OCEAN DRILLING PROGRAM

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Why is Antarctica so cold? Scientists pursue the history of the Antarctic Ice Sheet

The Antarctic ice sheet profoundly affects world climate. It cools the deep oceans and controls circulation, influences the chemical balance of the oceans and has a major effect on sea level and temperatures worldwide. The Ocean Drilling Program (ODP) is conducting a two-month expedition near the edge of the Antarctic continent, the first of a series to probe the historical development of the Antarctic ice sheet and its consequences for Earth's climate.

The Antarctic ice sheet is the world's largest, but scientists continue to have many questions regarding how it grew, when and why. Scientists recognize that considerable ice cover already existed on Antarctica 35 million years ago, and the ice sheet has waxed and waned through glacial cycles ever since.

"We all know about the ice sheets of the northern hemisphere, including the very large masses of ice that covered North America and northern parts of Europe and Asia in recent times," says Dr. Peter F. Barker, British Antarctic Survey and co-chief scientist for the ODP expedition, "but in geological terms these are relatively young at only three million years old, and they disappear entirely at frequent intervals. Today, for example, there is little or no ice left. Even the Greenland ice sheet, which does still exist, is a comparative newcomer at seven million years old, and small in comparison to the Antarctic."

The waxing and waning of the northern hemisphere ice sheets changed sea level by about 110 meters. Ocean Drilling Program results show these ice sheets were very sensitive to climate change. This expedition should help answer the question "How sensitive was the Antarctic Ice?"

Earth's climate change has recently been the focus of the world's policy makers. "Mankind is on the edge of having the power to change global climate. If we are to make wise decisions on this, we must understand how climate works - what drives it, how quickly the various parts of the system respond, what would be the full effect of what we might do, or have done," explains Barker. "And because of its pivotal importance to world climate, we must try to understand the history of the Antarctic ice sheet."

Ice sheets grow because snow accumulates on top, and this growth is balanced by drainage - the flow of ice from the center towards the edges (where it breaks off to form icebergs). Most of the ice sheet is frozen to the rock beneath and cannot flow easily. Ice is a solid near its melting point, so it will slowly flow internally (similar to tar), but very little of the ice sheet drains in this way.

The ice sheet drains by rapid ice flow, in narrow channels called ice streams. Here, the ice base is not frozen to the underlying rock, but is lubricated by unsorted wet sediment called

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till. The till is carried by the ice streams to the ice sheet edge. In the past, on Antarctica, the till was carried all the way to the edge of the continent and deposited there, as the ice broke off and floated.

Till deposits on the Antarctic margin contain a record of the past behavior of the ice sheet. Sampling and dating the till should provide information on when and why the ice sheet developedand its effects on sea level and ocean chemistry through time. A host of other geological processes, the effects of which are entangled with ice sheet effects, should become better understood.This expedition targets the Antarctic Peninsula because its sediments are relatively well-mapped and easy to interpret. Other drilling in future seasons will examine other sectors of the Antarctic margin, if this expedition is successful.

Scientific drilling in the deep ocean is a window on the past, wherever it is carried out. The sediment recovered contains a record of environmental conditions at the time it was deposited. Using the composition, texture, fossil content and other sediment information, scientists can travel back in time. How much detail is extracted depends on how fast the sediments were deposited. In some places around Antarctica, it may have taken 1000 years to deposit 10 cm, so drilling one kilometer of those sediments would take us back 10 million years, and a teaspoon of mud one centimeter thick will represent 100 years.

Departing Punta Arenas in mid-February, 26 scientists representing 10 countries will sail aboard the *JOIDES Resolution* to collect core samples from the continental rise and shelf of the Antarctic Peninsula. The deepest hole drilled may extend 850 meters below the seafloor and may recover sediments as old as 10 million years. The expedition will conclude April 11 with a port call in Cape Town, South Africa.

The Ocean Drilling Program, an international partnership of scientific institutions and governments, explores the history and evolution of Earth's crust. The Ocean Drilling Program is funded principally by the National Science Foundation, with substantial contributions from its international partners. These include the Federal Republic of Germany, France, Japan, and the United Kingdom. Australia, Canada, Chinese Taipei, and Korea hold a joint partnership. Another partner is the European Science Foundation, consisting of Belgium, Denmark, Finland, Iceland, Italy, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and Turkey. The program is managed by Joint Oceanographic Institutions, a consortium of 10 U.S. institutions, with Texas A&M University responsible for science operations. Lamont-Doherty Earth Observatory is the operator for downhole logging.

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In addition, the ODP Web Site includes much additional information on this leg (Leg 178 Scientific Prospectus) and will carry weekly reports on progress as the leg proceeds.
http://www-odp.tamu.edu/