NOAA Office of Ocean Exploration

Mission Capabilities of the *Okeanos Explorer* Program

January 2014

Overview

NOAA's Office of Ocean Exploration conducts a global program of collaborative, systematic ocean exploration with NOAA Ship *Okeanos Explorer*. This unique model of exploring provides NOAA and the public with federal standards-based real- or near-real time open data and deepwater environmental intelligence for priority ocean areas, habitats, biology, and processes. It contributes to NOAA's Next Generation Strategic Plan, Habitat Blueprint, and the Five-Year Research and Development Plan. Relying upon the inputs of a collaborative process with partners and stakeholders, expeditions are planned and executed for mutual and broad community and public benefit, and catalyze follow-on research and management activities.

The *Okeanos Explorer* Program operates this unique collaborative exploration paradigm which allows teams of scientists to guide expeditions from shore-based Exploration Command Centers, similar to NASA remote expeditions to other planets. Using "telepresence" technology, internet-based collaboration tools, and a dedicated broadband satellite communications and data transmission system, data and information is quickly made widely available to scientists, educators, the media, and the general public. This allows for any number of interested scientists, marine resource managers, educators, students, and the general public to participate in expeditions in real-time, strengthening and engaging the community of ocean explorers.

OE provides and maintains the mission systems and the Office of Marine and Aviation Operations provides and maintains ship systems and personnel.

This document provides detailed information on the mission operating principles, capabilities, and systems of the NOAA *Okeanos Explorer* Program.

EXPLORE
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Exploration Operating Principles and Concept of Operations

The NOAA *Okeanos Explorer* Program was developed through workshops with NOAA and external partners. These discussions yielded exploration operating principals and a concept of operations.

Core Operating Principles:

- Systematically explore unknown and poorly known areas identified by NOAA, other agencies, and the broader exploration and research community
- Expeditions will be interdisciplinary and engage scientists on behalf of the community
- Collect and process standardize, high-quality data and information, and make it publicly available in as real- or near-real time as possible to catalyze immediate scientific and management activities
- Use platform and systems to utilize, test, and advance new exploration systems, sensors, and methods
- Provide onshore and onboard opportunities for public engagement and training the next generation of explorers

Concept of Operations:

- *Reconnaissance* — (1) search unknown areas for anomalies and initiate site characterization; (2) maximize operations during transits through poorly known deep-water areas.
- *Site characterization* — focus on specific poorly known targets with high discovery potential.

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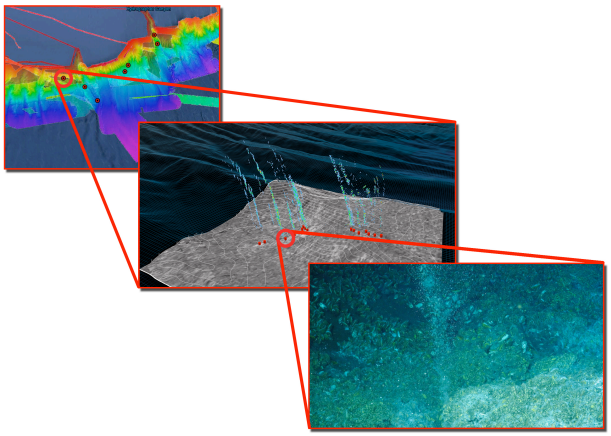
- *Water column exploration* — (1) advance capabilities to characterize water mass properties; (2) improve capabilities to search for anomalies;
- *Surveys of Opportunity* — consider surveys of opportunity that add to the exploration mission, advance new exploration capabilities, or enhance the collection, preservation, and public distribution of data.

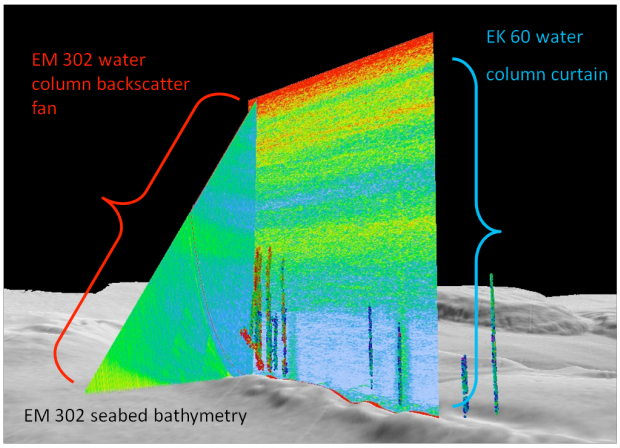
Core Capabilities

The *Okeanos Explorer* utilizes the following cutting edge deep-water capabilities to explore and characterize unknown or poorly known areas, features, and phenomena from 500 to 6000 meters depth.

Mapping and Water Column Systems



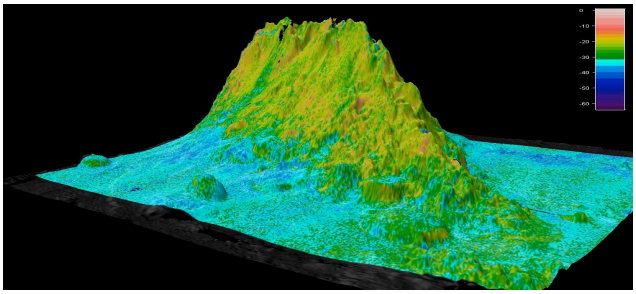
The *Okeanos Explorer* is equipped with a 30 kHz Kongsberg EM 302 multibeam sonar, a 3.5 kHz Knudsen SBP 3260 sub-bottom profiler, and an 18 kHz Kongsberg EK-60 single-beam sonar. During mapping operations the multibeam continuously records seafloor bathymetry, seabed backscatter, and water column backscatter data. The water column backscatter from both the EK-60 and the multibeam are highly effective at detecting gaseous anomalies in the water column. Additionally, sub-bottom profile data is collected at specific locations of interest during the day.



The multibeam is optimized for working in water depths of 500-6000 meters. The system can be operated in two modes – CW (continuous waveform) or FM (frequency modulated) mode. FM mode allows a larger swath to be mapped compared to traditional deep water multibeam systems. In shallower water depths (less than 3300 meters), the sonar also utilizes multi-ping technology (dual swath) where two pings are simultaneously sent into the water, thereby increasing the sounding data density.

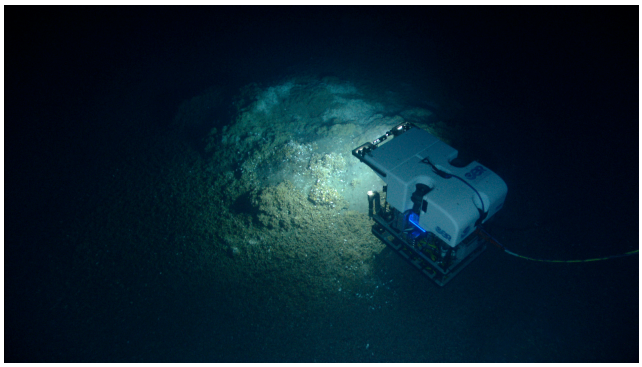
Summary map products created with the processed acoustic data are generated on a daily basis and immediately made available to collaborating scientists on shore via the ship's telepresence system for operational use. At the conclusion of each cruise, all collected raw sonar data and finalized summary map products, as well as associated metadata, are delivered to the National Geophysical Data Center (http://www.ngdc.noaa.gov), where they are archived and made available to the general public within 15 to 90 days.

The *Okeanos Explorer* is equipped with a conductivity, temperature, and depth (CTD) system



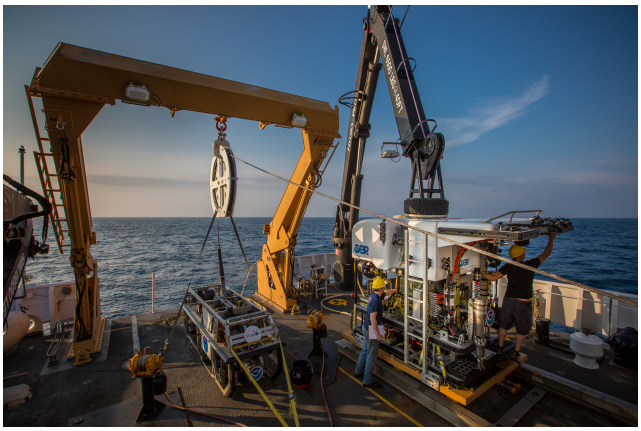
with rosette for collecting oceanographic data and water samples. The Seabird Electronics Model 9/11+ CTD is in a 24-position rosette frame with a seabird SBE-32 carousel. There are 24 2.5L niskin bottles. The SBE 9+ underwater unit is depth rated to 6800 meters and possesses dual conductivity and temperature sensor pair. This system has four ports available for up to 8 auxiliary sensors. Additional sensors installed on the CTD include: altimeter, Light Scattering (LSS), Dissolved Oxygen (DO), Oxygen Reduction Potential (ORP) and Altimeter.

A Lockheed Martin Sippican MK-21 expendable bathythermograph (XBT) system with a portable hand-held launcher is used for obtaining sound velocity profiles while underway. The ship's hull installed sound velocity probe (SVP) is also used in real-time multibeam data acquisition. These sound velocity profiles are processed and entered into the multibeam echosounder data acquisition software for accurate bathymetry data collection and provides valuable water column characterization data.



The onboard scientific seawater system (SSS) provides a continuous flow of water through the SBE 38 remote temperature probe and the SBE 45 micro-thermosalinograph (TSG). This system provides temperature, conductivity, salinity and sound velocity of the sea surface. Additional raw water connections in the wet lab for adding other sensors are also available.

Remotely Operated Vehicles (ROVs)



The *Okeanos Explorer* is equipped with OE's dedicated, fully integrated, dual-body ROV system. The ROV *Deep Discoverer* (D2) was put into service in 2013 and is capable of diving to 6000 meters and has a 200 lbs (in air) scientific payload for additional sensors. D2's primary data set is high definition video collected by two HD cameras. In addition to the HD video cameras, D2 carries a Sea Bird 9/11+ CTD with dissolved oxygen sensors. D2 has a unique lighting design with LED lights located on four swing arms that allow for the position and angle of the light to be adjusted for optimal imaging. In total D2 brings 96,000 lumens of light to the sea floor. The system is also capable of high-resolution ROV navigation using Doppler (DVL) bottom lock and PHINS heading reference, with an accuracy of 0.1% of distance traveled. Currently the *Okeanos Explorer* Program does not collect physical samples with the ROV pending completion of an open access sampling protocol (TBD 2014).

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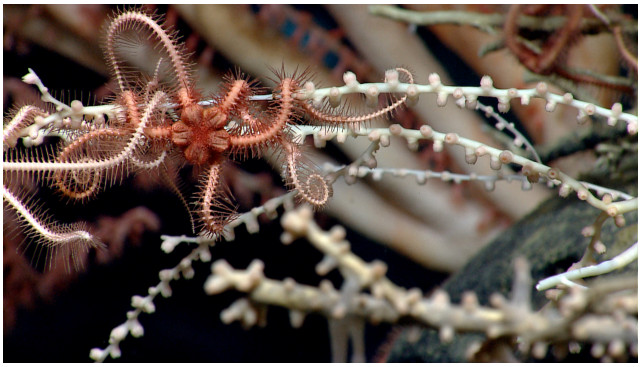

The second body of the system is the camera platform *Seirios* which provides additional lighting and an “aerial” view of D2 while she investigates the seafloor. Like D2, *Seirios* carries two HD cameras, a Sea Bird 9/11+ CTD with DO2 sensors and 72,000 lumens of light.

Telepresence

The *Okeanos Explorer* is the leading platform for collaborative telepresence-enabled exploration, enabling a shore-based team of scientists and students to fully engage in an ongoing expedition.

Telepresence operations integrate seven years worth of development and investment in specialized protocols, hardened high-speed satellite networks, internet-based collaboration tools, broadcast industry standard video/audio management and product generation solutions, standards-based data management systems, terrestrial networks (Internet 2, shore-based servers), commodity internet streaming, and web and social media interfaces. OER provides the expert staff to develop, maintain, and operate these systems, including shore-based systems at Exploration Command Centers (ECCs) and the University of Rhode Island’s Inner Space Center, and the terrestrial and satellite links.

The *Okeanos Explorer* Program uses telepresence to engage a theoretically unlimited number of scientists and managers on shore in real-time, minute-to-minute, collaborative decision making during mapping, CTD, and ROV operations. Simultaneously, thousands of general public viewers can tune in online to watch and listen to the ongoing exploration.

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On the Internet:
http://oceanexplorer.noaa.gov/okeanos