

## Leg 202

### Ocean Drilling Explores Climate Change in the Southeast Pacific

**July 2002** The sea floor of the Southeast Pacific is one of the least studied regions on Planet Earth. Starting from Valparaiso, Chile in March, scientists representing nine nations set sail on Leg 202 of the Ocean Drilling Program (ODP) drillship *JOIDES Resolution*, bound for sites ranging from the roaring 40s off southern Chile to the steamy Gulf of Panama. The path taken by *JOIDES Resolution* roughly followed that taken by Charles Darwin, 170 years ago on *HMS Beagle*. Surprisingly, some of Darwin's observations foreshadowed discoveries of today. One of the team leaders, Dr. Alan Mix of Oregon State University (USA), noted, "We've targeted sites expected to record global and regional climate to test competing ideas about where the triggers for major change lie—in the southern oceans, near the equator, or in the northern hemisphere. We're looking at climate effects on several scales, from the slow tectonic uplift of the Andes to abrupt climate shifts within human history. We've never had the right samples before. Now we do."

After weathering a Force 8 storm off southern Chile, the team recovered remarkable sediment sequences that accumulated so rapidly they will provide a record of changing ocean conditions at intervals of 40 years or less through the last ice-age cycle of more than 100,000 years. The last 10,000 years, an interval known as the Holocene, was once thought of as a time of stable climate that nurtured the growth of civilizations throughout the world. New data show this is not the case, and the results from Leg 202 confirm such variability in the South Pacific. Says sedimentologist Frank Lamy of University of Bremen (Germany), "we now have evidence that the Westerly winds, and the torrential rains they bring to the southern Andes, oscillated in both their strength and position. These changes appear to be linked to rapid climate oscillations of the ice age."

Detailed dating methods put the new South Pacific records into a global framework. Magnetics specialists Dr. Steve Lund of

University of Southern California (USA) and Dr. Joe Stoner of University of Colorado (USA) provided age control based on subtle changes in Earth's magnetic field. Says Lund, "This is outstanding. We've never seen magnetic excursions in such detail." Careful analyses of the fossil shells of evolving plankton species provide more dates, in a region not far from Darwin's inspiration on natural selection in the Galapagos Islands.

Paleontologists Wuchang Wei of Scripps Institution of Oceanography (USA) and Fatima Abrantes of the Institute of Mineralogy and Geology (Portugal) remarked, "this complete record of all the major fossil groups will provide a much-needed reference section for the South Pacific." Another kind of age control comes from small changes in Earth's orbit, which are revealed in rhythmic changes in sediment type. Ule Ninneman, logging scientist from Lamont Doherty Earth Observatory (USA), tested new instruments that measure properties inside the borehole, and noted, "these new high-resolution tools are the best I've seen. The rhythms of Earth's orbit just jump out at you." Stratigraphic coordinator Mike Wara of University of California at Santa Cruz (USA) confirmed the logging data by linking it to the sediment cores. "It's a great fit," he said.

Sediments recovered from Nazca Ridge off Peru revealed long-term history of the Andes and the role mountains play in global climate, confirming some of Darwin's speculations about mountain uplift when he experienced the great Chilean earthquake of 1835. Volcano expert Tomohisa Irino of Hokkaido University (Japan) said, "We can clearly see ash layers that date the onset of volcanic eruptions in the Andes." Organic geochemist Philippe Martinez of University of Bordeaux (France) added, "as the Andes rose, South Pacific winds were diverted along the coast and the Peru Chile Current strengthened. We can see this change in the organic matter that fell to the sea floor as life bloomed in the northward flow of cool, nutrient-rich water."

The drillship crossed the equator into the northern hemisphere in mid-May to explore long-term changes in the trade winds near Cocos Island. Paleoclimatologist Heather Benway of Oregon State University (USA) is examining the role of these tropical winds in global climate. She notes, "as the Trades cross Panama, they carry moisture from the Atlantic and Caribbean. This

movement of fresh water from one ocean basin to another changes the salinity of the whole Atlantic and may set up deep-sea currents that transport heat around the globe. Panama is small, but its impact on climate may be huge." Co-chief Tiedemann adds, "due to tectonics, there was no Panama Isthmus five million years ago and water could flow between the oceans. This is an important experiment to see the effects of such a change."

When they arrived in Panama in June, the group led by Co-Chief Scientists Mix and Ralf Tiedemann of GEOMAR Research Institute (Germany), along with Staff Scientist Peter Blum from Texas A&M University (USA), hauled in nearly seven kilometers of sediment cores drilled from water depths ranging from a few hundred meters to nearly three kilometers below the sea surface. Much hard work remains to be done studying these cores in advanced laboratories throughout the world. The international team will continue its cooperative effort for several years, pooling its resources to make the most of this rare opportunity.

ODP is an international partnership of scientists and research institutions organized to study the evolution and structure of the Earth. It is funded principally by the US 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.

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