Climate Records

What Corals Tell Us About the Past

Final Report for 2006 OCCI Funded Project:

Constraints on Overturning Strength in the North Atlantic during Times of Rapid Climate Change

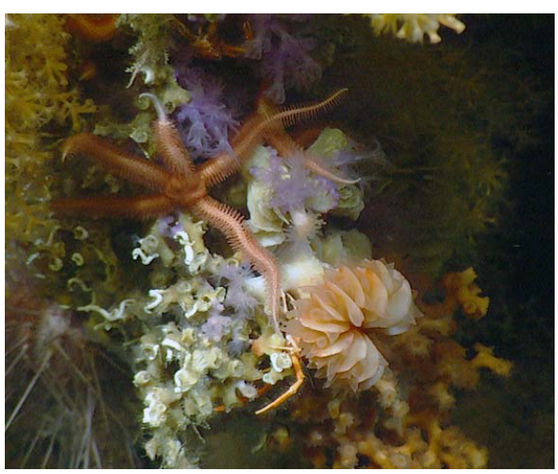
Laura Robinson, Marine Chemistry & Geochemistry

There are many species of deep sea (also known as cold-water) corals and they live in a wide diversity of environments. For example, the solitary coral *Desmophyllum dianthus*, which has a life expectancy of about a hundred years, can live close to the surface in high-latitude fjords and also at thousands of meters water depth in the North Atlantic. Although very little is known about the biology and ecology of these organisms, we do know enough to be able to predict the most likely locations of both living and fossil corals on the seafloor. We study the chemical makeup of fossil samples of these organisms to infer changes in deep-ocean circulation rates over tens of thousands of years, which in turn aids our understanding of how and why Earth's climate changes.

Chemicals derived from seawater are incorporated into corals, allowing their skeletons to form some of the best records of climate variability in the ocean. There have been numerous climate studies using tropical corals; however their symbiotic relationship with photosynthetic algae limits them to the warm shallow waters of the low latitudes. Luckily, some corals do not use algal symbionts and are able to live in cold or dark waters, extending their range to a global distribution. Measurements of the chemistry of these corals are important because we are interested in tracing water as its spreads through the deep ocean.

With support from the Ocean and Climate Change Institute, I am working to develop new chemical tracers of past ocean circulation. The rare earth element neodymium (Nd) proves useful for this purpose, as different water masses display distinctive Nd isotopic signatures. In collaboration with Tina van de Flierdt at Columbia University's Lamont Doherty Earth Observatory (LDEO) and using coral samples loaned to us by Stephen Cairns at the Smithsonian Institution, we have found that Nd isotopes are not altered when incorporated into coral skeletons. We have also shown that this signature is well preserved, even in corals that are over two hundred thousand years old. Coupled with radiocarbon analyses, this new chemical tracer can now be used to improve our understanding of past ocean circulation rates in the deep ocean.

In the spring of 2008, coral biologist Rhian Waller (University of Hawaii) and I will head to the Southern Ocean on the R/V *Nathanial Palmer* to map, image and collect deep-sea corals from the Drake Passage and the Scotia Sea. These samples will be used to determine how deep water that forms in the Southern Ocean has changed over time, and how these changes influenced deep waters in the rest of the ocean. Support from the OCCI was instrumental in securing funding from the National Science Foundation for this upcoming cruise and for my ongoing collaboration with Tina van de Flierdt.



Right: Deep-sea or cold-water corals such as Desmophyllum dianthus *(pink pleated coral in the lower right, off center) provide a record of how ocean circulation has changed over time. This photo shows live coral on the New England Seamounts.*

Below: A 40,000-year-old fossil of the same deep-water coral species. Analyzing fossil skeletons such as these enables researchers to construct climate records spanning tens of thousands of years.