Leg 127

Ocean Drilling Program explores geologic life of a marginal sea

September 16, 1989 COLLEGE STATION, TX -- Scientists have learned that a marginal sea in the Western Pacific has expanded and contracted and its level has risen and fallen in response to 20 million years of geologic upheaval. Their findings will help them understand the origin and evolution of marginal seas, which are common to the western Pacific and once ringed the North and South American continents.

Scientists for the Ocean Drilling Program spent two months drilling holes up to 1,000 meters (3300 feet) in almost two miles of water to investigate the history of the Japan Sea, which is about the size of Texas. They discovered that the sea began to form at least 20 million years ago when a piece of Asia, now known as Japan, broke off the mother continent. For several million years the sea continued to deepen and spread. But about 2 million years ago, the sea began to shrink, spawning destructive earthquakes that continue to plague northern Japan.

Arcuate chains of volcanic islands like the Japanese, Philippines and Marianas segregate marginal seas from the main body of the Pacific Ocean. Scientists believe that marginal seas may have formed over several million years as crustal plate movement caused the ocean crust behind the island chains to stretch and break. The Japan Sea's origin is especially enigmatic because its underlying crust is thicker than normal.

Twenty million years of history

Scientists on board *JOIDES Resolution*, drill ship for the ODP, accounted for the thick crust when they discovered that the basement rock underlying the sediments in one of the sea's basins was composed of sills alternating with sediment layers. Sills are flat bodies of rock that form when magma is injected horizontally into sediments. The magma-injected sediment forms a thicker crust than that resulting from lava flowing-onto hard rock, which normally occurs during seafloor spreading.

The record left by the sediment and underlying basement enabled scientists to construct a 20-million-year time scale: -- about 19 to 20 million years ago, relatively shallow-water sands began to deposit indicating that at least part of the Japan Sea was already in existence. -- about 9 million years ago, the sea had deepened enough so that seawater freely circulated between it and the Pacific Ocean. With increased circulation came an abundance of nutrients, creating a population explosion in diatoms -- single-celled, microscopic plants. -- until about 2 million years ago, the diatom bloom continued carpeting the seafloor with thick deposits of skeletal remains.

Glaciers and uplift

During the last 2 million years, two geologic events have left their mark in the sea's sediment layers. About 1.8 million years ago, shifting crustal plates began to close the sea, causing the Japanese islands to uplift above the sea surface and decreasing water circulation from the Pacific. Without the constant flow of nutrient-rich ocean waters, the amount of organic deposits in the sediment diminished. At the same time, the waxing and waning of great continental glaciers during the Ice Ages lowered the sea level, coincidentally contributing to an additional decrease both in circulation with the Pacific and in the amount of microorganisms.

Although decreased circulation depleted organic deposits, the uplift of the Japanese islands combined with the glaciation of Asia caused massive amounts of sediment to be transported from land to the sea bed. The scientists have found in these alternating layers of sediment the sensitive responses the Japan Sea has made to changes in Earth's climate.

Scientists also discovered that subaerial volcanic activity of the Japanese islands has varied greatly since the Japan Sea opened. After the initial volcanic pulse when the sea opened, the ash layers almost disappeared. During the last few million years, however, the amount of ash layers jumped dramatically, reflecting an increase in above-water volcanic activity in the Japanese volcanic arcs as the Japan Sea started to close and Japan starting uplifting above sea level.

Marginal seas contain geologic secrets that scientists hope to learn. When these ancient basins collapse, for instance, pieces of ocean crust meld onto continental margins. These unique geologic formations contain rich mineral deposits, including those of gold. Drilling results from the Japan Sea, which is still forming, will help scientists unravel the environmental history of marginal seas from inception to destruction.

Co-chief scientists for the cruise were Dr. Kensaku Tamaki of the Ocean Research Institute, Tokyo, Japan, and Dr. Kenneth Pisciotto of El Cerrito, Calif. Dr. Jamie Allan of Texas A&M University was the ODP staff scientist.

The ship departed Tokyo, Japan, on June 24 and arrived in Pusan, South Korea, on August 21. Twenty-eight scientists from the United States, Bangladesh, Australia, Canada, Denmark, Federal Republic of Germany, France, Italy, Japan and the United Kingdom sailed on the cruise, the 27th for the ODP.

JOIDES Resolution, registered as SEDCO/BP 471, 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 for the Ocean Drilling Program, 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.

"During the next two years, JOIDES Resolution will drill in the western Pacific," said Dr. Philip D. Rabinowitz, director of the ODP. "We will investigate the Pacific's complex tectonic zones, which comprise several oceanic and continental plates."

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.)

The scientific party for Leg 127 was: Kenneth Pisciotto, co-chief scientist, El Cerrito, Calif.; Kensaku Tamaki, co-chief scientist, Ocean Research Institute, University of Tokyo, Japan; James Allan, Ocean Drilling Program, Texas A&M University, College Station; Joanne M. Alexandrovich, Lamont-Doherty Geological Observatory, Palisades, N.Y.; David A. Barnes, Western Michigan University, Kalamazoo, Mich.; Sam Boggs, University of Oregon, Eugene; Hans-Jurgen Brumsack, Geochemisches Institut, Gottingen, F.R.G.; Charlotte A. Brunner, University of Southern MiSSiSSippi; Adrian Cramp, University College, Swansea, United Kingdom; Laurent Jolivet, Ecole Normale Superieure, Paris, France; Orest E. Kawka, Oregon State University, Corvallis; Itaru

Koizumi, Osaka University, Japan; Shin'ichi Kuramoto, University of Tokyo, Japan; Marcus Langseth, Lamont-Doherty Geological Observatory; James McEvoy, University College of North Wales, United Kingdom; Jeffrey A. Meredith, Massachusetts Institute of Technology, Cambridge; Karl A. Mertz Jr., Miami University, Oxford, Ohio; Richard W. Murray, University of California, Berkeley; David C. Nobes, University of Waterloo, Ontario, Canada; Atiur Rahman, University of Utah, Salt Lake City; Ralph Schaar, Lamont-Doherty Geological Observatory, Kathryn P. Stewart, University of Adelaide, Australia, Ryuji Tada, University of Tokyo, Peter Thy, NASA, Johnson Space Center, Luigi Vigliotti, Istituto di Geologia Marina, Bologna, Italy; Lisa D. White, University of California at Santa Cruz; Jobst J.M. Wippern, Universitaet Munchen, F.R.G.; Shigeru Yamashita, University of Tokyo, Japan.