Leg 185

An Expedition to a Subduction Factory: ODP Searches for Bacteria in Ancient Rock

28 June 1999 An Ocean Drilling Program (ODP) expedition dedicated to the ocean's deepest trenches, the Mariana and Izu-Bonin, ended June 15 in the port of Yokohama, Japan. These trenches form the boundary between colliding tectonic plates, and cataclysmic events such as earthquakes, tsunamis, and explosive volcanism. At the Mariana and Izu-Bonin trenches, these collisions cause one plate to slide under the other plate, a process known as subduction. As one plate is subducted deep into the Earth, the material (sediments) on the plate and the plate itself are consumed and then re generated to form materials that are expelled onto the Earth's surface in volcanoes. This process is part of an important Earth chemical cycle that scientists have dubbed, "the subduction factory." The subduction factory is a dynamic system in which the subducting seafloor and overlying mantle are recycled and processed into new products on the upper plate. Beneficial products such as ore deposits are part of the factory's outputs. In order to understand the formation processes of previous ores and the timing and magnitudes of cataclysmic events, scientists need to know the true workings of the subduction factory. As in all factories, a knowledge of the most basic information is needed: what goes in versus what goes out. Or in scientific language, researchers need to understand the mass balance of chemicals cycled through Earth. The scientific goal of this expedition was to determine important missing gaps in the factory cycling system along the Mariana and Izu-Bonin arcs. These gaps include an incomplete understanding of the aging process of the uppermost layer of the solid Earth, the flow of materials through the zone between deep sea trenches and volcanic arc, and the fluid circulation at active margins. The Mariana and Izu-Bonin arcs are ideal for subduction recycling studies because both are created by the same subducting plate, yet have distinct geochemical signatures. Studies of the relative amounts of several important components in the subducted plate (e.g.,

water, carbon dioxide, and trace metals) were used to determine whether the chemical differences between the two arc systems are the result of different inputs to the two trenches or different behavior of the subduction factories. Another objective of this expedition was to sample the Earth's deep biosphere, and, in particular, to establish protocols for studying these potentially new life forms. It is currently speculated that a large part of the Earth's biosphere is locked beneath the ocean's floor. The discovery of bacteria, living in extreme conditions of pressure and temperature (extremophiles), has important implications for understanding the origins of life, discovering new life forms, understanding the link between these Earth-thriving bacteria and the formation of oil and gas, and Earth's carbon budget.

Two deep-water sites were drilled and studied during Leg 185. The research team sampled and measured the in situ conditions of the upper alteration zone at an existing ODP Hole (801C), located seaward of the Mariana Trench, and the entire sedimentary section into basement at a new site (BON-8A) located near the Bonin Islands. These sites were drilled to depths as great as 900 m below the seafloor in up to 6 km of water. Samples were retrieved from these sites that represent the oldest rocks ever collected from the ocean floor and some of the deepest rocks ever recovered from the ocean crust. The chemical composition of the recovered rocks were measured as were properties of the borehole using special logging techniques. Scientists discovered that patterns in the basalts collected at depths of 590 to 920 m below the seafloor were characteristic of those associated with life forms discovered previously in other younger and shallower parts of the ocean floor. This suggests that life can exist and survive in very high pressure settings and in rocks that formed 167 million years ago. Following the expedition, scientists will continue to study the microbes by culturing and extracting DNA from microbes in rock, sediment and water samples. Samples collected by the scientists could potentially be contaminated by the actual drilling process. One of the scientists' objectives was to evaluate the amount of contamination in the recovered rocks and sediment. This was accomplished by injecting tracers into the seafloor as they drilled. Challenges of the Deep

During Leg 185, ODP drilled in one of the deepest parts of the

world's ocean. The sites were located in water depths ranging from 5.7 to 6 km. These water depths combined with the drilling depths pushed the state-of-the-art deep water drillship, *JOIDES Resolution*, beyond any previous drilling. The ship's derrick, designed to carry the weight of 9,000 m of steel drill pipe, successfully worked at its maximum capacity breaking a world record in deep water drilling. The research vessel, *JOIDES Resolution*, departed for its next expedition to the Japan Trench on June 19. The goal of Leg 186 is to install long-term, deep, seabed observatories for the study of earthquakes and measuring properties of the Earth's mantle. ODP

The Ocean Drilling Program, an international partnership of scientific institutions and governments, explores the Earth's history and evolution. The Ocean Drilling Program is funded principally by the U.S. National Science Foundation, with substantial contributions from its international partners. These include the Federal Republic of Germany, Japan, the United Kingdom, the Australia/Canada/Chinese Taipei/Korean Consortium for Ocean Drilling, the European Science Foundation Consortium for Ocean Drilling (Belgium, Denmark, Finland, Iceland, Italy, The Netherlands, Norway, Portugal, Spain, Sweden, and Switzerland), France and the People's Republic of China. The program is managed by Joint Oceanographic Institutions, a consortium of 11 U.S. institutions, Texas A&M University is responsible for science operations, and Lamont-Doherty Earth Observatory of Columbia University is responsible for logging services. Scientists Contacts: Dr. Terry Plank, Co-Chief Department of Geology-Geophysics Program University of Kansas, USA Internet: tplank@kuhub.cc.ukans.edu Work: (785) 864-2725 Fax: (785) 864-5276

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In addition, the ODP Web Site includes information on this leg (Leg 185 Scientific Prospectus) http://www.oceandrilling.org