OCEAN EXPLORATION & RESEARCH

The NOAA Ship *Okeanos Explorer* Education Materials Collection

For Grades 5 – 12

Volume 2:

How Do We Explore?

National Oceanic and Atmospheric Administration
Office of Ocean Exploration and Research

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Foreword

It is through exploration that we obtain our fundamental knowledge and basic understanding of things and places previously unknown to us. When it comes to ocean exploration, one must consider that the ocean is part of a much larger integrated system - neither can one separate it from the atmosphere at its surface nor the deepest parts of Earth's interior at spreading centers and subduction zones. As such, ocean exploration is, by definition, multidisciplinary.

As I write this, I am at sea with a team of scientists exploring the NE Lau Basin in the South Pacific Ocean (*http://oceanexplorer.noaa.gov/explorations/12fire/welcome.html*). We are exploring deep-sea volcanoes and their associated hydrothermal vent systems and are seeing stunning deep-sea ecosystems harboring new species with nearly every dive of the remotely operated vehicle. As one can imagine, our equipment and instrumentation is highly technical and the scientific, engineering and technical expertise is remarkable. The codependency of ocean exploration on engineering and technology and engineering and technology on the sciences employed to explore the ocean is striking. Our sciences steer advances in engineering and technology; similarly, engineering enables advancements in ocean exploration—they are inextricably intertwined.

Recognizing, among many other elements, the overlap between science and engineering and the importance of teaching the practices of both, science education has recently seen a major change in the U.S. with the release of the Next Generation Science Standards (NGSS). The precursor to the development of the NGSS, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (Framework)*, notes, "Although the intrinsic beauty of science and a fascination with how the world works have driven exploration and discovery for centuries, many of the challenges that face humanity now and in the future—related, for example to the environment, energy, and health —require social, political, and economic solutions that must be informed deeply by knowledge of the underlying science and engineering." (National Research Council, 2012).

Ocean exploration presents a unique context through which to support the NGSS. The very topic in and of itself captures imaginations, intrigues young minds, has the potential to inspire an ocean science-literate citizenry and foster the innovative thinking that leads to engineering and technology literacy. In 2008, the National Oceanic and Atmospheric Administration (NOAA) commissioned the NOAA Ship *Okeanos Explorer*; the first Federally-dedicated ship to explore the ocean in an effort to increase the pace, efficiency and scope of ocean exploration. The *Okeanos Explorer* is equipped with advanced technological capabilities and assets which are strategically applied during ocean expeditions by a multidisciplinary exploration team. *How Do We Explore?*, Volume 2 of the NOAA Ship *Okeanos Explorer Education Materials Collection* has been designed to assist educators with teaching about these unique technological capabilities and assets and how the ocean sciences are integrated into them to explore the little-known ocean world. To emphasize the codependence of science and engineering, these lessons support the Performance Expectations and associated Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas of the NGSS.

Excitement at the 2012 USA Science & Engineering Festival held in Washington, DC. Image courtesy of NOAA.

The essential importance of science education in stimulating the innovations needed to meet the challenges of ocean exploration extends far beyond scientific curiosity. The support of an educated public, informed decision-makers, and a globally-competitive workforce that understands the combined role that science, engineering and technology have in the development of innovative solutions and applications is paramount.

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NOAA Ship *Okeanos Explorer:* America's Ship for Ocean Exploration. Image courtesy of NOAA. *http://oceanexplorer.noaa.gov/okeanos/about.html*

About this Volume

An essential component of NOAA's Ocean Exploration and Research Program mission is to enhance understanding of ocean exploration, and build interest in careers that support ocean-related work. To help fulfill this mission, the *Okeanos Explorer Education Materials Collection* has been developed to encourage educators and students to become personally involved with the voyages and discoveries of the *Okeanos Explorer* – America's first Federal ship dedicated to Ocean Exploration. In *Volume 2* of the *Education Materials Collection, How Do We Explore?* we focus on the methods used by modern ocean explorers, including the overall strategy for exploration aboard the *Okeanos Explorer*, as well as four of the technologies that contribute to this strategy: telepresence, multibeam sonar, instruments for water column studies, and remotely operated vehicles (underwater robots).

Lesson plans developed for *Volume 2* are correlated with Ocean Literacy Essential Principles and Fundamental Concepts as indicated in the back of this book. Additionally, a separate *online document* illustrates individual lesson support for the Performance Expectations and three dimensions of the *Next Generation Science Standards* and associated Common Core State Standards for Mathematics and for English Language Arts & Literacy. This information is provided to educators as a context or point of departure for addressing particular standards and does not necessarily mean that any lesson fully develops a particular standard, principle or concept.

Lessons also include links to other relevant lesson plans from NOAA's Office of Ocean Exploration and Research, as well as the Ocean Explorer Web site (*http://oceanexplorer.noaa.gov/*). Educators who use the ***Okeanos Explorer Education Materials Collection*** should regularly check the Education page on the *Okeanos Explorer* Web site (*http://oceanexplorer.noaa.gov/okeanos/edu/welcome.html*) for the latest information about new education materials and professional development opportunities.

Welcome aboard!

Notes: