Leg 204

Ocean Drilling Program Explores Large Gas Hydrate Field Offshore Oregon

September 2002 The international Ocean Drilling Program (ODP) just completed a two-month expedition that investigated the origin and distribution of gas hydrates. Their findings could help identify locations and quantify amounts of this potential resource. Gas hydrates are frozen deposits of natural gas that scientific evidence suggests may eventually serve as a major new worldwide energy source. Hydrates also have the potential to cause global warming if released suddenly by landslides because methane is a powerful greenhouse gas. Although scientists know that gas hydrates are common in the seafloor on the margins of continents around the world, they do not know how much hydrate is present.

Scientists onboard the research vessel *JOIDES Resolution* spent the past two months during ODP Leg 204 (6 July–2 September) studying gas hydrates offshore Oregon in an area known as Hydrate Ridge. Their primary objective was to determine how much gas hydrate is present beneath the seafloor in a region where hydrates have previously been observed and where geophysical evidence indicates that they are widespread. Dr. Anne Tréhu of Oregon State University (USA), a co-chief scientist on the cruise, stated, "Measurements made during this cruise will permit us to update estimates of the volume and flux of methane and other hydrocarbon gases trapped in the sediments on the Oregon continental margin and, by extension, in other regions."

Ocean drilling plays a critical role in addressing questions about hydrates because it provides the only means available to the international academic community of directly sampling gas hydrates and the sediments that host them deep beneath the seafloor. In 1995, ODP drilled into gas hydrates off the U.S. east coast. From that study, scientists have estimated that this area could contain enough methane to supply US needs for more than 100 years. They also found evidence suggesting that hydrates

are involved in the global climate cycle and that they can cause massive landslides. The next natural step for ODP was to study gas hydrates on a geologically active margin. Dr. Gerhard Bohrmann, GEOMAR (Germany), a co-chief scientist on the cruise, noted, "The Oregon margin is an excellent place to study the dynamics of hydrate formation."

Among the most surprising findings of Leg 204 was the rate at which hydrate is forming near the summit. Salts are excluded when hydrates form, and the excess salt in the pore water diffuses away from the gas hydrate with time. However, if the hydrate forms very rapidly, the salts do not have time to diffuse and the water in the sediment pore space will become saltier than seawater. Dr. Marta Torres of Oregon State University and acting ODP postcruise staff scientist, explained, "During Leg 204, high concentrations of sea salts were observed in the upper 10-15 meters of sediment at the summit, indicating that hydrate is forming very rapidly below the seafloor in this region."

Scientists also gained an understanding of the importance of sediment properties (composition and size of grains) in the distribution of hydrate within the sediments, which may provide clues to their locations. Says Bohrmann, "Coarse-grained layers are the primary conduits for fluid flow and tend to have the highest concentration of hydrate."

During Leg 204, scientists used the floating laboratories of the *JOIDES Resolution* to conduct chemical and physical studies on core samples. Leg 204 was also a test-bed for several technological innovations that promise to make an important contribution to hydrate studies in the future. Breaking new ground, Leg 204 saw, for the first time, laboratory measurements of the physical properties of natural hydrates at subseafloor pressures without ever releasing this pressure. This was made possible by new tools developed by the European HYACINTH consortium. It also saw the first simultaneous acquisition of both core samples and Logging-While-Drilling data using tools developed in a US-based industry/academic collaboration. In an example of successful technology transfer, infrared thermal imaging cameras developed for other uses proved invaluable for rapidly identifying hydrate samples buried in cores. The thermal imaging cameras, pressure vessels to

preserve key hydrate samples for further study, and other and logging and physical properties measurement equipment and equipment upgrades were supplied by the U.S. Department of Energy's National Energy Technology Laboratory. Frank Rack, Joint Oceanographic Institutions (USA) and acting ODP staff scientist on the leg, stated, "Leg 204 was the first of what we hope will be a series of drilling expeditions dedicated to understanding the distribution, concentration and environmental impact of gas hydrates in nature."

Scientists on Leg 204 represented the United States, Germany, Japan, Canada, Spain, Norway, the United Kingdom, Taiwan, the People's Republic of China, and South Korea. After the cruise, these scientists will return home to continue study on the cores. Tréhu stated, "Analysis of this extensive, integrated data set is just beginning. Ultimately it will yield a better understanding of the processes that form and focus hydrate in nature and lead to more precise methods to predict regional hydrate distribution and concentration."

ODP is an international partnership of scientists and research institutions organized to study the evolution and structure of the Earth. While ODP is funded primarily by the US National Science Foundation and its international partners, the US Department of Energy and the European Commission played important roles in funding much of the innovative technology used on this Leg. 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.

Photographs from Leg 204 are available on the web at http://www-odp.tamu.edu/public/life/leg204.html.

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