A screen grab of the stacked beams are provided below in Figure 5.

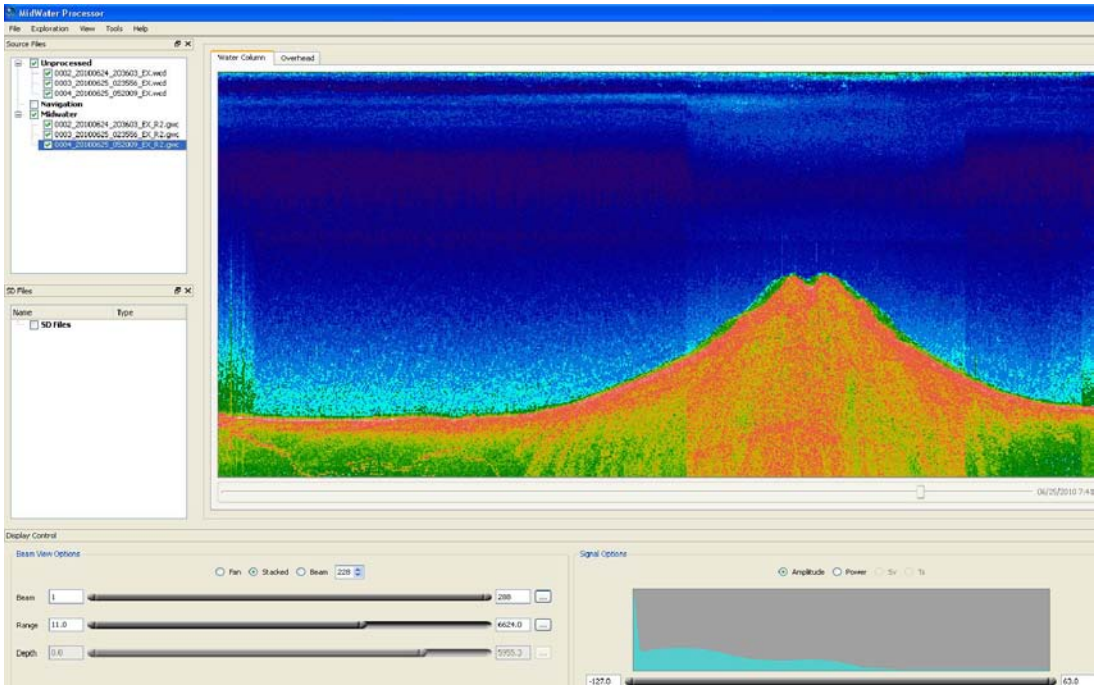


**Figure 5. Screengrab of EM302 multibeam water column data of submarine volcano Kawio Barat shown in FM Midwater (IVS Fledermaus version 7). Image credit: NOAA.**

## June 26, 2010

Continued mapping in the exploration box. No sign of water column targets in the water column data during a second and third pass over Kawio Barat.

## June 27, 2010

Finished 3rd line in the yellow exploration box and ran 4th line to half of the line distance to turn back and run the 5th line back to Kawio Barat to be at Kawio Barat at 0800 to conduct CTD operations over Kawio Barat.

## June 28, 2010

Conducted CTD operations over Kawio Barat observing plume signals in the CTD data. Resumed mapping operations during night time. Completed processing of the data. Observed a feature which appears to rise more than 1500 m above the seafloor not shown in the satellite derived bathymetry. See Figure 6 below. This feature is presumed a previously unknown seamount. A potential discovery report was drafted with complete details (attached as Appendix B).

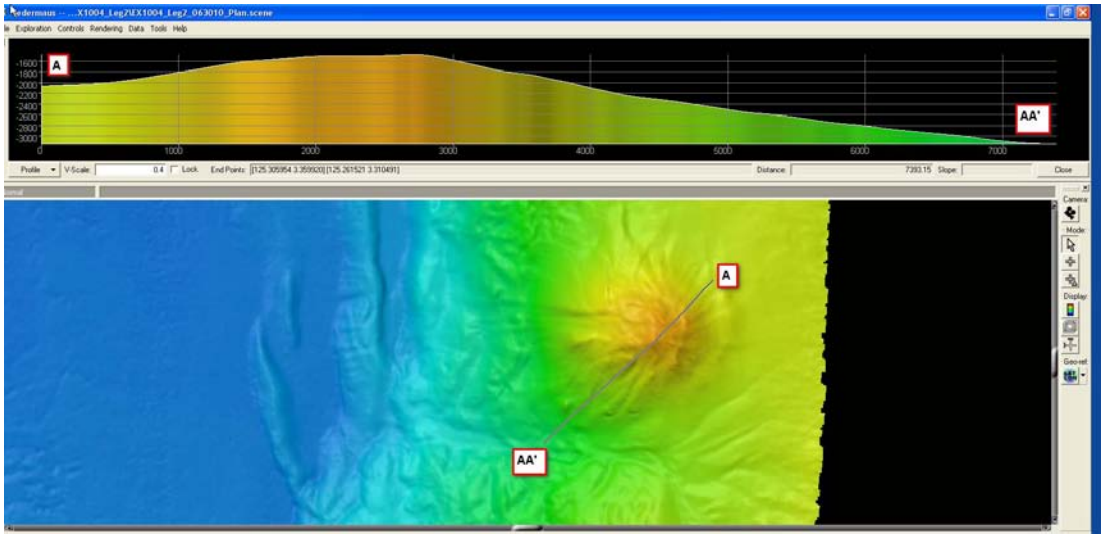

**Figure 6. EM302 multibeam bathymetry of potential discovery, a 1500+ meter high seamount. Data shown in IVS Fledermaus. Image credit: NOAA.**

**June 29, 2010**

Conducted ROV Dive over Kawio Barat observing several interesting features. Towards the end of the dive, heavy smoke and reduced visibility showed that ROV is very close to the source of the plume. Resumed mapping operations during night.

**June 30, 2010**

Conducted ROV operations over Kawio Barat which showed spectacular images of the smokers and chimneys. Water column data from multibeam did not show these features. Resumed mapping operations during night.

**July 1, 2010**

Conducted ROV operations on a feature east of Kawio Barat depth ~ 1000 m. Referred as target R in the ROV dive map. Transited to south over night to conduct mapping operations between the islands in shallow waters.

**July 2, 2010**

During today's launch of ROV, EM 302 was turned on to test if ROV and Camera sled will be picked up by EM 302 in the water column data. The EM 302 successfully picked up the ROV all the way down to the depth of ~ 1650. A discrepancy was observed between the across track depth (shown as a number in across track window) and the depth inferred in the water column

target based on visual seafloor. Looks like the number in the cross track does not show the depth at the nadir. Also a lot of water column particulate material were observed as ROV descended to the seafloor. However, any quantitative analysis of scattering particles in the water column is difficult from the ROV data alone.

**July 3, 2010**

Conducted ROV dive over site Naung. Started transit towards EX1 box after completion of the dive.

**July 4, 2010**

Arrived in vicinity of EX1 mapping area and started mapping operations.

**July 5, 2010**

Conducted ROV dive.

**July 6, 2010**

Started having issues with the XBT launcher. The ETs found out that the connector on the fantail is not working. Spares have been ordered and will be available for next leg.

**July 7, 2010**

Conducted ROV dive, resumed mapping during night.

**July 8, 2010**

Conducted ROV dive, resumed mapping during night.

**July 9, 2010**

Conducted ROV dive over the shallow area plateau like feature which was detected during transit from EX2 box to EX1 box.

**July 10, 2010**

Conducted ROV dive over sedimented area in EX2 box. Overnight ran the lines over target K and J.

**July 11, 2010**

Conducted ROV dive over target K. While passing over the dive site observed water column target in the multibeam sonar water column target (line #133) as shown in the figure below.

ROV dive site ~ 600 m east of this observation but did not observe any anomaly in the ROV data. See Figure 7.

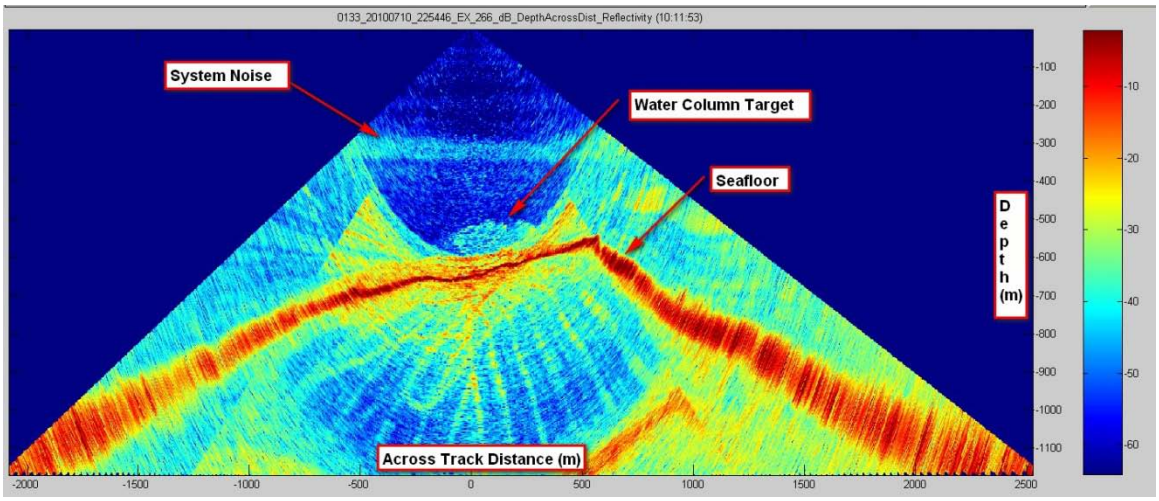


**Figure 7. Water column target observed on July 11, 2010 at Site K. Data shown in FM Midwater (IVS Fledermaus version 7) water column data processing software. Image credit: NOAA.**

**July 12, 2010**

Conducted ROV dive over target J.

**July 13, 2010**

Conducted ROV dive over target K again. Observed the water column target in EM 302 water column data. Description of the feature is shown below in Figure 8.

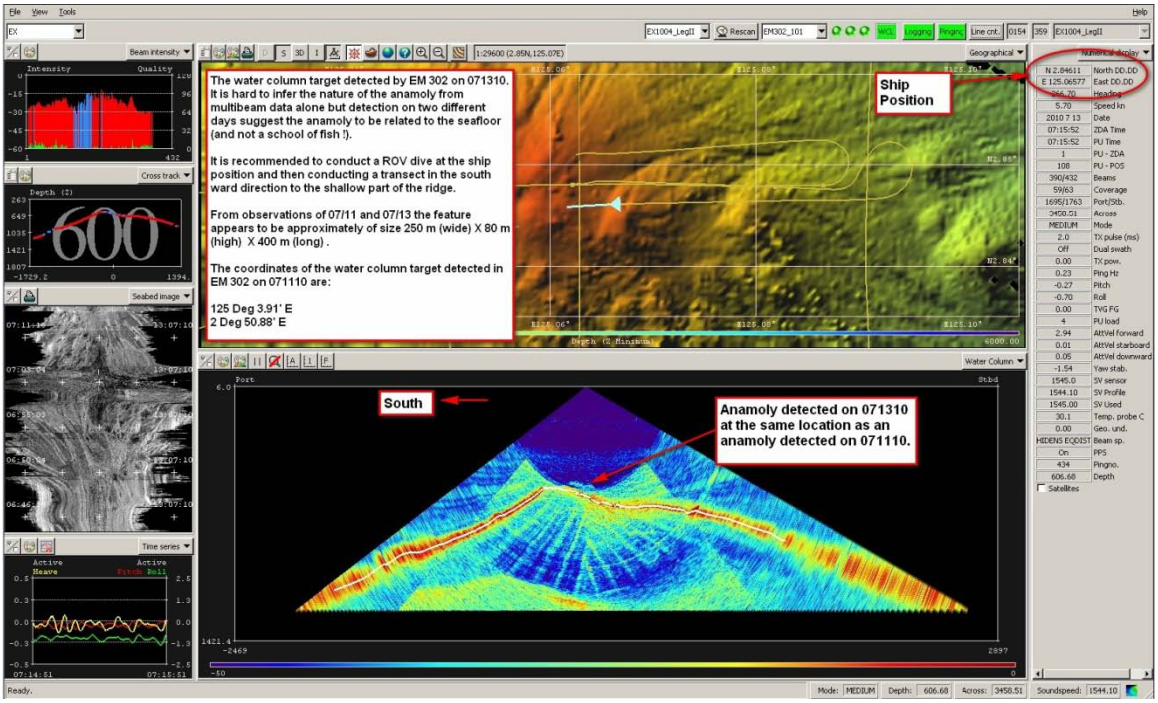


**Figure 8. Screengrab showing water column target observed on July 13, 2010 at Site K. Data shown in Kongsberg SIS data acquisition software. Image credit: NOAA.**

## 10. References


A. John McDonough, Captain Michael Devany, Catalina Martinez, Cruise Instructions EX1004 Leg 1, 2 and 3.

B. T F McConachy, H. Permana, R A Binns, I Zulkarnain, J M Parr, C J Yeats, N D Hananto, B Priadi, S Burhannuddine and E P Utomo, Recent investigations of Submarine Hydrothermal Activity in Indonesia, PACRIIM 2004, Adelaide, SA 19-22 September, 2004.

C. NOAA Ship *Okeanos Explorer* Mapping Readiness Report, 2010. Available on request from the ship. Email contact: ops.explorer@noaa.gov.

D. Smith, W. H. F., and D. T. Sandwell, Global seafloor topography from satellite altimetry and ship depth soundings, Science, v. 277, p. 1957-1962, 26 Sept., 1997.

## 11. Appendices

## Appendix A: Field Products

*Potential* *Discovery* *Report*

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NOAA OFFICE OF OCEAN EXPLORATION AND RESEARCH

NOAA SHIP *OKEANOS* *EXPLORER*

POTENTIAL DISCOVERY (DISCO-P) REPORT - SEAMOUNT

July 1, 2010

Prepared By:
*NOAA Ship Okeanos Explorer*
Mapping Team
Team Lead: Mashkoor Malik

Submitted To:
NOAA Office of Ocean Exploration
Jeremy Potter (OER)
Expedition Coordinator

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CRUISE: EX1004 Leg 2
*INDEX-SATAL* 2010 CRUISE

DATE/TIME
July 1, 2010 / 0900 GMT

FILED:

VESSEL:
NOAA Ship *Okeanos Explorer* (EX)

Location of potential discovery:
North of Bitung, Indonesia about 200 km
In location 3.34305 N 125.29062 E

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SUMMARY:

A structure on the seafloor was detected around 2000 on June 27, 2010, while mapping in the *INDEX-SATAL* approved exploration area. The structure appears to be an underwater seamount with shallowest depth of ~ 1490 m below sea level. The adjacent seafloor to the north-northeast of the structure lies at ~ 2000-2200 m while the seafloor to the south-southwest lies at water depth of greater than 3000 m making the maximum height of the top of the structure rising more than 1500 m from adjacent seafloor. No existing data other than Sandwell and Smith seafloor Topography are available onboard to verify if this is a new discovery. Sandwell and Smith seafloor topography; however, does not appear to show this structure.

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DISCUSSION:

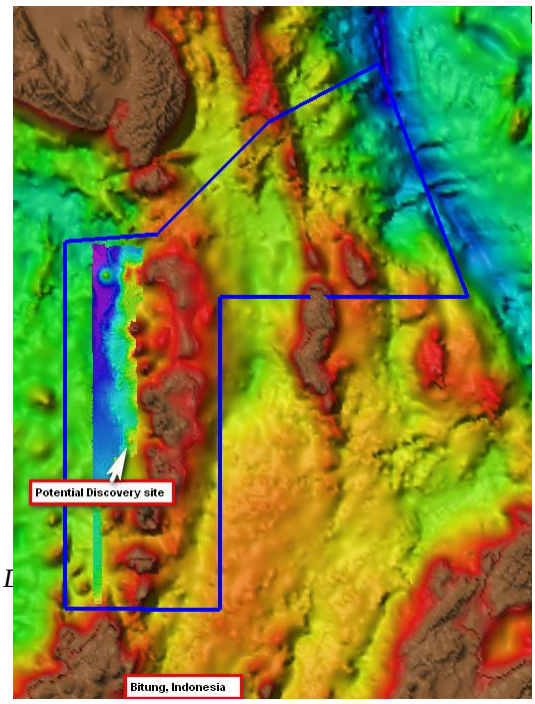

Figure 1: Location map of the potential seamount showing background bathymetry from Sandwell and Smith seafloor topography overlaid with the multibeam data collected during EX1004 Leg 2. Image credit NOAA.

The underwater seamount was found while conducting INDEX-SATAL 2010 exploration of the approved areas for the exploration using Kongsberg EM 302 multibeam sonar. The data were processed in CARIS HIPS and brought into Fledermaus for visualization and measurements.

No existing data available onboard showed this structure but more detailed scientific vetting is required before this find can be labeled as discovery.

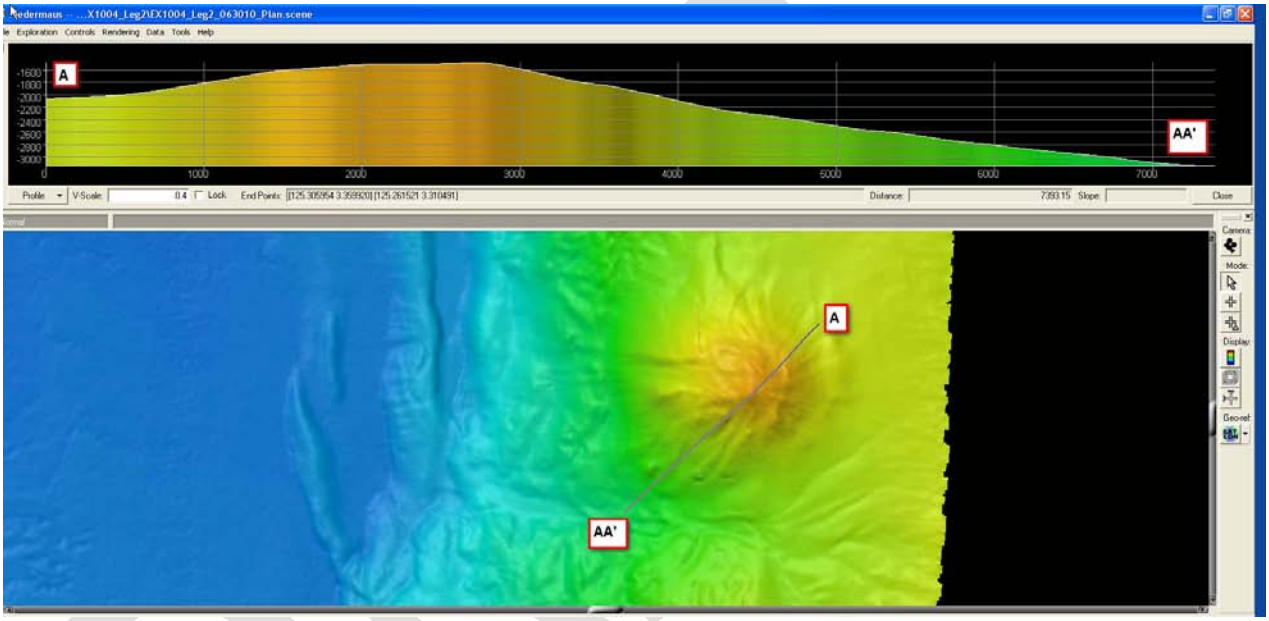


Figure 2: Bathymetric profile across the potential seamount showing a rise of more than 1500 m from adjacent seafloor. Image from IVS Fledermaus ver. 6. Image credit NOAA.

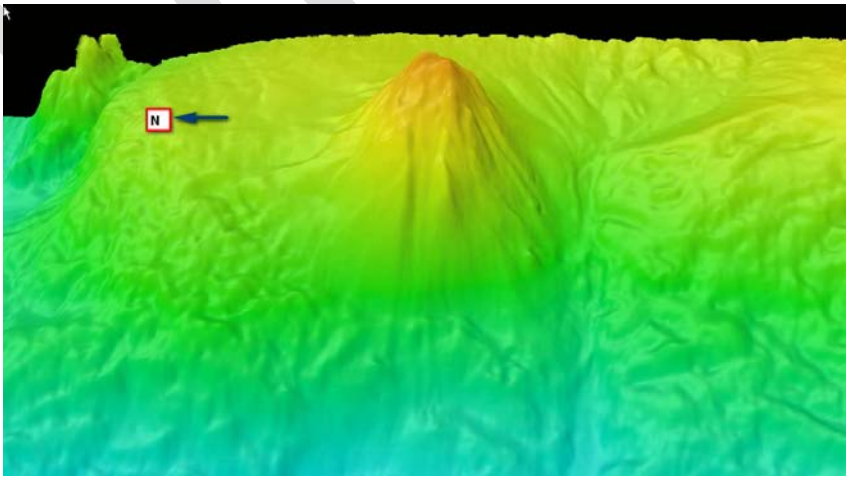

Figure 3: Perspective view of the structure created using IVS Fledermaus with sun illumination from northwest with 3 times vertical exaggeration. Image shows a view looking east. Image credit NOAA.

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FURTHER WORK BEING PLANNED:

There is a possibility of conducing CTD casts and ROV dives on this site during the current cruise. At the time of writing of this report no further data have been collected at the site.
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COMMENTS:

Discoveries are a cornerstone of EX work. Protocols still need to be designated for presenting the news of discoveries, soliciting pertinent help from shore based scientists, communicating the results to the 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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## Appendix B: Tables of Data Collected

**EX1004 LEG 2 MULTIBEAM**
**BATHYMETRY / BOTTOM BACKSCATTER FILES**
Note: WCD in comments section indicates water column data also collected to separate .wcd file

| Cruise Day No | Date (GMT) | MB Line Filename | Location | SIS Survey Name | Comments |
|---|---|---|---|---|---|
| 1 | 6/24/2010 | 0000_20100624_083556_EX.all | Transit to Box EX2 | EX1004_LegII | |
| 1 | 6/24/2010 | 0001_20100624_143556_EX.all | Box EX2 | EX1004_LegII | |
| 1 | 6/24/2010 | 0002_20100624_203603_EX.all | Box EX2 | EX1004_LegII | WCD |
| 2 | 6/25/2010 | 0003_20100625_023556_EX.all | Box EX2 | EX1004_LegII | WCD |
| 2 | 6/25/2010 | 0004_20100625_052009_EX.all | Box EX2 | EX1004_LegII | WCD |
| 2 | 6/25/2010 | 0005_20100625_112011_EX.all | Box EX2 | EX1004_LegII | |
| 2 | 6/25/2010 | 0006_20100625_172007_EX.all | Box EX2 | EX1004_LegII | |
| 2 | 6/25/2010 | 0007_20100625_191551_EX.all | Box EX2 | EX1004_LegII | |
| 2 | 6/25/2010 | 0008_20100625_193721_EX.all | Box EX2 | EX1004_LegII | |
| | | 0009 | Box EX2 | EX1004_LegII | SIS skipped to line 10, no data for line 9 |
| 3 | 6/26/2010 | 0010_20100626_000938_EX.all | Box EX2 | EX1004_LegII | WCD |
| 3 | 6/26/2010 | 0011_20100626_060932_EX.all | Box EX2 | EX1004_LegII | WCD |
| 3 | 6/26/2010 | 0012_20100626_081740_EX.all | Box EX2 | EX1004_LegII | |
| 3 | 6/26/2010 | 0013_20100626_092439_EX.all | Box EX2 | EX1004_LegII | Not Processed |
| 3 | 6/26/2010 | 0014_20100626_095422_EX.all | Box EX2 | EX1004_LegII | WCD |

| | | | | | |
|---|---|---|---|---|---|
| 3 | 6/26/2010 | 0015_20100626_155420_EX.all | Box EX2 | EX1004_LegII | |
| 3 | 6/26/2010 | 0016_20100626_164845_EX.all | Box EX2 | EX1004_LegII | Turn |
| 3 | 6/26/2010 | 0017_20100626_171313_EX.all | Box EX2 | EX1004_LegII | WCD |
| 3 | 6/26/2010 | 0018_20100626_223459_EX.all | Box EX2 | | Not processed –Turn WCD |
| 3 | 6/26/2010 | 0019_20100626_223727_EX.all | Box EX2 | EX1004_LegII | WCD |
| 3 | 6/26/2010 | 0020_20100626_232606_EX.all | Box EX2 | EX1004_LegII | Transit to CTD WCD |
| 4 | 6/27/2010 | 0021_20100627_110455_EX.all | Box EX2 | EX1004_LegII | |
| 4 | 6/27/2010 | 0022_20100627_131414_EX.all | Box EX2 | EX1004_LegII | |
| 5 | 6/28/2010 | 0023_20100627_191414_EX.all | Box EX2 | EX1004_LegII | |
| 5 | 6/28/2010 | 0024_20100628_002308_EX.all | Box EX2 | EX1004_LegII | |
| 5 | 6/28/2010 | 0025_20100628_004332_EX.all | Box EX2 | EX1004_LegII | |
| 5 | 6/28/2010 | 0026_20100628_050153_EX.all | Box EX2 | EX1004_LegII | |
| 5 | 6/28/2010 | 0027_20100628_052516_EX.all | Box EX2 | EX1004_LegII | |
| 5 | 6/28/2010 | 0028_20100628_093225_EX.all | Box EX2 | EX1004_LegII | |
| 5 | 6/28/2010 | 0029_20100628_102612_EX.all | Box EX2 | EX1004_LegII | |
| 5 | 6/28/2010 | 0030_20100628_160017_EX.all | Box EX2 | EX1004_LegII | Jog around island |
| 5 | 6/28/2010 | 0031_20100628_171656_EX.all | Box EX2 | EX1004_LegII | WCD |
| 5 | 6/28/2010 | 0032_20100628_212540_EX.all | Box EX2 | EX1004_LegII | Transit to line |
| 6 | 6/29/2010 | 0033_20100629_141135_EX.all | Box EX2 | EX1004_LegII | Holiday fill |
| 6 | 6/29/2010 | 0034_20100629_145931_EX.all | Box EX2 | EX1004_LegII | Holiday fill |
| 6 | 6/29/2010 | 0035_20100629_151957_EX.all | Box EX2 | EX1004_LegII | Holiday Fill WCD |
| 6 | 6/29/2010 | 0036_20100629_174910_EX.all | Box EX2 | EX1004_LegII | WCD |
| 6 | 6/29/2010 | 0037_20100629_225420_EX.all | Box EX2 | EX1004_LegII | Not Processed-Turn WCD |
| 7 | 6/30/2010 | 0038_20100630_110000_EX.all | Box EX2 | EX1004_LegII | |
| 7 | 6/30/2010 | 0039_20100630_154151_EX.all | Box EX2 | EX1004_LegII | |
| 7 | 6/30/2010 | 0040_20100630_160559_EX.all | Box EX2 | EX1004_LegII | |
| 7 | 6/30/2010 | 0041_20100630_210250_EX.all | Box EX2 | EX1004_LegII | |
| 7 | 6/30/2010 | 0042_20100630_220112_EX.all | Box EX2 | EX1004_LegII | |
| 8 | 7/1/2010 | 0043_20100701_100210_EX.all | Box EX2 | EX1004_LegII | |
| 8 | 7/1/2010 | 0044_20100701_103947_EX.all | Box EX2 | EX1004_LegII | |
| 8 | 7/1/2010 | 0045_20100701_115254_EX.all | Box EX2 | EX1004_LegII | |
| 8 | 7/1/2010 | 0046_20100701_130115_EX.all | Box EX2 | EX1004_LegII | |
| 8 | 7/1/2010 | 0047_20100701_132518_EX.all | Box EX2 | EX1004_LegII | |
| 8 | 7/1/2010 | 0048_20100701_150613_EX.all | Box EX2 | EX1004_LegII | |
| 8 | 7/1/2010 | 0049_20100701_154503_EX.all | Box EX2 | EX1004_LegII | |
| 8 | 7/1/2010 | 0050_20100701_160852_EX.all | Box EX2 | EX1004_LegII | Turn WCD |
| 8 | 7/1/2010 | 0051_20100701_162924_EX.all | Box EX2 | EX1004_LegII | WCD |

| | | | | | |
|---|---|---|---|---|---|
| 8 | 7/1/2010 | 0052_20100701_170322_EX.all | Box EX2 | EX1004_LegII | WCD |
| 8 | 7/1/2010 | 0053_20100701_171249_EX.all | Box EX2 | EX1004_LegII | WCD |
| 8 | 7/1/2010 | 0054_20100701_192634_EX.all | Box EX2 | EX1004_LegII | WCD |
| 8 | 7/1/2010 | 0055_20100701_193244_EX.all | Box EX2 | EX1004_LegII | WCD |
| 8 | 7/1/2010 | 0056_20100701_215117_EX.all | Box EX2 | EX1004_LegII | WCD |
| 8 | 7/2/2010 | 0057_20100702_002106_EX.all | Box EX2 | EX1004_LegII | WCD |
| 9 | 7/2/2010 | 0058_20100702_142850_EX.all | Box EX2 | EX1004_LegII | Cross line |
| 9 | 7/2/2010 | 0059_20100702_175600_EX.all | Box EX2 | EX1004_LegII | Turn |
| 9 | 7/2/2010 | 0060_20100702_185046_EX.all | Box EX2 | EX1004_LegII | Cross line |
| 9 | 7/2/2010 | 0061_20100702_215740_EX.all | Box EX2 | EX1004_LegII | WCD |
| 9 | 7/2/2010 | 0062_20100702_230355_EX.all | Box EX2 | EX1004_LegII | WCD |
| 10 | 7/3/2010 | 0063_20100703_152131_EX.all | Transit to Box EX1 | EX1004_LegII | |
| 10 | 7/3/2010 | 0064_20100703_153522_EX.all | Transit to Box EX1 | EX1004_LegII | |
| 10 | 7/3/2010 | 0065_20100703_173256_EX.all | Transit to Box EX1 | EX1004_LegII | |
| 10 | 7/3/2010 | 0066_20100703_182836_EX.all | Transit to Box EX1 | EX1004_LegII | |
| 10 | 7/3/2010 | 0067_20100703_191344_EX.all | Transit to Box EX1 | EX1004_LegII | |
| 11 | 7/4/2010 | 0068_20100704_002501_EX.all | Box EX1 | EX1004_LegII | |
| 11 | 7/4/2010 | 0069_20100704_062500_EX.all | Box EX1 | EX1004_LegII | |
| 11 | 7/4/2010 | 0070_20100704_073014_EX.all | Box EX1 | EX1004_LegII | |
| 11 | 7/4/2010 | 0071_20100704_075754_EX.all | Box EX1 | EX1004_LegII | |
| 11 | 7/4/2010 | 0072_20100704_135750_EX.all | Box EX1 | EX1004_LegII | |
| 11 | 7/4/2010 | 0073_20100704_153009_EX.all | Box EX1 | EX1004_LegII | Not Processed |
| 11 | 7/4/2010 | 0074_20100704_155738_EX.all | Box EX1 | EX1004_LegII | |
| 11 | 7/4/2010 | 0075_20100704_194647_EX.all | Box EX1 | EX1004_LegII | |
| 11 | 7/4/1010 | 0076_20100704_202509_EX.all | Box EX1 | EX1004_LegII | |
| 11 | 7/4/1010 | 0077_20100704_222645_EX.all | Box EX1 | EX1004_LegII | |
| 12 | 7/5/1010 | 0078_20100705_105639_EX.all | Box EX1 | EX1004_LegII | |
| 12 | 7/5/1010 | 0079_20100705_130028_EX.all | Box EX1 | EX1004_LegII | |
| 12 | 7/5/1010 | 0080_20100705_132918_EX.all | Box EX1 | EX1004_LegII | |
| 12 | 7/5/2010 | 0081_20100705_173238_EX.all | Box EX1 | EX1004_LegII | |
| 12 | 7/5/2010 | 0082_20100705_175853_EX.all | Box EX1 | EX1004_LegII | |
| 12 | 7/5/2010 | 0083_20100705_215108_EX.all | Box EX1 | EX1004_LegII | |
| 13 | 7/6/2010 | 0084_20100706_141345_EX.all | Box EX1 | EX1004_LegII | |
| 13 | 7/6/2010 | 0085_20100706_162757_EX.all | Box EX1 | EX1004_LegII | |
| 13 | 7/6/2010 | 0086_20100706_165221_EX.all | Box EX1 | EX1004_LegII | |
| 13 | 7/6/2010 | 0087_20100706_200634_EX.all | Box EX1 | EX1004_LegII | |
| 13 | 7/6/2010 | 0088_20100706_200922_EX.all | Box EX1 | EX1004_LegII | |
| 14 | 7/7/2010 | 0089_20100707_053149_EX.all | Box EX1 | EX1004_LegII | |
| 14 | 7/7/2010 | 0090_20100707_055021_EX.all | Box EX1 | EX1004_LegII | |
| 14 | 7/7/2010 | 0091_20100707_092110_EX.all | Box EX1 | EX1004_LegII | |
| 14 | 7/7/2010 | 0092_20100707_095651_EX.all | Box EX1 | EX1004_LegII | |

| | | | | | |
|---|---|---|---|---|---|
| 14 | 7/7/2010 | 0093_20100707_130542_EX.all | Box EX1 | EX1004_LegII | |
| 14 | 7/7/2010 | 0094_20100707_133312_EX.all | Box EX1 | EX1004_LegII | |
| 14 | 7/7/2010 | 0095_20100707_170142_EX.all | Box EX1 | EX1004_LegII | |
| 14 | 7/7/2010 | 0096_20100707_174951_EX.all | Box EX1 | EX1004_LegII | |
| 14 | 7/7/2010 | 0097_20100707_175206_EX.all | Box EX1 | EX1004_LegII | |
| 14 | 7/7/2010 | 0098_20100707_221913_EX.all | Box EX1 | EX1004_LegII | |
| 15 | 7/8/2010 | 0099_20100708_095657_EX.all | Box EX1 | EX1004_LegII | |
| 15 | 7/8/2010 | 0100_20100708_113239_EX.all | Box EX1 | EX1004_LegII | |
| 15 | 7/8/2010 | 0101_20100708_113541_EX.all | Transit to Box EX2 | EX1004_LegII | |
| 15 | 7/8/2010 | 0102_20100708_151650_EX.all | Transit to Box EX2 | EX1004_LegII | |
| 15 | 7/8/2010 | 0103_20100708_155930_EX.all | Transit to Box EX2 | EX1004_LegII | WCD |
| 15 | 7/8/2010 | 0104_20100708_172056_EX.all | Transit to Box EX2 | EX1004_LegII | WCD |
| 15 | 7/8/2010 | 0105_20100708_175603_EX.all | Transit to Box EX2 | EX1004_LegII | WCD |
| 15 | 7/8/2010 | 0106_20100708_180558_EX.all | Transit to Box EX2 | EX1004_LegII | WCD |
| 15 | 7/8/2010 | 0107_20100708_201520_EX.all | Transit to Box EX2 | EX1004_LegII | WCD |
| 15 | 7/8/2010 | 0108_20100708_203134_EX.all | Transit to Box EX2 | EX1004_LegII | WCD |
| 15 | 7/8/2010 | 0109_20100708_210135_EX.all | Transit to Box EX2 | EX1004_LegII | Not processed WCD |
| 15 | 7/8/2010 | 0110_20100708_210146_EX.all | Transit to Box EX2 | EX1004_LegII | WCD |
| 15 | 7/8/2010 | 0111_20100708_211154_EX.all | Transit to Box EX2 | EX1004_LegII | WCD |
| 15 | 7/8/2010 | 0112_20100708_221100_EX.all | Transit to Box EX2 | EX1004_LegII | |
| 15 | 7/8/2010 | 0113_20100708_222729_EX.all | Transit to Box EX2 | EX1004_LegII | |
| 15 | 7/8/2010 | 0114_20100708_231235_EX.all | Transit to Box EX2 | EX1004_LegII | not processed |
| 16 | 7/9/2010 | 0115_20100709_083427_EX.all | Transit to Box EX2 | EX1004_LegII | |
| 16 | 7/9/2010 | 0116_20100709_135812_EX.all | Box EX2 | EX1004_LegII | WCD |
| 16 | 7/9/2010 | 0117_20100709_195808_EX.all | Box EX2 | EX1004_LegII | |
| 16 | 7/9/2010 | 0118_20100709_212211_EX.all | Box EX2 | EX1004_LegII | |
| 16 | 7/9/2010 | 0119_20100709_212734_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0120_20100710_093427_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0121_20100710_112510_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0122_20100710_115056_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0123_20100710_134751_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0124_20100710_152136_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0125_20100710_162824_EX.all | Box EX2 | EX1004_LegII | WCD |
| 17 | 7/10/2010 | 0126_20100710_171455_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0127_20100710_185722_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0128_20100710_192118_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0129_20100710_211721_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0130_20100710_213644_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0131_20100710_215146_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0132_20100710_222837_EX.all | Box EX2 | EX1004_LegII | |
| 17 | 7/10/2010 | 0133_20100710_225446_EX.all | Box EX2 | EX1004_LegII | WCD Water |

| | | | | | column target observed over target K |
|---|---|---|---|---|---|
| 17 | 7/10/2010 | 0134_20100710_233055_EX.all | Box EX2 | EX1004_LegII | WCD |
| 18 | 7/11/2010 | 0135_20100711_142441_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/11/2010 | 0136_20100711_154552_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/11/2010 | 0137_20100711_175139_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/11/2010 | 0138_20100711_180928_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/11/2010 | 0139_20100711_200254_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/11/2010 | 0140_20100711_202317_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/11/2010 | 0141_20100711_215532_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/11/2010 | 0142_20100711_220314_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/12/2010 | 0143_20100712_090847_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/12/2010 | 0144_20100712_094919_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/12/2010 | 0145_20100712_130735_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/12/2010 | 0146_20100712_133637_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/12/2010 | 0147_20100712_170426_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/12/2010 | 0148_20100712_170856_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/12/2010 | 0149_20100712_182150_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/12/2010 | 0150_20100712_191808_EX.all | Box EX2 | EX1004_LegII | |
| 18 | 7/12/2010 | 0151_20100712_194329_EX.all | Box EX2 | EX1004_LegII | |
| 19 | 7/13/2010 | 0152_20100713_064333_EX.all | Box EX2 | EX1004_LegII | |
| 19 | 7/13/2010 | 0153_20100713_065620_EX.all | Box EX2 | EX1004_LegII | |
| 19 | 7/13/2010 | 0154_20100713_071440_EX.all | Box EX2 | EX1004_LegII | |
| 19 | 7/13/2010 | 0155_20100713_071858_EX.all | Box EX2 | EX1004_LegII | |
| 19 | 7/13/2010 | 0156_20100713_091420_EX.all | Box EX2 | EX1004_LegII | |
| 19 | 7/13/2010 | 0157_20100713_115542_EX.all | Box EX2 | EX1004_LegII | |
| 19 | 7/13/2010 | 0158_20100713_120138_EX.all | Box EX2 | EX1004_LegII | |

*Sound Velocity Profile Log (XBT)*

| **EX1004 LEG 2 SOUND VELOCITY FILES** | | | | |
|---|---|---|---|---|
| **DATE (GMT)** | **TIME (GMT)** | **XBT/CTD FILE NAME** | **LAT (WGS84)** | **LONG (WGS84)** |
| 6/24/2010 | 8:23:32 | XBT_062410_01.asvp | 2.0389 | 125.0198893 |
| 6/24/2010 | 16:14:42 | XBT_062410_02.asvp | 3.1383 | 125.0132 |
| 6/24/2010 | 22:38:00 | XBT_062410_03.asvp | 4.0422 | 125.0057 |
| 6/25/2010 | 4:23:00 | XBT_062510_04.asvp | 4.8605 | 124.9990 |
| 6/25/2010 | 10:34:38 | XBT_062510_05.asvp | 4.1823 | 125.0540853 |
| 6/25/2010 | 16:47:16 | XBT_062510_06.asvp | 3.3104 | 125.0611817 |
| 6/26/2010 | 22:39:00 | XBT_062510_07.asvp | 3.3940 | 125.1101 |
| 6/26/2010 | 04:39:15 | XBT_062610_08.asvp | 4.2511 | 125.1028972 |
| 6/26/2010 | 10:48:09 | XBT_062610_09.asvp | 4.7843 | 125.1485515 |
| 6/262010 | 16:38:18 | XBT_062610_10.asvp | 3.9467 | 125.155013 |
| 6/27/2010 | 10:58:00 | CTD_062710_01.asvp | 4.6762 | 125.0852 |
| 6/27/2010 | 16:36:54 | XBT_062710_11.asvp | 4.4036 | 125.2468098 |
| 6/27/2010 | 22:32:19 | XBT_062710_12.asvp | 3.5587 | 125.255599 |

| | | | | |
|---|---|---|---|---|
| 6/28/2010 | 5:18:15 | XBT_062810_13.asvp | 3.9327 | 125.1639973 |
| 6/28/2010 | 10:35:29 | XBT_062810_14.asvp | 3.2772 | 125.3060 |
| 6/28/2010 | 17:53 | XBT_062810_15.asvp | 4.4009 | 125.296208 |
| 6/29/2010 | 9:51:48 | CTD_062910_02.asvp | 4.6762 | 125.0852 |
| 6/29/2010 | 18:08:00 | XBT_062910_16.asvp | 4.8465 | 125.3438 |
| 6/30/2010 | 0:21:56 | ROV_063010_01.asvp | 4.6748 | 125.0871 |
| 6/30/2010 | 17:06:04 | XBT_063010_17.asvp | 4.4062 | 124.9120932 |
| 7/1/2010 | | ROV_070110_02.asvp | 4.6683 | 125.2542 |
| 7/1/2010 | 16:36:02 | XBT_070110_18.asvp | 3.8355 | 125.356722 |
| 7/2/2010 | 11:00:08 | CTD_070210_03.asvp | 3.7780 | 125.3705 |
| 7/3/2010 | 15:11 | XBT_070310_19.asvp | 4.8550 | 125.3195313 |
| 7/3/2010 | 22:35:10 | XBT_070410_20-1.asvp | 5.1119 | 126.252767 |
| 7/3/2010 | 6:38 | XBT_070410_21.asvp | 5.7445 | 127.1764 |
| 7/3/2010 | 10:12 | XBT_070410_23.asvp | 5.6053 | 127.0812988 |
| 7/5/2010 | 0:30 | ROV_070510_03.asvp | 5.3721 | 126.7716 |
| 7/6/2010 | 11:59:56 | CTD_070610_04.asvp | 5.3268 | 126.6131667 |
| 7/7/2010 | 0:32:12 | CTD_070710_11.asvp | 5.8723 | 127.2533333 |
| 7/7/2010 | 10:36:53 | XBT_070710_29.asvp | 5.5159 | 127.127067 |
| 7/8/2010 | 0:27:00 | ROV_070810_04.asvp | 5.0793 | 126.6552 |
| 7/9/2010 | 0:29 | ROV_070910_05.asvp | 4.9493 | 125.7783 |
| 7/9/2010 | 15:58 | XBT_071010_33.asvp | 3.9998 | 124.9534 |
| 7/10/2010 | 2:24 | ROV_071010_06.asvp | 3.26821 | 125.29090 |
| | | | | |
| 7/10/2010 | 11:59 | XBT_071010_36.asvp | 2.59567 | 125.06305 |
| 7/11/2010 | 12:46 | CTD_071110_13.asvp | 2.62666 | 125.0863 |
| 7/12/2010 | 00:27 | ROV_071210_12.asvp | 2.62466 | 125.08633 |
| | | | | |

*CTD File Log*

| **EX1004 LEG 2 CTD FILES** | | | |
|---|---|---|---|
| **CTD Cast Station** | **Date** | **Latitude (N)** | **Longitude (E)** |
| EX1004L2_01 | 62710 | 4.6762 | 125.0852 |
| EX1004L2-02 | 62910 | 4.6723 | 125.0868 |
| EX1004L2-03 | 62910 | 4.6760 | 125.0870 |
| EX1004L2-04 | 62910 | 4.6778 | 125.0875 |
| EX1004L2-05 | 70210 | 3.7780 | 125.3705 |
| EX1004L2-06 | 70210 | 3.7757 | 125.3718 |
| EX1004L2-07 | 70210 | 3.7738 | 125.3743 |
| EX1004L2-08 | 70210 | 3.7715 | 125.3792 |
| EX1004L2-09 | 70610 | 5.2675 | 126.6175 |
| EX1004L2-10 | 70610 | 5.3268 | 126.6132 |
| EX1004L2-11 | 70710 | 5.8723 | 127.2533 |
| EX1004L2-12 | 71109 | 2.8480 | 125.0680 |
| EX1004L2-13 | 71109 | 2.6267 | 125.0863 |

*ROV Dive Locations*

| **EX1004 LEG 2 ROV DIVE LOCATIONS** |
|---|

| Dive Number # | Date (GMT) | Latitude (N) | Longitude (E) |
|---|---|---|---|
| 1 | 062910 | 4.6785 | 125.0730 |
| 2 | 063010 | 4.6765 | 125.0873 |
| 3 | 070110 | 4.6683 | 125.2542 |
| 4 | 070210 | 4.0127 | 125.2800 |
| 5 | 070310 | 3.7788 | 125.3697 |
| 6 | 070510 | 5.3773 | 126.7669 |
| 7 | 070610 | 5.2494 | 126.6563 |
| 8 | 070810 | 5.0780 | 126.6521 |
| 9 | 070910 | 4.9512 | 125.7848 |
| 10 | 071010 | 3.3413 | 125.2817 |
| 11 | 071110 | 2.8627 | 125.0343 |
| 12 | 071210 | 2.6247 | 125.0863 |
| 13 | 071310 | 2.8442 | 125.0584 |

## Appendix C: List of acronyms

BIST – Built In System Test

BJIV – Baruna Jaya IV

BPPT - Badan Pengkajian Dan Penerapan Teknologi (Indonesian Agency for the Assessment and Application Technology) CO – Commanding Officer

CDR - Commander

CIMS – Cruise Information Management System

CO – Commanding Officer

CTD – conductivity temperature and depth

CW – continuous wave

dB – decibels

DGPS –Differential Global Positioning System

DTM – digital terrain model

ECS – Extended Continental Shelf

EEZ –Exclusive Economic Zone

ET – Electronics Technician

EX – NOAA Ship *Okeanos Explorer*

FM – frequency modulation

FOO – Field Operations Officer

INDEX-SATAL – Indonesia Exploration–Sangihe Talaud Region

kHz - kilohertz

Km – kilometers

KM – Kongsberg Maritime AS

Kt(s) – knots

LT – Lieutenant

Ma – megaannum

MBES – multibeam echosounder

NCDDC – National Coastal Data Development Center

NGDC – National Geophysical Data Center

NOAA – National Oceanic and Atmospheric Administration

NODC – National Oceanographic Data Center

OER – Office of Ocean Exploration and Research

OMAO – Office of Marine and Aviation Operations

PMEL – Pacific Marine Environmental Laboratory

ROV – Remotely Operated Vehicle

RX – receive

SST – Senior Survey Technician

SV – sound velocity

TNI –Tentara Nasional Indonesia (Indonesian Navy)

TRU – transmit and receive unit

TSG - thermosalinograph

TX – transmit

UNCLOS – United Nations Convention on the Law of the Sea

UNH-CCOM/JHC – University of New Hampshire Center for Coastal and Ocean Mapping / Joint Hydrographic Center

UPS – uninterruptable power supply

USBL – ultra-short base line

WD – water depth

XBT – expendable bathythermograph

## 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 3. 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 4. 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 5. 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 6. 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

```
#// Database Parameters

#// Seafloor Information System
#// Kongsberg Maritime AS
#// Saved:  2010.07.14 05:01:52

#// 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                [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                 [3000] #//
Force Depth (m)
    #* MID                 [50] #// Min.
Depth (m):
    #* MAD                 [7000] #//
Max. Depth (m):
    #* DSM                 [0] #// Dual
swath mode: OFF
    #* PMO                 [0] #// Ping
Mode: AUTO
    #* FME                 [1] #// FM
enable
  #} Depth Settings

  #{ Stabilization #//
    #* YPS                 [1] #// Pitch
stabilization
    #* TXA                 [2] #// 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                 [6.224] #//
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.minPointCoun
t                [6]
    #*        PingProc.quantileRule.use
[false]
    #*
PingProc.quantileRule.quantile
[0.100000]
    #*
PingProc.quantileRule.scaleFactor
[6.000000]
    #*
PingProc.quantileRule.minPointCou
nt               [40]
    #*                GridProc.minPoints
[8]
    #*                GridProc.depthFactor
[0.200000]
    #*
GridProc.removeTooFewPoints
[false]
    #*
GridProc.surfaceFitting.surfaceDegr
ee               [1]
    #*
GridProc.surfaceFitting.tukeyConsta
nt               [6.000000]
    #*
GridProc.surfaceFitting.maxIteration
[10]
    #*
GridProc.surfaceFitting.convCriterio
n                [0.010000]
    #*
GridProc.surfaceDistanceDepthRule.
use              [false]
    #*
GridProc.surfaceDistanceDepthRule.
depthFactor      [0.050000]
    #*
GridProc.surfaceDistancePointRule.
use              [false]
    #*
GridProc.surfaceDistancePointRule.s
caleFactor       [1.000000]
    #*
GridProc.surfaceDistanceUnitRule.u
se               [false]
    #*
GridProc.surfaceDistanceUnitRule.s
caleFactor       [1.000000]
    #*
GridProc.surfaceDistanceStDevRule.
use              [false]
```

```
    #*
GridProc.surfaceDistanceStDevRule.
scaleFactor     [2.000000]
    #*
GridProc.surfaceAngleRule.use
[false]
    #*
GridProc.surfaceAngleRule.minAngl
e               [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 EX1004 Leg 2

| Software | Version | Purpose |
|---|---|---|
| CARIS HIPS and SIPS | 6.1 Service Pack 2 | Multibeam processing |
| ECDIS | | Ship line keeping |
| ESRI – ArcMap | 9.3 | Map products |
| Fledermaus | 6.7.0h Build 419 Professional | Multibeam QC, Line planning |
| Fledermaus | 7.2.0 Build 411 Professional, 32 bit Edition | |
| Hypack | 9.0.0.22 | Survey planning |
| Hypack | 9.0.4.0 | Realtime monitoring |
| Kongsberg SIS (installed 2/12/10) | 3.6.4 build 174 | EM302 data acquisition |
| Velocipy (NOAA) | 10.7 | XBT, ROV CTD processing |
| Velociwin (NOAA) | 8.92 | XBT processing |