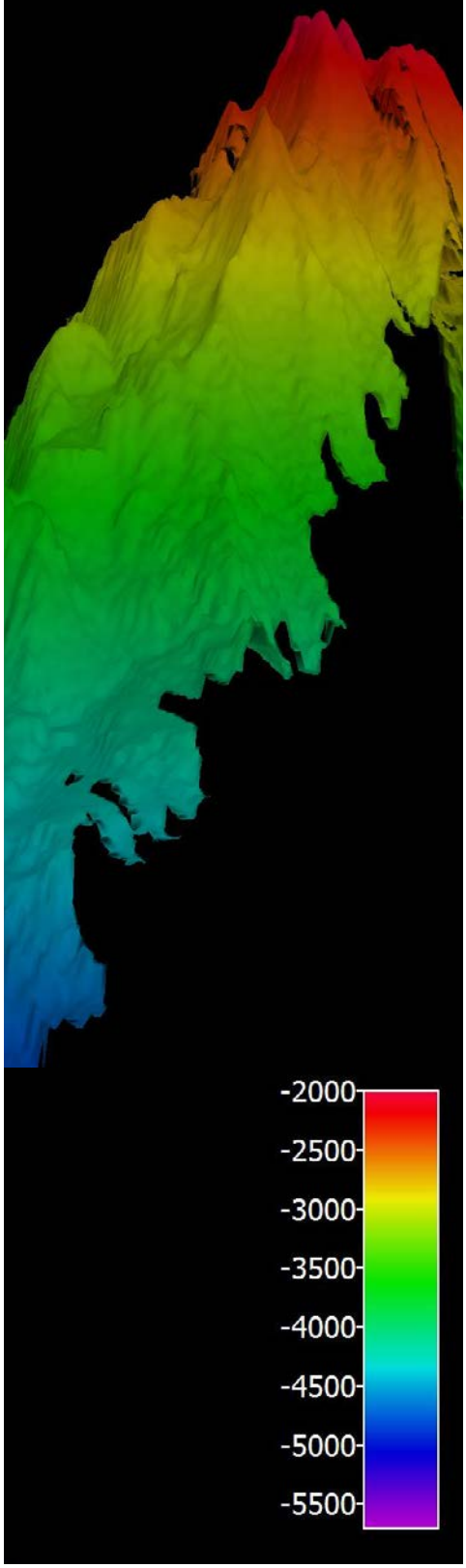


Introduction to Ships of Exploration and Their Strategy for Ocean Exploration

On August 13, 2008, the NOAA Ship *Okeanos Explorer* was commissioned as "America's Ship for Ocean Exploration;" the only federal U.S. ship whose sole assignment is to systematically explore our largely unknown ocean for the purposes of discovery and the advancement of knowledge. Similar ships are operated by the Schmidt Ocean Institute (R/V *Falkor*) and the Ocean Exploration Trust (E/V *Nautilus*). These three ships of exploration are briefly described below.

While specific activities aboard these ships vary from mission to mission, they all use a similar overall strategy for exploring Earth's ocean: to develop baseline information about the biological, geological, and water chemistry features of unexplored areas to provide a foundation for future exploration and research. Baseline information includes:

- High resolution maps of the area being explored, as well as areas that the ship crosses while underway from one location to the next (underway reconnaissance);
- Data about water column chemistry and other features; and
- High definition video of biological and geological features in the exploration area (site characterization), as well as additional data about water chemistry, living organisms, and geologic features in this area.

Four key technologies are used to obtain this baseline information:

- Multibeam sonar mapping system and other types of sonar that can detect specific features in the water column and on the seafloor;
- Conductivity, Temperature and Depth profilers (CTDs) and other electronic sensors to measure chemical and physical seawater properties;
- A Remotely Operated Vehicle (ROV) capable of obtaining high-quality imagery and samples in depths as great as 6,000 meters; and

Mulitbeam image of a seamount rising approximately 3,000 meters (9,840 feet) from the seafloor. Image courtesy of the NOAA OER, Mountains in the Deep: Exploring the Central Pacific Basin.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1705/dailyupdates/media/may17-1.html

- Telepresence technologies that allow scientists with many different areas of expertise to observe and interact with exploration activities, though they may be thousands of miles from the ship.

For additional information about these technologies and the types of data they produce, please see the introductory pages for Sonar and Multibeam Mapping, Water Column Investigations, Remotely Operated Vehicles and Autonomous Underwater Vehicles, and Telepresence.

The NOAA Ship *Okeanos Explorer*, America's ship for ocean exploration. Image courtesy NOAA. *http://oceanexplorer.noaa.gov/okeanos/explorations/ex1702/logs/mar1/media/okeanos.html*

NOAA Ship *Okeanos Explorer*

Missions of the *Okeanos Explorer* are focused on initial baseline characterizations of the basic parameters described above. During *Okeanos Explorer* expeditions, data are collected using a variety of advanced technologies. The ship is equipped with four different types of mapping sonars that collect high-resolution data about the seafloor and the water column, as well as a dual-body remotely operated vehicle (ROV) capable of diving to 6,000 meters (19,700 feet) and other instruments to help characterize the deep ocean. Expeditions typically consist of either 24-hour mapping operations or a combination of daytime ROV dives and nighttime mapping operations.

Most of the scientists participating in *Okeanos Explorer* missions remain on shore, thanks to telepresence technology. The ship is equipped with a high-bandwidth satellite communications system capable of transmitting data to scientists and technicians on shore. Using this technology, the ship sends multibeam mapping data; data collected from ship sensors; and real-time, high-definition video feeds from the ROV at high speeds. Scientists can view the live feeds from Exploration Command Centers ashore, or from the comfort of their own desks. These scientists add their expertise to missions no matter where in the world the ships, or the scientists, are located. The same telepresence technology also allows live seafloor video and other data to be broadcast over standard Internet connections, bringing the excitement of

The VSAT (large dome; stands for "Very Small Aperture Terminal") is the critical piece of infrastructure that makes telepresence possible. Image courtesy NOAA OER, Deepwater Wonders of Wake *http://oceanexplorer.noaa.gov/okeanos/explorations/ex1703/logs/mar16/welcome.html*

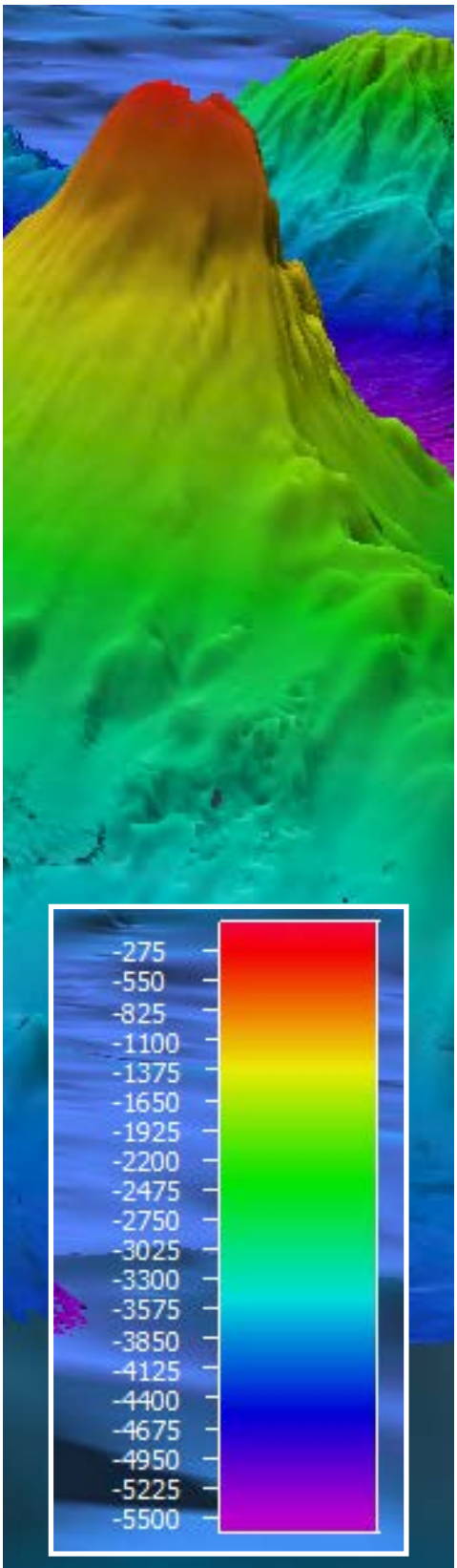
ocean exploration and discoveries into classrooms, newsrooms, and homes—to anyone who has an Internet connection and a passion for learning about the ocean.

Since being commissioned in 2008, NOAA Ship *Okeanos Explorer* has traveled the globe, exploring everywhere from the Indonesian 'Coral Triangle Region," to benthic environments in the Galápagos, canyons and seamounts off the Northeast U.S. coast, and marine protected areas within the Pacific. By collecting baseline information in never-before-explored areas, *Okeanos Explorer* expeditions further our knowledge of many previously unexplored areas while setting the stage for future in-depth exploration activities.

Vital Statistics:

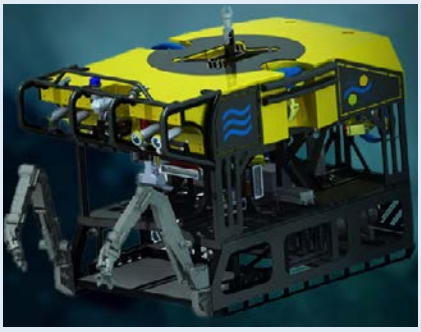
Commissioned: August 13, 2008; Seattle, Washington
Length: 224 feet
Beam: 43 feet
Draft: 15 feet
Displacement: 2,298.3 metric tons
Berthing: 49, including crew and mission support
Operations: Ship crewed by NOAA Commissioned Officer Corps and civilians through NOAA's Office of Marine and Aviation Operations (OMAO); Mission equipment operated by NOAA's Office of Ocean Exploration and Research.
For more information, visit *http://oceanexplorer.noaa.gov/okeanos/welcome.html*.

Members of the on-ship science team prepare a sample in the wet lab aboard NOAA Ship *Okeanos Explorer*. Image courtesy of the NOAA OER, Mountains in the Deep: Exploring the Central Pacific Basin.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1705/dailyupdates/media/apr30-2.html



Section of a multibeam image of Pao Pao Seamount with inset of depth scale in meters. Image courtesy of the NOAA Discovering the Deep: Exploring Remote Pacific MPAs 2017.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1703/dailyupdates/media/mar9.html

A CTD (Conductivity, Temperature, Depth). Image courtesy NOAA OER.
http://oceanexplorer.noaa.gov/explorations/12fire/background/plumes/media/ctd_closeup.html



ROV SuBastian
https://schmidtocean.org/technology/robotic-platforms/4500-m-remotely-operated-vehicle-rov/

The sonar gondola beneath *Falkor's* bow.
A big challenge for sonar systems on most ships is bubbles. As a ship moves faster, or encounters heavy seas, bubbles formed at the surface wash down the hull, where they can interfere with the sending and receiving of sonar signals. To overcome this issue, Falkor's sonar systems are installed on the bottom of a streamlined platform. The sonar systems are embedded into the bottom surface of this gondola, where they are isolated from bubbles, which pass between the hull and the top of the gondola.
https://schmidtocean.org/technology/seafloor-mapping/

The R/V Falkor. Image courtesy Schmidt Ocean Institute.
https://schmidtocean.org/collection/falkor/

R/V *Falkor*

R/V *Falkor* is operated by the Schmidt Ocean Institute, a private non-profit operating foundation established to foster a deeper understanding of our environment by combining advanced science with state-of-the-art technology to achieve lasting results in ocean research, to catalyze sharing of the information, and to communicate this knowledge to audiences around the world.

Technologies aboard R/V *Falkor* include:

- Sonars: EM 302 deep water multi-beam sonar, EM 710 shallow water multi-beam, Simrad EK60 echo sounder, Knudsen CHIRP 3260 sub-bottom profiler, Teledyne Acoustic Doppler Current Profiler;
- CTD sampling rosette and other water column sensors;
- ROV Seaeye *Falcon* with a 300m depth rating, high definition camera, 5-function hydraulic manipulator arm, and hand winch spooled with 600m of protected fiber tether;
- ROV *SuBastian* with a 4500 m depth rating, and fitted with a suite of sensors and scientific equipment to support scientific data and sample collection.
- Mammal and Bird Observation from open air Observation Deck above Falkor's Bridge; and
- Support for outreach and operations requiring continuous global internet access including VSAT System with dual tracking antennas, video routing from 64 input sources to 64 outputs, internal streaming to Android and iOS devices, modulation over Advanced Television Systems Committee (ATSC) to any TV monitor or projector on *Falkor*, and Conference/Library Room to broadcast presentation and support for video conference calls.

Vital Statistics:

Built: 1981, Lübeck, Germany
Length: 272 feet
Beam: 42 feet
Draft: 19 feet
Tonnage: 2,260 metric tons
Berthing: 41, including crew and mission support
For more information, visit *https://schmidtocean.org/falkor/*

The E/V Nautilus explores the ocean. Image courtesy Ocean Exploration Trust.
http://www.nautiluslive.org/tech

E/V *Nautilus*

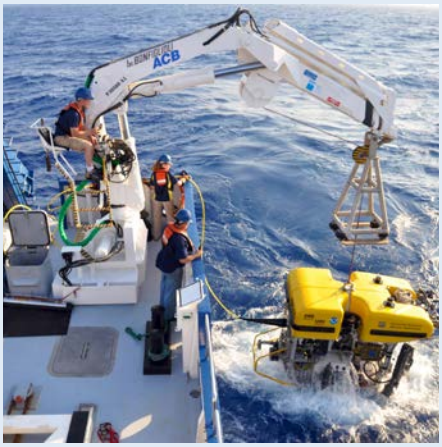
E/V *Nautilus* is operated by the Ocean Exploration Trust (OET), founded in 2008 by Dr. Robert Ballard to explore the ocean. In addition to conducting scientific research, OET offers its expeditions to explorers on shore via live video, audio, and data feeds from the field; and brings educators and students of all ages aboard during E/V *Nautilus* expeditions, offering hands-on experience in ocean exploration, research, and communications.

E/V *Nautilus* is equipped with all of the latest in ocean technology including:

- Multiple sonars and multibeam mapping instruments;
- CTD sampling rosette and other electronic sensors;
- Telepresence capability; and
- ROVs *Hercules* and *Argus*, a tandem system with equipped with high-definition video, sonar, CTD, and a variety of sampling systems.

Vital Statistics:

Built: 1967, Rostock, E. Germany
Length: 211 feet
Beam: 34 feet
Draft: 15 feet
Tonnage: 1249 tons
Berthing: 48, including crew and mission support
For more information, visit *http://www.nautiluslive.org/tech*



Hercules is recovered by operators on board the E/V Nautilus after a dive. Image courtesy of The Ocean Exploration Trust.
http://oceanexplorer.noaa.gov/technology/subs/hercules/hercules-recover.html

Argus acts as a stabilizing platform for Hercules, following the ROV into the water. Image courtesy of The Ocean Exploration Trust.
http://oceanexplorer.noaa.gov/technology/subs/hercules/argus.html

The Kongsberg EM 302 Multibeam Echosounder system, mounted on the ship's hull, can efficiently map the seafloor in waters ranging from 10 meters to 7,000 meters deep, all while the ship cruises at up to 10 knots. The sonar collects bathymetric data, surface sediment characteristics, and water column data. The information it collects helps identify areas or features of interest to plan ROV dives. Image courtesy Ocean Exploration Trust.
http://www.nautiluslive.org/tech

Notes