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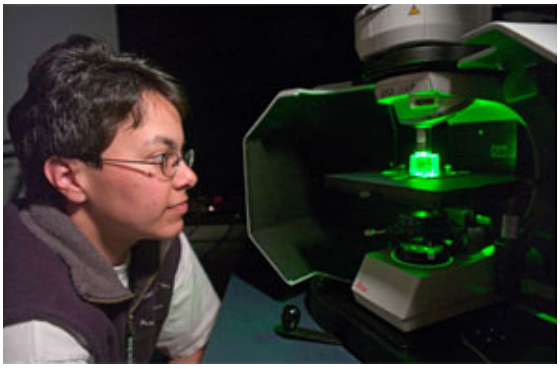
2008 Annual Report: Deep Ocean Exploration Institute

Vast areas of Earth's seafloor have yet to be explored, from dynamic areas near subduction zones where tectonic plates slide under other plates, in back-arc basins (behind subduction zones,) and along the mid-ocean ridge system, to more quiescent areas dominated by deep sediments that have accumulated over millions of years. The Deep Ocean Exploration Institute (DOEI) fosters multi-disciplinary study of physical, chemical, geological, and biological processes in all these areas and in the planet's interior, and development of the technology needed to access environments at and below the seafloor.



Enlarge Image

DOEI provided funding to researcher Sheri White to develop a laser Raman spectrometer for use in the deep sea to analyze the chemical composition and structure of materials. Many materials exist only under the unusual conditions of the deep sea and cannot be brought to the surface to study. (Photo by Tom Kleindinst, Woods Hole Oceanographic Institution)

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» Deep Ocean Exploration Institute

In 2008, DOEI funded twelve new research projects, many with co-investigators from different departments, to explore questions related to the Institute's three thematic areas: seafloor observatory science and instrumentation, Earth's deep biosphere (organisms living deep below the Earth's surface), and fluid flow in geologic systems. Highlights of some of these are below.

- Rob Reves-Sohn (G&G, the Geology and Geophysics Department) and Andy Solow (the Marine Policy Center) are applying statistical modeling techniques to existing data to identify and quantify the relationships between seismic (earthquake) activity and temperatures of heated fluids exiting hydrothermal vents at the TAG hydrothermal mound.
- Mark Behn and Brian Tucholke (both in G&G) study a very different type of fluid flow—magma. They use numerical modeling (mathematical representations of processes with equations and variables) to investigate factors affecting magma flow and its interactions with tectonic plates at mid-ocean ridges.
- Virginia Edgcomb (G&G) and Rebecca Gast (Biology Department) are considering another distinct environment, investigating whether single celled eukaryotic organisms (protists) are present and active in deep-sea sediments by analyzing material from four existing deep subsurface sediment cores. Their project includes developing RNA extraction protocols to help identify genetic signatures of these organisms.
- Greg Ventura and Chris Reddy (both in MC&G, the Marine Chemistry and Geochemistry Department) are also searching for evidence of organisms in sediments, specifically the molecular lipid remains of organisms, but in young, shallow sediments from another hydrothermal area, the Guaymas Basin off Mexico's coast, that are subject to rapid changes in temperature.
- And Ray Schmitt (in the Physical Oceanography Department) and Robert Petitt (in the Applied Ocean Physics and Engineering Department) are developing new instruments for use in the unusual hot brine pools deep in the Red Sea. Their high-range CTD (conductivity-temperature-depth recorder), designed to work in these very warm and salty waters, allows documentation of the detailed thermal and physical structure of these layered regions and provides estimates of heat and salt exchanges with adjacent water.

Other projects span a range of environments and topics, including the impact of hydrothermal plumes on the deep ocean, volcanism away from the central mid ocean ridge axis, the heterogeneity of the mantle, sulfur cycling (moving of sulfur-containing compounds) through subduction zones, sources of hydrothermal CO_2 in the Lau Basin in Tonga's waters, and the biology and geology of deep-sea brine areas of the Red Sea.

DOEI supported three Fellows in 2008: Jeff McGuire (G&G) uses recordings of seismic waves and ground deformation to investigate rupture processes and faulting, and is working to develop a real-time earthquake early warning system for the Pacific Northwest. Tim Shank (Biology Department) combines multiple genetic approaches to examine ecological and evolutionary factors that affect populations of deep-sea species, incuding deep-sea corals and hydrothermal vent fauna. Maurice Tivey (G&G) uses magnetic imaging to learn about the subsurface structure of hydrothermal vents.

As part of his 2008 Fellowship activities, Maurice Tivey planned the MORSS Colloquium on "Precious Metals from Deep-Sea Vents," with keynote speakers from the Rule of the Law Committee for the Oceans, the International Seabed Authority, Colorado School of Mines, and WHOI. A one and a half day workshop preceded the April 2009 colloquium; 98 people from 20 nations participated, including students from Papua New Guinea, Mauritius and Djibouti. The aim of the colloquium and workshop was to discuss issues related to deep-sea mining of seafloor massive sulfide deposits, a topic connected to society, the global economy, and the conservation of unique marine ecosystems. Media representatives attended, and the Associated Press bulletin was broadcast on more than three thousand web pages around the globe.

In addition to these research and fellow activities, an important new endeavor was launched in 2008 – the Ocean Ridge Initiative. Its purpose is to explore the largest continuous geologic feature on Earth – the mid-ocean ridge system. The Initiative acknowledges the value of the many unanticipated discoveries that have been made in the past along this system, such as the presence of unusual chemosynthesis-based biological communities at areas of hydrothermal venting.

A major focus of the Initiative will be development of new technologies for efficient surveying, sensing, and sampling of areas along and beneath the ridge, and for information exchange. A workshop held to identify the overarching vision of this initiative, needed technological advances, and specific projects to be carried out, drew thirty-six scientists and engineers from all of the five WHOI departments, as well as eight participants from communications and development.

As in years past, DOEI continued to promote WHOI educational and outreach opportunities. In 2008, DOEI provided support for two post-doctoral scholars, two graduate students, and the annual multi-disciplinary Geodynamics Program.

–*Margaret K. Tivey, Institute Director*

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Mail: Woods Hole Oceanographic Institution, 266 Woods Hole Road, Woods Hole, MA 02543, USA.
E-Contact: info@whoi.edu; press relations: media@whoi.edu, tel. (508) 457-2000
Problems or questions about the site, please contact webdev@whoi.edu