Print

2008 Annual Report: Marine Chemistry & Geochemistry

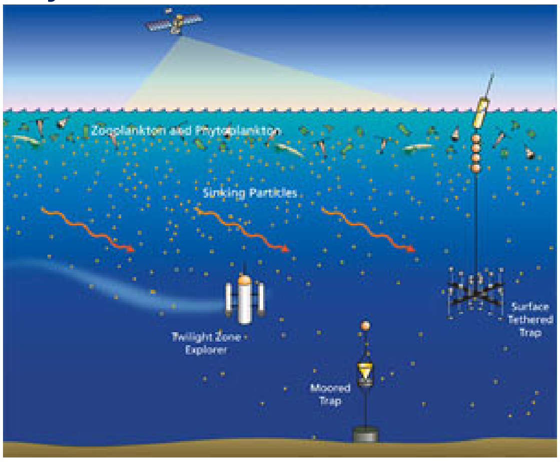
Scientists in the Marine Chemistry and Geochemistry (MC&G) Department seek to understand processes that drive chemical cycling in the ocean (chemicals moving between air, water, organisms, sediments and rock) and to learn how ocean chemistry influences and responds to biological activity and climate on Earth, now and in the past.

Ocean chemists increasingly work at the interfaces with other disciplines, because important new questions arise at these boundaries — questions that bridge not only seawater chemistry, but also processes that influence ocean life, geology and climate.

For example, novel techniques have revealed the remarkable diversity of single-celled microbes in the ocean and their powerful role in biogeochemical processes (processes involving organisms interacting with their physical and chemical environments). This is a vibrant area of interaction between chemists and biologists, including many Department members. In 2008, Assistant Scientist Tracy Mincer – who has expertise in both natural products chemistry and molecular biology – joined the MC&G staff to further strengthen such interactions.

MC&G scientists Scott Doney, Dan Repeta and Mak Saito participate in another research program at the biology-chemistry interface – a large, on-going NSF-sponsored, multi-investigator, multi-institutional program coordinated from Hawaii. Called “C-MORE” (Center for Microbial Oceanography: Research and Education) the program investigates biological and ecological diversity of marine microbes and their role in global processes.

2008 also marked the culmination of a major research program called “VERTIGO” (VERtical Transport In the Global Ocean) spearheaded by MC&G scientist Ken Buesseler, to understand processes in the middle depths of the ocean (approximately 100 to 1000 meters). This “mesopelagic” region is also called the “Twilight Zone” [Figure 1] – because of its location below the sunlit surface and above deep abyssal waters, and because of its enigmatic biological, chemical and physical processes.



Enlarge Image

FIGURE 1: An array of sampling technologies were utilized in the VERTIGO program to follow the fate of particles sinking from sunlit surface waters through the ocean’s dimly lit twilight zone. In particular, Ken Buesseler and engineer Jim Valdes designed a new-generation neutrally buoyant untethered vehicle called the Twilight Zone Explorer, that is swept along with the currents and surfaces periodically to relay data via satellite. (Illustration by Jack Cook, Woods Hole Oceanographic Institution)

Despite its mysteries, understanding this region is critical for assessing the ocean’s ability to remove CO_2 from the atmosphere via a “biological pump” – whereby photosynthetic organisms convert CO_2 into organic matter in surface waters, and sinking dead cell debris and fecal material remove this carbon to the deep ocean, sequestering it. The VERTIGO program used innovative sampling [Figure 2] and measurement technologies, developed with WHOI engineers and including contributions from MC&G scientists Karen Casciotti, Phoebe Lam, Carl Lamborg, and Ben Van Mooy. VERTIGO shed important new light on the Twilight Zone, and the findings were highlighted in a special issue of *Deep-Sea Research* that was published this year.

Enlarge Image

Figure 2: Recovery of a neutrally buoyant sediment trap (or “Twilight Zone Explorer”) following deployment as part of the VERTIGO program. (Woods Hole Oceanographic Institution)

Department members continue to make discoveries about processes at the bottom of the ocean. Postdoctoral investigator Giora Proskurowski – working with MC&G scientist Jeff Seewald and colleagues at the University of Washington and ETH Zurich in Switzerland – has been studying geochemical processes at the “Lost City” hydrothermal vent system on the Mid-Atlantic Ridge [Figure 3]. They found evidence for *non-biological* reactions that result in the synthesis of small organic (hydrocarbon) molecules under the geochemical and thermal conditions at Lost City. These findings, which have important implications for the origin of life on Earth, were reported in 2008 in the journal *Science*.

Enlarge Image

Figure 3: Gas-tight sampler attached to *Alvin* collecting fluid at Lost City hydrothermal field. (Courtesy of Deborah Kelley - University of Washington, Institute for Exploration, URI-IAO, and NOAA.)

Scientists in MC&G study not only chemical “species” (elements, organic compounds, isotopes) resulting from natural processes; they also investigate the types, sources, concentrations and impact of chemicals stemming from human activity. Much research has focused on the fate and impact of such chemicals after their release into the environment, but chemists at WHOI are trying to head off effects of potentially harmful chemicals even before they are produced.

For example, one of the most rapidly growing areas of technological innovation is nanotechnology. An important aspect of this involves carbon nanotubes –tubular arrangements of carbon molecules that exhibit remarkable mechanical properties. MIT/WHOI Joint Program student Desiree Plata, with MC&G scientist Chris Reddy and Dr. Phil Gschwend at MIT, has examined nanotubes' chemical properties and potentially harmful by-products from their manufacture. They found that some commercially available carbon nanotubes contain large amounts of toxic metal and carbon-containing impurities. These distinct chemical signatures may serve as 'fingerprints' to trace the sources of carbon nanotubes released into the environment [Figure 4].

In one regard, 2008 was no exception: MC&G scientists traveled extensively to undertake fieldwork in remote corners of the globe and under challenging conditions.

In April-May 2008 Laura Robinson and several colleagues participated in a research cruise on the ice breaker *Nathaniel B. Palmer* to study cold-water corals in the Drake Passage between Antarctica and the southernmost tip of South America - some of the most inhospitable waters in the world! [Figure 5]

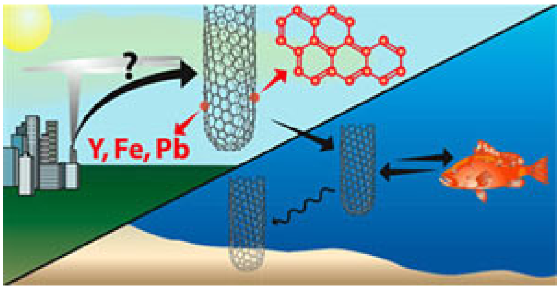
Corals inhabit many areas of the world's ocean, some living more than 3 miles deep. Deep-living corals' calcareous skeletons may hold important clues about past deep ocean variability and climate history, but their distributions, ecology and life histories are poorly known. The cruise brought together experts in coral ecology and habitats, seafloor mapping, and paleoclimate (Earth's past climate), to start building a coherent picture of temporal and spatial distributions of deep-sea corals in the Southern Ocean. Researchers used multibeam sonar and WHOI's TOWCAM camera system to document cold-water coral habitats, and used research trawls [Figure #6] and dredges to collect living and long-dead ("fossil") corals [Figure #7]. These samples are now being dated to determine how long they have been living in the Southern Ocean, and to select corals to use for paleoclimate estimates.

In the Arctic, MC&G scientists Elizabeth Kujawinski and Matt Charette joined Joint Program student Maya Bhatia and scientists from WHOI's Geology & Geophysics Department on the coast of Greenland, to examine the biogeochemical significance of materials transported in meltwater from the adjacent ice sheet. The WHOI Ocean and Climate Change Institute's Arctic Research Initiative funds supported this work. And in the tropics, Phoebe Lam transited the Atlantic from Barbados to the Cape Verde Islands and then onto the Canary Islands aboard R/V *Oceanus* to explore the sources of iron emanating from the African continent, and its role in ocean biological productivity.

Finally, in addition to their activities in the field and in the laboratory, MC&G scientists also helped to shape science policy and scientific programs through service on panels, in working groups and at conferences. Overall, it was a busy and highly successful year for the Department!

—Timothy Eglinton, Department Chair

Last updated: August 6, 2009



Enlarge Image

Figure 4: Environmental risk assessment and fate models for carbon nanotubes rely on detailed knowledge of nanotube composition. The work of Desiree Plata and colleagues reported in *Nanotechnology* represents a first effort to provide such data. (Illustration by E. Paul Oberlander, Woods Hole Oceanographic Institution)

Enlarge Image

Figure 5: Working in the Southern Ocean! (Woods Hole Oceanographic Institution)

Enlarge Image

Figure 6: Southern Ocean trawl sample (Woods Hole Oceanographic Institution)

Enlarge Image

Figure 7: Photograph of fossil deep-water coral. (Woods Hole Oceanographic Institution)

Related Multimedia

2008 Photo Highlights

» View Slideshow

Related Links

» Marine Chemistry & Geochemistry Department

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