Leg 199

Ocean Drilling Reveals Clues about Warmer Earth

January 2002 Scientists using cores from far below the ocean floor are uncovering details about the warmest period on Earth in the past 65 million years. During the warm Eocene period (34 to 55 million years ago), the first recognizable mammals appeared in North America, palm trees were found in the Rocky Mountain region, and alligators were found as far north as the Arctic. The Eocene time period and its associated oceanographic and climatic regime appears to have begun very quickly, with a warming on the scale and rate of modern global warming and ended almost as abruptly. A recent research expedition aimed to find out how and why this warm climate period began, maintained itself and ended. Scientists found the transition from the Eocene to the modern world occurred abruptly, with major ocean circulation changes.

The Ocean Drilling Program drillship *JOIDES Resolution* left Honolulu in late October with 28 scientists from eight nations gathered to focus on understanding the Eocene. Led by co-chiefs Mitch Lyle, from Boise State University, and Paul Wilson, from the Southampton Oceanography Centre in the United Kingdom, the shipboard scientists analyzed drillcores from 8 sites near the Eocene equator. Because the drift of the Earth's plates moves north in the Pacific, the area studied was north of the modern equator, about half way between Hawaii and Mexico. From these sites, scientists recovered cores that contain continuous records from this warm period that were not previously available.

Results of the on-board studies reveal a very different equatorial oceanographic world in the Eocene. Co-Chief Lyle remarked, "The Eocene isn't subtle, it sort of hits you in the face." Today, wind systems from the northern and southern hemispheres come together and stir the ocean near the equator such that deep, nutrient-rich waters come to the surface and support a thriving and diverse community of plankton. Fossil remains of these plankton provide the primary geological record of equatorial processes.

During the Eocene, the equatorial circulation system was quite broad, but had very low plankton productivity. The ecology of the area was dominated by a group called radiolarians, a small zooplankton that builds its shell of silica. After the end of the Eocene, these organisms never again attained their earlier dominance. These dominance of different organisms indicate that the Eocene low latitude oceanic system is fundamentally different from that which developed at the end of Eocene time.

Scientists recovered sediment that recorded the transition from the warm Eocene to the cool Oligocene climates that occurred at 33.7 million years ago. This transition coincides with the first build up of significant ice on Antarctica and marks a change in oceanic ecology from siliceous plankton to an assemblage dominated by calcium carbonate-producing plankton. This shift also marks the beginning of an oceanic biological system where all the action is focused at the equator, in stark contrast to the broad and diffuse system that preceded it.

This transition from warm to cool climates and diffuse to focused equatorial systems took place in less than 100,000 years - well within the time span that humans have been functioning on our planet. Rates of change are important clues to causes of change and the stability of the climate system as a whole. The rapidity of the change from warm to cool climates suggests that the warm climate system as it existed in the Eocene was relatively unstable.

The recovered cores will also be used to intercalibrate different "yardsticks" for measuring geologic time, a fundamental earth science problem. The cores contain a continuous record of reversals of the Earth’s magnetic field and clearly show the evolutionary history of siliceous and calcareous plankton. The sediments are ideal for developing a common time scale. Much of this material has not been intercalibrated before. Lyle added, "Furthermore, we were able to demonstrate that even subtle changes in the equatorial sediments can be correlated over distances of 500 miles or more with submeter precision. This allows scientists to apply information learned from one location to results from another, and do it with an accuracy never before accomplished."

The Ocean Drilling Program (ODP) is an international partnership of scientists and research institutions organized to study the evolution and structure of the Earth. C. Nigrini, a scientist participating the expedition, remarked, "The opportunity to work with an international team, all coming together to work on a single grand problem, is always a thrill." Although the cruise ended in December, these scientists will continue to study the cores to make additional scientific discoveries.

ODP is funded principally by the National Science Foundation, with substantial contributions from its international partners. The Joint Oceanographic Institutions manages the program. Texas A&M University is responsible for science operations, and Lamont-Doherty Earth Observatory of Columbia University is responsible for logging services.

Photos showing life on board the drillship during this leg, both at work and play, are available on the web at http://www-odp.tamu.edu/public/life/leg199.html