



MAPPING DATA ACQUISITION AND PROCESSING SUMMARY REPORT

CRUISE EX-12-05 Leg 2 Canyons and Continental Margin Exploration (Mapping)

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1. Introduction

The NOAA Office of Ocean Exploration and Research is the only federal program dedicated to exploring our deep ocean, closing the prominent gap in our basic understanding of U.S. deep waters and seafloor and delivering the ocean information needed to strengthen the economy, health, and security of our nation.

Using the latest tools and technology, OER **explores** previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, OER allows scientists, resource managers, students, members of the general public, and others to actively **experience** ocean exploration, expanding available expertise, cultivating the next generation of ocean explorers, and engaging the public in exploration activities. From this exploration, OER makes the collected data needed to **understand** our ocean publicly available, so we can maintain the health of our ocean, sustainably manage our marine resources, accelerate our national economy, and build a better appreciation of the value and importance of the ocean in our everyday lives.



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2. Report Purpose

The purpose of this report is to briefly describe the acoustic seafloor and water column mapping data collection and processing methods used during exploration expedition EX-12-05 Leg 2, and to present a summary of the overall mapping results and mapping related cruise activities.

3. Cruise Objectives

EX-12-05 Leg 2 primarily focused on conducting mapping operations while in transit from Morehead City, NC to Davisville, RI. The multibeam and single beam mapping operations were conducted 24 hours a day during the transit. Sub-bottom profiling was conducted between the hours of 1000 and 1800 (local ship time) during the transit. Mapping operations were planned in priority areas defined by the NOAA National Marine Fisheries Service Northeast Fisheries Science Center (NMFS NEFSC) and The Mid-Atlantic Regional Council on the Ocean (MARCO). Due to the short duration of cruise and the primary objective of the cruise to transit to RI, the ship deviated from transit mapping to conduct surveys only in upper Hudson Canyon. Cruise objectives that were not successfully completed during this cruise were deferred to later Okeanos cruises in the region.

Training of mapping personnel new to the ship was an ancillary objective, including physical scientists from the NOAA Pacific and Atlantic Hydrographic Branches, and three Explorers-in-Training. Two NOAA Teachers at Sea were also onboard to learn about mapping systems.

The objectives for this cruise are further detailed in the EX-12-05 Leg 2 Project Instructions, which are archived in the NOAA Central Library.



4. Summary of Mapping Results

Cruise Overview Map



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EX-12-05 Leg 2
Canyons and Continental Margin Exploration (Mapping)
Cruise Summary Map
July 28 - August 2, 2012

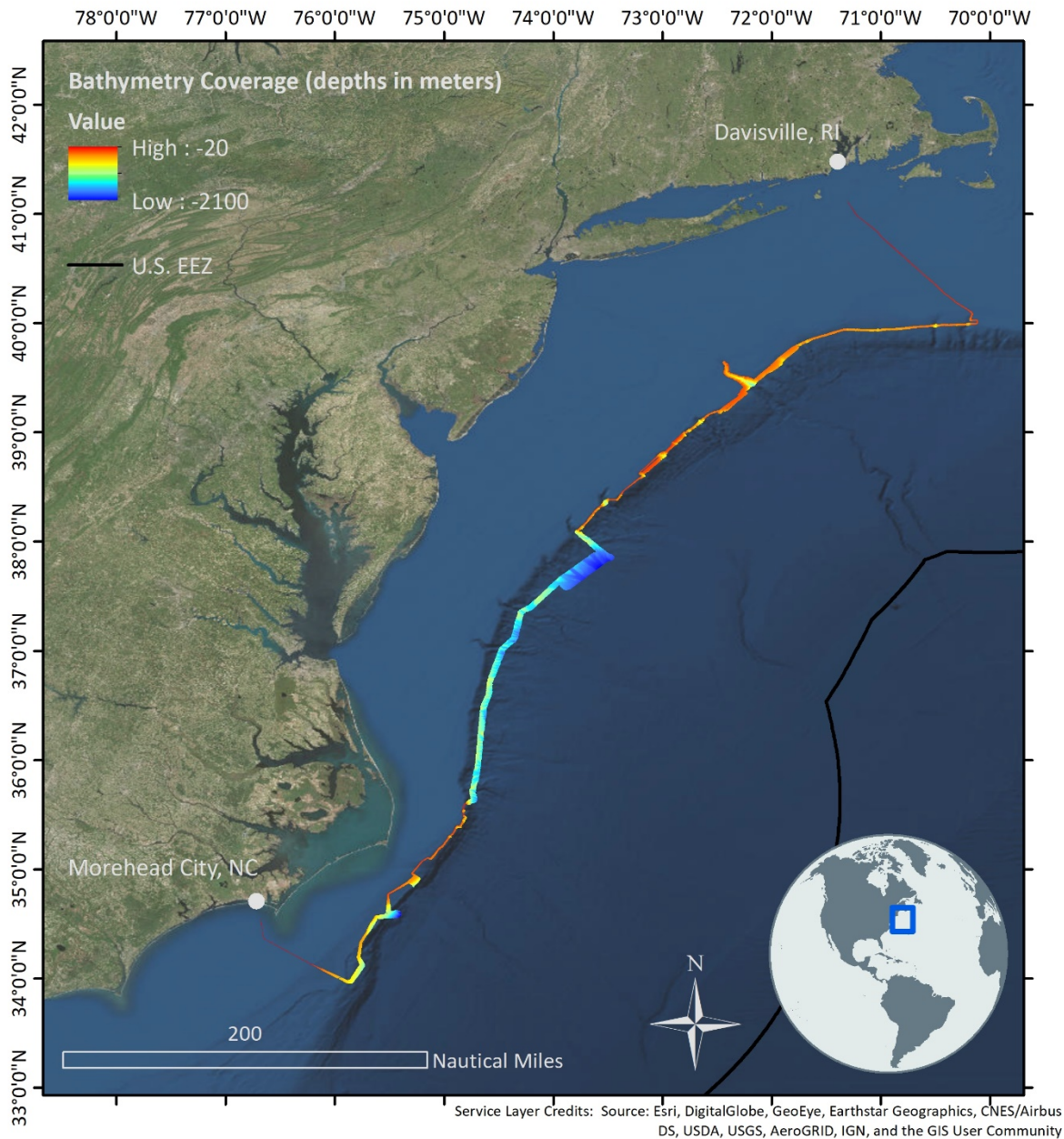


Figure 1. Cruise map showing overall EX-12-05 Leg 2 bathymetry coverage. Map generated in ArcMap.



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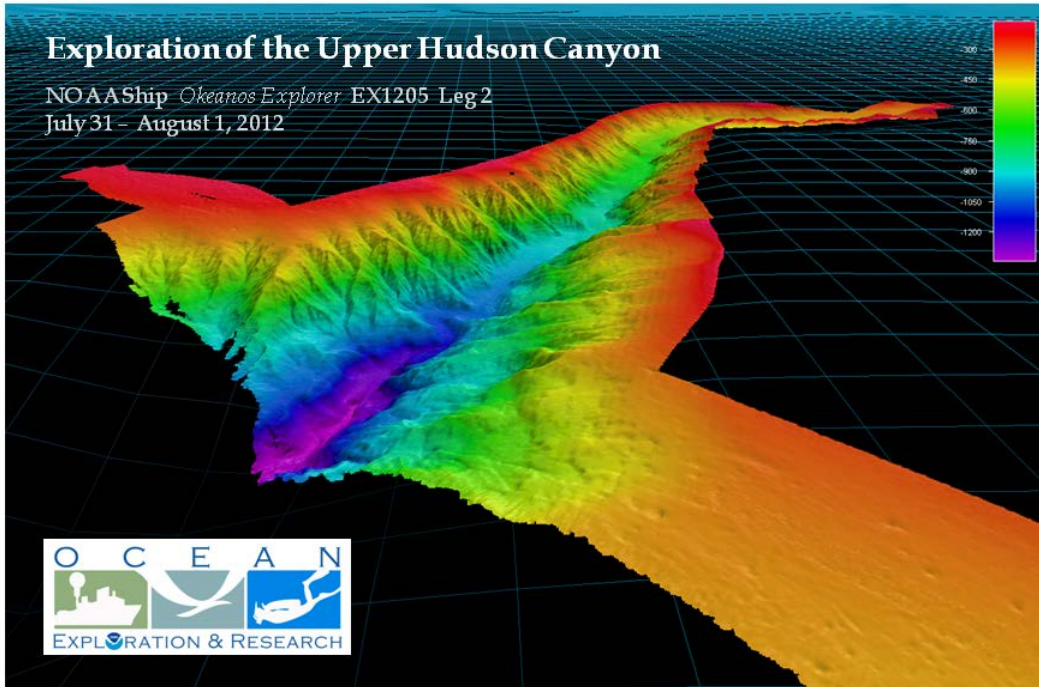


Figure 2. Screenshot of perspective view of bathymetry data collected over upper Hudson Canyon. Depth units in meters, vertical exaggeration 3, 30 meter data resolution. Map created in QPS Fledermaus.

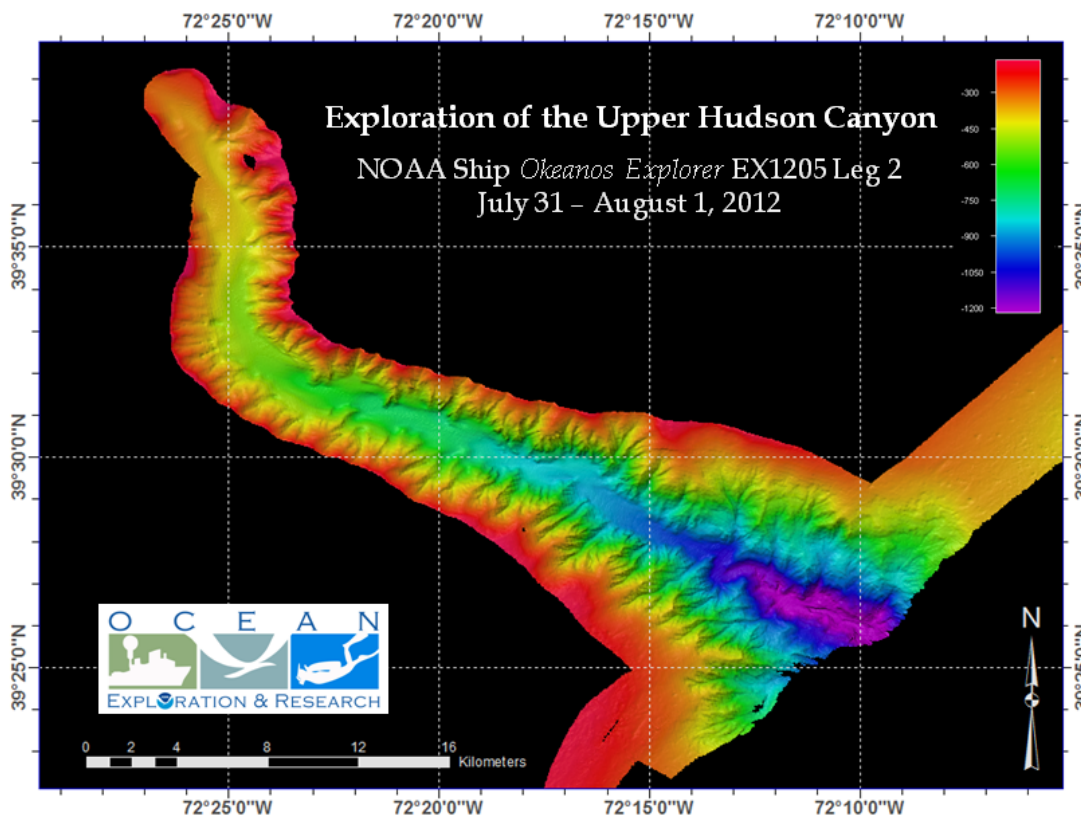


Figure 3. Screenshot of top view of bathymetry data collected over upper Hudson Canyon. Depth units in meters, vertical exaggeration 3, 30 meter data resolution. Map created ArcMap.

5. Mapping Statistics

Dates of cruise	July 28 – August 3, 2012
Ship's draft Start of cruise End of cruise	Fore: 14' 9", Aft: 14' 0.25" Fore: 14' 4"; Aft: 14' 1.5"
Linear kilometers of survey with EM 302	1,940
Square kilometers mapped with EM 302	4,578
Number / Data Volume of EM 302 raw bathymetric / bottom backscatter multibeam files (.all)	166 files/ 25.5 GB
Number / Data Volume of EM 302 water column multibeam files	165 files / 63 GB
Number / Data Volume of EK 60 water column split beam files (.raw)	189 / 19.1 GB
Number / Data Volume of sub-bottom sonar files (.segy, .kea, .keb)	30 / 0.5 GB
Number of XBT casts	33
Number of CTD casts (including test casts)	0



6. Mapping Sonar Setup

Kongsberg EM 302 Multibeam Sonar

The NOAA Ship *Okeanos Explorer* is equipped with a 30 kHz Kongsberg EM 302 multibeam sonar capable of mapping the seafloor in 0 to 8000 meters of water. The system generates a 150° beam fan containing up to 432 soundings per ping in waters deeper than 3300 meters. In waters less than 3300 meters, the system is operated in multi-ping, or dual swath mode, and obtains up to 864 soundings per ping, by generating two swaths per ping cycle. The multibeam sonar is used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter. Backscatter represents the strength of the acoustic signal reflected from a target, such as the seafloor or bubbles in the water column.

Kongsberg EK-60 Split-Beam Sonar

The ship is also equipped with one Kongsberg EK 60 split-beam fisheries sonar. The 18 kHz transducer and transmits a 7° beam fan. This sonar is a quantitative scientific echosounder calibrated to identify the target strength of water column acoustic reflectors - typically biological scattering layers, fish, or gas bubbles – providing additional information about water column characteristics and anomalies.

Knudsen Sub-bottom Profiler

Additionally, the ship is equipped with a Knudsen 3260 sub-bottom profiler that produces a frequency-modulated chirp signal with a central frequency of 3.5 kHz. This sonar is used to provide echogram images of shallow geological layers underneath the seafloor to a maximum depth of about 80 meters below the seafloor. The sub-bottom profiler is normally operated to provide information about the sedimentary features and the bottom topography that is simultaneously being mapped by the multibeam sonar. The data generated by this sonar is fundamental to helping geologists interpret the shallow geology of the seafloor.

7. Data Acquisition Summary

Mapping operations included EM 302 multibeam, EK 60 split-beam, and Knudsen 3260 sub-bottom profile data collection.

Survey lines were planned to maximize either bathymetry edge matching of existing data or data gap filling in areas where existing bathymetry coverage existed. In regions with no existing data, lines were planned to optimize potential exploration discoveries.

Throughout the cruise multibeam data quality was monitored in real-time by acquisition watch standers. Ship speed was adjusted to maintain data quality as necessary and line spacing was planned to ensure at



least ¼ swath width overlap between lines. Cutoff angles in SIS were generally left wide open for maximum exploration data collection and were adjusted on both the port and starboard side to ensure the best data quality and coverage. Data were corrected for sound velocity in real-time using the Reson SVP-70 data at the sonar head, and profiles from Expendable Bathythermographs (XBTs) that were conducted at intervals no greater than 6 hours, or as dictated by local oceanographic conditions.

Simrad EK 60 18 kHz split-beam water column sonar data were collected continuously during the cruise. The screenshot below shows data holdings in www.ncei.noaa.gov (last accessed 4 April 2019).

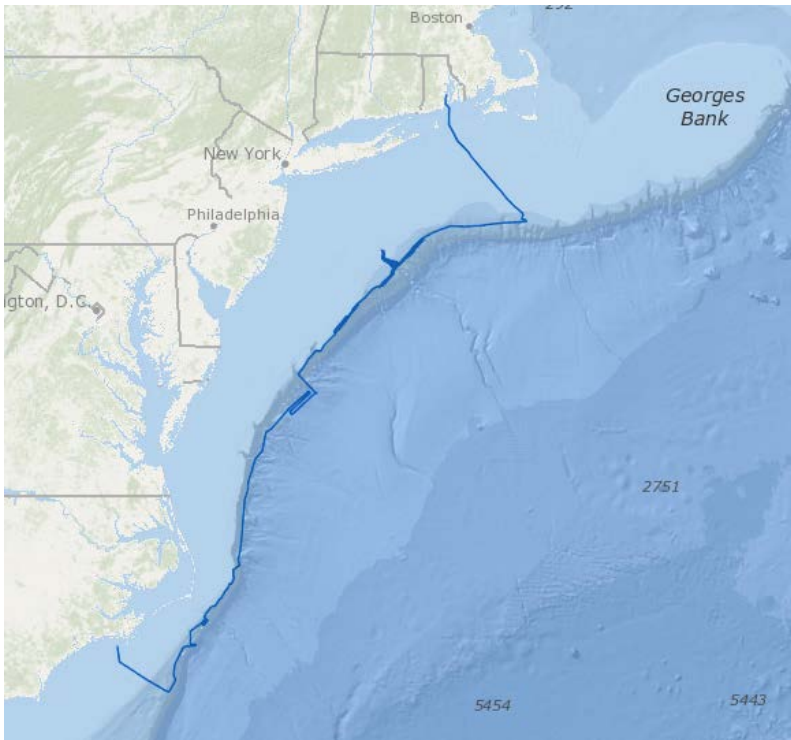


Figure 4. Screenshot of Simrad EK 60 18 kHz split-beam sonar data tracklines (in blue) collected during EX-12-05 Leg 2.

Knudsen 3260 sub-bottom profiler data were collected daily from 1000 – 1800 local ship time. The screenshot below shows data holdings in www.ncei.noaa.gov (last accessed 4 April 2019).

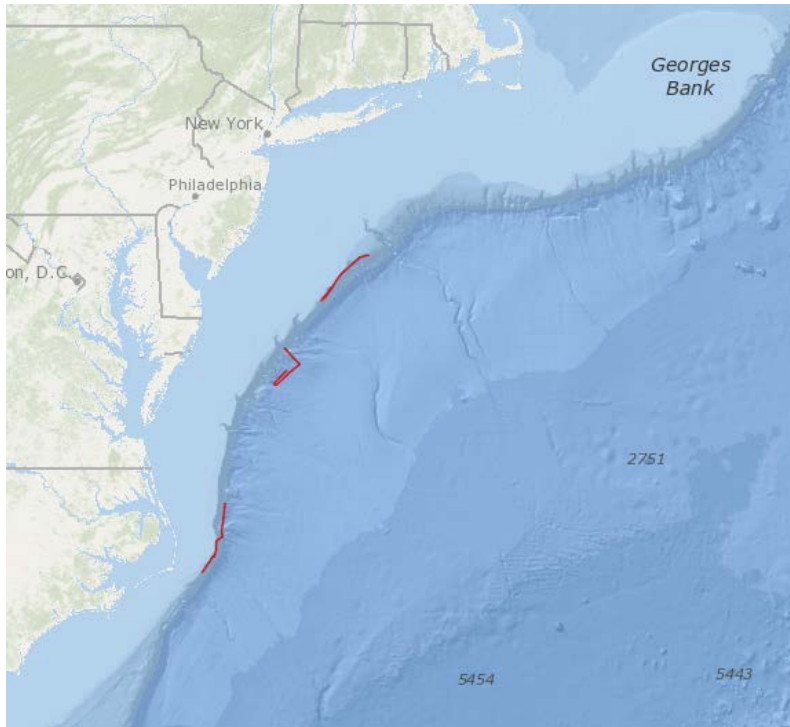


Figure 5. Screenshot of sub-bottom profiler data tracklines (in red) collected during EX-12-05 Leg 2.

8. Multibeam Sonar Data Quality Assessment and Data Processing

EM 302 Built-in Self Tests (BISTs) were run throughout the cruise to monitor multibeam sonar system status and are available as ancillary files in the sonar data archives. Raw multibeam bathymetry data files were acquired by SIS, and then imported into Caris HIPS and SIPS for processing. In Caris, attitude and navigation data stored in each file were checked and erroneous soundings were flagged off. Gridded digital terrain models were created and posted to the ship's ftp site for daily transfer to shore. Final bathymetry QC was completed post-cruise onshore at the Center for Coastal and Ocean Mapping at the University of New Hampshire. With the vast majority of surveying completed in deep water, depth measurements were not adjusted for tides, as they are an essentially insignificant percent of the overall water depth.

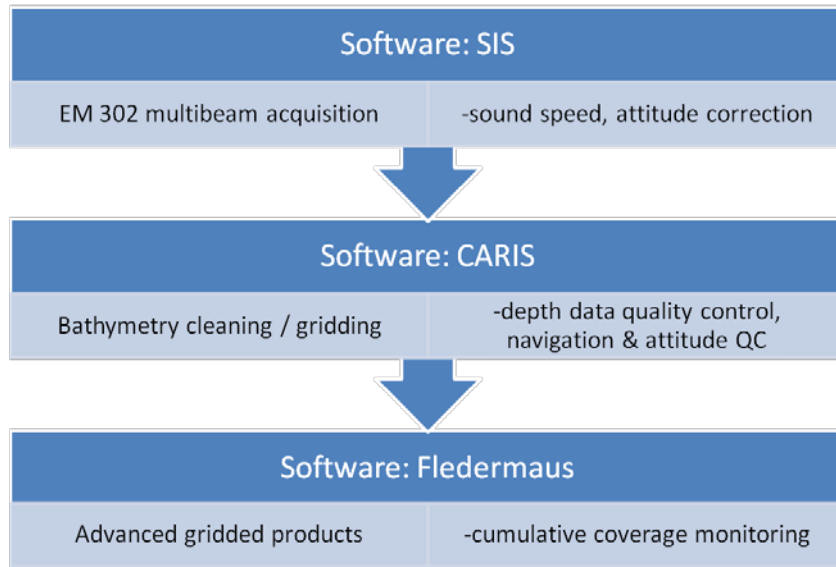


Figure 6. Shipboard multibeam data flow.

Crosslines

Due to cruise being cut short for electrical failure, no crossline was conducted. However, crosslines conducted on the cruises directly before and after EX-12-05 Leg 2 showed excellent data quality.

EM 302 Patch Test

The annual multibeam patch test was conducted during cruise EX-12-01 and the results are available in the 2012 NOAA Ship *Okeanos Explorer* Survey Readiness Report which is available in the NOAA Central Library.

EM 302 Multibeam Water Column Backscatter Data Processing

Water column data was reviewed daily throughout the cruise to examine for the presence of seeps and other water column anomalies.

9. Data Archival Procedures

All mapping data collected by the NOAA Ship *Okeanos Explorer* are archived and publicly available within 90 days of the end of each cruise via the National Centers for Environmental Information (NCEI) online archives. The complete data management plan (which describes the raw and processed data formats produced for this cruise) is available as an appendix in the project instructions which is available in the NOAA Central Library.

Ancillary and supporting files are archived with the sonar datasets. These include:

EM 302 Multibeam bathymetry and bottom backscatter dataset:

- Mapping watchstander log
- Weather log
- Sound velocity profile log
- Multibeam acquisition and processing log
- Built-In-System-Tests (BISTs)
- Processor Unit Parameters
- Text files of telnet sessions on the EM 302 transceiver unit

Simrad EK split-beam water column dataset:

- Mapping watchstander log
- Weather log
- EK data log

Knudsen 3260 Sub-bottom Profiler dataset:

- Mapping watchstander log
- Weather log
- Sub-bottom data log

EM 302 Multibeam water column dataset:

- Mapping watchstander log
- Weather log
- Sound velocity profile log
- Multibeam acquisition and processing log
- Built-In-System-Tests (BISTs)
- Processor Unit Parameters
- Text files of telnet sessions on the EM 302 transceiver unit
- MB WCD review log if data were reviewed for presence of seeps in Fledermaus MidWater



At the time of writing this report, the following DOIs were available as permanent links to sonar datasets:

EM 302 water column data <http://doi.org/10.7289/V5736NT6>

EK 60 data <http://doi.org/10.7289/V5M906KW>

Sub-bottom data, supporting data, and informational logs are available in the NCEI Data Archives accessible at <https://www.ngdc.noaa.gov/>(last accessed 3/21/2019).

EM 302 bathymetry data, supporting informational logs, and ancillary files are available in the NCEI Data Archives accessible at <https://www.ngdc.noaa.gov/>(last accessed 3/21/2019).

10. Cruise Calendar

All times listed are local ship time, which was -4 hours from UTC

July/August 2012						
Sun	Mon	Tues	Wed	Thur	Fri	Sat
						28. Departed Morehead, NC. Mapping operations commenced.
29. In transit mapping continued.	30. In transit mapping continued.	31. In transit mapping continued. Commenced upper Hudson Canyon mapping.	1. Completed upper Hudson Canyon mapping. In transit mapping commenced.	2. Mapping operations suspended due to electrical malfunction. Commenced Transit to Davisville, RI. Arrived in port.		



11. Daily Cruise Log Entries

Generated from the daily expedition situation reports. All times listed are in local ship time which was Eastern Daylight Savings Time (EDT) (-4 hours from Coordinated Universal Time (UTC)).

July 28, 2012

Okeanos Explorer (EX) departed Morehead City, North Carolina at 1230 bound for the Atlantic Ocean and cleared the Beaufort Inlet sea buoy at approximately 1400. Multibeam, split-beam, and sub-bottom sonar data collection commenced at 1430 in approximately 30 meters of water. EX collected mapping data for the remainder of the day while transiting across the continental shelf to the south of Cape Lookout Shoals.

Wind and sea conditions are calm and the ship is making a nominal speed of 8.5 knots while conducting transit mapping operations. The EM 302, EK 60, and Knudsen 3260 sonars are fully operational and data quality is high.

July 29, 2012

Okeanos Explorer (EX) reached the edge of the continental rise and began transit mapping to the northeast along the continental shelf break. Multibeam and split-beam sonar data were collected continuously and sub-bottom sonar data were collected between 1000 and 1800 ship time.

Wind and sea conditions are calm and the ship is making a nominal speed of 8.5 knots while conducting transit mapping operations. The EM 302, EK 60, and Knudsen 3260 sonars are fully operational and data quality is high.

July 30, 2012

Okeanos Explorer (EX) continued transit mapping to the northeast along the continental shelf break throughout the day. Limited focused survey mapping operations were conducted in the vicinity of Spencer, Lindenkohl, and Carteret Canyons in order to increase coverage within MARCO identified priority areas. Multibeam and split-beam sonar data were collected continuously and sub-bottom sonar data were collected between 1000 and 1800 ship time.

July 31, 2012

Continued transit mapping to the northeast. Limited focused survey mapping operations were conducted in the vicinity of Babylon, Jones, Emery, and Uchupi Canyons in order to increase coverage within MARCO identified priority areas. Due to significant observed variability in sea water salinity and temperature, XBT profiles are being collected every three hours, or more often as dictated by physical oceanographic conditions. Heavy commercial fishing activity is taking place in and around the canyons necessitating periodic divergence from the line plan to avoid fishing vessels and gear.

August 1, 2012



Okeanos Explorer (EX) continued transit mapping to the northeast along the continental shelf break throughout the day. Focused survey mapping operations were conducted in the upper Hudson Canyon in order to increase coverage within a MARCO identified priority area. Multibeam and split-beam sonar data were collected continuously.

August 2, 2012

Okeanos Explorer (EX) continued transit mapping to the east along the continental shelf break until 0834. At that time mission operations were suspended due to electrical malfunctions on the bridge and the ship proceeded directly to Davisville, RI. Multibeam and split-beam sonar data were collected continuously until the ship reached the mouth of Narragansett Bay, RI. The ship arrived at the Port of Davisville, pier one, North Kingstown, RI at approximately 2130.

12. References

The 2012 NOAA Ship *Okeanos Explorer* Survey Readiness Report can be obtained in the NOAA Central Library or by contacting the NOAA OER mapping team at oar.oer.exmappingteam@noaa.gov.

The EX-12-05 Leg 2 Project Instructions can be obtained from the NOAA Central Library. The EX-12-05 Leg 2 Data Management Plan is an appendix of the project instructions.

EM 302 water column data <http://doi.org/10.7289/V5736NT6>

EK 60 data <http://doi.org/10.7289/V5M906KW>

Sub-bottom data, supporting data, and informational logs are available in the NCEI Data Archives accessible at <https://www.ngdc.noaa.gov/> (last accessed 3/21/2019).

EM 302 bathymetry data, supporting informational logs, and ancillary files are available in the NCEI Data Archives accessible at <https://www.ngdc.noaa.gov/> (last accessed 3/21/2019).

The following was used for reference throughout the cruise:

Sandwell, D. T., and W. H. F. Smith, Global marine gravity from retracked Geosat and ERS-1 altimetry: Ridge Segmentation versus spreading rate, J. Geophys. Res., 114, B01411, doi:10.1029/2008JB006008, 2009.

NOAA Nautical Charts

