Leg 132

Engineers develop hard-rock drilling technology

August 29, 1990 COLLEGE STATION, TX -- Applying a drilling technique analogous to a high-speed dental tool whirring through tooth enamel, the Ocean Drilling Program (ODP) took a significant step forward in recovering volcanic rock.

The international program, funded through the National Science Foundation and 18 member countries, investigates Earth's structure and evolution beneath the seafloor. One of its remaining obstacles in drilling technology has been to retrieve continuous cores of hard-rock and basalts. On a cruise dedicated primarily to developmental testing, ODP adapted technology from the mining industry to core into bare-rock lava flows in an active submarine volcanic field near the Bonin Island arc south of Japan.

The cruise demonstrated ODP's ability to drill into active submarine volcanoes along the global system of mid-ocean ridges where molten rock surfaces on the seafloor to add new material to drifting crustal plates.

Marine scientists have been especially interested in the spreading centers around the world because of their significant role in opening new ocean basins and pushing crustal plates apart. Scientists have gathered data from these regions with manned submersibles and sophisticated seismic and sonar instruments. Scientists have been able to obtain only limited amounts of core samples from shallow holes, and they have not been able to place seismic sensors or other equipment into holes for lang-term study of submarine volcanic and hydrothermal processes.

Diamond Coring System

Until recently, scientists used conventional drill bits, similar to those in the oil field, to core into the ocean ridges. These bits crushed the unstable formations of brittle, fractured rocks. On land, the mining industry drills into these kinds of formations with smaller diamond-impregnated bits rotated at high speeds.

Over the past two years, the ODP has developed an integrated system of several components from mining systems designed specifically for use aboard the drill ship *JOIDES Resolution*. Called the Diamond Coring System, it employs a mast 32-feet tall to support an electric top drive that rotates a string of slender drill pipe, which extends from the ship to seafloor. A narrow diamond bit attached at the end cuts through the volcanic rock to retrieve core samples.

The development engineers' primary design task was to adapt the fragile mining hardware to a configuration that could be used on a drill ship. The system had to be strong enough to rotate a more-than-mile long drill string, but delicate enough not to disturb the delicate rock formation while coring. To overcome these obstacles, the engineers designed--

a gear box driven by an 800-horsepower electric motor -- similar to electric motors used in locomotives -- to rotate the drill string at speeds up to 540 revolutions per minute, which is up to 10 times faster than speeds used in conventional coring operations.--

a special computer-activated system to compensate for the ship's heave or vertical motion. ThiS secondary system was used in tandem with the ship's primary heave compensator to virtually eliminate all vertical motion of the drill-rod string caused by the ship's riding the ocean waves.--

a special platform tucked inside the ship's existing derrick from which to suspend the system.

The DCS was tested in 1800 meters of water (more than a mile) on a small volcanic ridge. The system drilled a 79-meter hole, deeper than any previous hole in a recently erupted lava field on the seafloor. With the successful testing of this new system, fullscale scientific ocean drilling is close to realization. The ODP can for the first time plan scientific cruises around the system including the crest of the East Pacific Rise, a fast-spreading system off the coast of South America, and high temperature hot springs off the coast of Oregon.

Michael A. Storms, supervisor of development engineering, Ocean Drilling Program at Texas A&M University in College

Station, was operations superintendent for Leg 132. Dr. James H. Natland of Scripps Institution of Oceanography in La Jolla, Calif., was the chief scientist. Barry W. Harding is manager of engineering and drilling operations for the ODP.

The cruise's 16-member engineering and scientific party comprised participants from the United States, Canada, Federal Republic of Germany, France, Italy and Japan.

JOIDES Resolution, registered as SEDCO/BP 471, is the research vessel for the ODP, which is funded by the United States National Science Foundation, the Canada/Australia Consortium for the ODP, the European Science Foundation Consortium for the ODP, the Federal Republic of Germany, France, Japan and the United Kingdom.

The 470-foot-long drill ship's derrick towers 200 feet above the waterline. A seven-story laboratory stack provides facilities for on board examination of sediment and hard-rock cores. Laboratories contain space and equipment for studies in chemical, gas and physical properties, paleontology, petrology, paleomagnetics and sedimentology. Marine geophysics research is conducted while the ship is under way.

Texas A&M University, as science operator, operates and staffs the drill ship and retrieves cores from strategic sites around the world. The science operator also ensures that adequate scientific analyses are performed on the cores. To do this, Texas A&M maintains shipboard scientific labs and provides logistical and technical support for shipboard scientific teams. On shore,in the Texas A&M University Research Park, the science operator manages post-cruise activities, curates the cores and publishes the scientific results.

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 (JOI, Inc.), a nonprofit consortium of 10 major U.S. oceanographic institutions, manages the program.

"JOIDES Resolution is currently drilling off the northeast coast of Australia," said Dr. Philip D. Rabinowitz, director of the ODP. "Scientists will investigate global changes in climate and sealevels that occurred during the past 10 million years," he said.

Note: JOIDES Institutions 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.

Non-U.S. members are Canada and Australia Consortium for the ODP, European Science Foundation Consortium for the ODP: Belgium, Denmark, Finland, Iceland, Italy, Greece, the Netherlands, Norway, Spain, Sweden, Switzerland and Turkey; Federal Republic of Germany; France; Japan; and the United Kingdom.

Shipboard participants on Leg 132 were Michael A. Storms, operations superintendent, Ocean Drilling Program, College Station, Texas; Dr. James Natland, chief scientist, Scripps Institution of Oceanography, La Jolla, Calif.; Dr. Garrett W. Brass, Rosenstiel School of Marine and Atmospheric Science, Miami, Fla.; Dr. Glenn R. Brown, University of Toronto, Canada; John-Baptiste Fay, Institut Francais du Petrole, Rueil Malmaison, France; Glen Foss, ODP; G. Leon Holloway, ODP; Steven P. Howard, ODP; Dietmar Krehl, Eastman Christensen GmbH, Celle, Federal Republic of Germany; Rolf Luy, Institut fur Tiefbohrtechnik, Clausthal-Zellerfeld, Federal Republic of Germany; Dr. Isabella Premoli-Silva, University of Milano, Italy; Frank Rack, ODP; Daniel H. Reudelhuber, ODP; Dr. William V. Sliter, U.S. Geological Survey, Menlo Park, Calif.; Robert J. van Waasbergen, Scripps Institution of Oceanography, La Jolla, Calif.; and M. Masataka Zaitsu, Nippon Marine Enterprises, LTD, Yokosuka, Japan.