# Leg 150

## Scientists read Earth's transition from a greenhouse to icehouse world

**September 3, 1993 COLLEGE STATION, TX** -- Researchers for the Ocean Drilling Program (ODP) are reading the pages of sea-level history in the sediment layers off New Jersey to track Earth's transition from a "greenhouse" world to its more recent "icehouse" environment.

Global sea level has risen and fallen during the past 35 million years, responding to the growth and decay of large continental ice sheets. Before this icehouse world, Earth was in an ice-free, greenhouse mode. Sediments buried beneath the coastal plain and offshore regions of New Jersey contain a record of the rhythms of these sea-level variations as Earth passed from this greenhouse to icehouse world.

"We drilled on the continental slope in water depths as shallow as 1,400 feet and on the continental rise in water depths exceeding more than a mile and a half," said Dr. Gregory S. Mountain of Lamont-Doherty Earth Observatory and one of two chief scientists for the program's 50th cruise. Local fishermen trawl the region for the great catches in the submarine canyons that slice into the slope. One of the scientific questions to be answered by the cruise's scientists concerned the origin of these Grand Canyon-sized features.

Scientists recovered sediments at five sites to determine the history of sea-level variations and to identify breaks in sedimentation caused by global lowering of the sea level. These breaks serve as missing pages in an otherwise intact record of sediments deposited over millions of years. The breaks are also evident as buried surfaces that reflect sound energy directed into the seafloor from a survey ship. These acoustic profiles provide a sonogram-like reading of sediment layers, called reflectors, the most prominent of which are erosional surfaces cut when the sea level lowered. By dating the age of these reflectors, the scientists determined when these lower sea levels occurred.

The oldest sediment recovered was deposited 52 million years ago in the early Eocene, a greenhouse world. The researchers recovered a 38-million year old layer of glassy droplets called microtektites, evidence of an extraterrestrial body slammed into the Earth near present-day New Jersey.

Numerous Oligocene-Miocene (35 to 5 million years old) reflectors were dated, providing a record of sea-level falls and rises as the Earth passed into the icehouse world. The New Jersey margin underwent a dramatic change, scientists learned, during this climatic transition as evidenced by calcium carbonate chalks from a warmer climate lying beneath sands and muds deposited by glacial activity. Beginning about 22 million years ago, the surface waters in this region became unusually productive, resulting in blooms of diatoms and an abundant supply of organic carbon to the sea bottom. Scientists found a record of another sharp change beginning about 14 million years ago when an increase in sediments, wood fragments and organic matter were deposited from adjacent land masses.

The first large submarine canyons cut into the slope about 14 million years ago. "We identified the origin and demise of one of these buried canyons, which was partly filled with the material from large avalanches of sediments that slid down these conduits onto the rise ," said Co-chief Scientist Dr. Kenneth G. Miller of Rutgers University.

Between 8 and 10 million years ago, huge blocks slid downslope and 20 miles out onto the rise. Other sediments on the rise were influenced by swiftly flowing bottom currents that cut a submarine surface about 11 million ago.

Sedimentation took another turn in this region during the later part of the Pleistocene (about 600,000 years ago) when large continental ice sheets advanced and retreated to New Jersey from the Arctic.

"By reading the sediment layers, we gained a clear insight into how large, rapid global sea-level changes result from the waxing and waning of northern hemisphere ice sheets," Miller said.

The rates of sedimentation were remarkably high on the slope during the last 600,000 years, evidence of the high rate that sediments were sloughed from the nearby ice sheets. Today's large submarine canyons were cut at this time. Despite the influence of large and rapid sea-level changes, sedimentation was remarkably continuous on the intercanyon areas during the past 500,000 years.

The drilling conducted offshore is part of a coordinated program that includes onshore and nearshore drilling. The onshore program is being currently conducted with drilling boreholes at Island Beach and Atlantic City, New Jersey; Boreholes are also planned at Harrisville and Cape May, N.J. in 1994.

"The final page of our exploration will turn when the program's ship returns to drill the shallowest water boreholes yet attempted by ODP on the continental shelf, perhaps as early as 1996," said Miller.

"We are excited about the results from this cruise," said Dr. Philip D. Rabinowitz, director of the ODP, "because it adds one more piece to the critical puzzle of the global climate record."

*JOIDES Resolution* is the research vessel for the ODP, which is funded by the United States National Science Foundation, Canada and Australia, the European Science Foundation Consortium, Germany, France, Japan and the United Kingdom.

Texas A&M University, science operator, operates and staffs the drill ship and retrieves cores from strategic sites around the world. Lamont Doherty Geological Observatory of Columbia University is responsible for downhole logging.

Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), an international group of scientists, provides scientific planning and program advice. Joint Oceanographic Institutions, a nonprofit consortium of 10 major U.S. Oceanographic institutions, manages the program.

Note: JOIDES members are: University of California at San Diego; Columbia University; University of Hawaii; University of Miami; Oregon State University; University of Rhode Island; Texas A&M University; University of Texas at Austin; University of Washington; and Woods Hole Oceanographic Institution.

Canada and Australia Consortium; European Science Foundation Consortium (Belgium, Denmark, Finland, Iceland, Italy, Greece, the Netherlands, Norway, Spain, Sweden, Switzerland and Turkey); Germany; France; Japan; and the United Kingdom.

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