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Ocean Drilling Program constructs new model of plate convergence

February 1, 1991 COLLEGE STATION, TX The Ocean Drilling Program recently completed a cruise that investigated deformation of plate edges and the volcanic record associated with plate movement. Cores recovered through drilling yielded data that challenge previously established models of plate movement in convergence zones.

The ODP cruise targeted the regions of the Vanuatu islands, which form part of a narrow, sinuous volcanic chain, extending from Papua New Guinea through the Solomon, Fiji and Tonga islands. The islands of Vanuatu are aligned along the edge of a huge subsea trench where the Australia-India plate plows beneath the Pacific plate at rates of about 10 centimeters (4 inches) a year.

As the plate descends, some of its sedimentary layers scrape off and plaster onto the front of the overriding plate--analogous to the pile formed when plowing into soft dirt. The mounded material creates what oceanographers call an accretionary prism.

In the Vanuatu region, collision processes are further complicated because the subducting plate features two relatively rare formations--a ridge caused by seafloor spreading and a volcanic underwater mountain called a guyot. Scientists surmised that the two features are not completely subducted but are clogging the trench and deforming the island-arc chain of Vanuatu.

One of the cruise's primary objectives was to investigate water flow through the amalgamation of sediment and rock forming the accretionary prism. Previous drilling into accretionary prisms off Japan and Barbados revealed dewatering systems that allowed seawater to percolate relatively freely through the layers of accumulated sediment. Drilling into the accretionary prism off Vanuatu, however, revealed a chunk of material more than a

mile thick but with relatively few paths for water flow.

The prism's composition tells the story of its particular brand of plate collision. Sheets of deformed chalk alternate with layers of volcanic siltstone and sediment featuring fragments of volcanic material. These layers plaster on top of each other like shingles on a roof.

The scientists discovered that, unlike other accretionary prisms, very little water flows at the Vanuatu convergence zone. The scientists speculate that the low fluid content resulted from the unique conjuncture of a guyot and ridge subducting at the same time. The volcanic ridge's dense basement rocks riding on the descending plate caused massive deformation at the convergence site, clogging pathways that may have otherwise permitted more water flow.

The portion carrying the guyot, however, was less deformed, leading scientists to surmise that the underwater mountain's composition of lighter, more buoyant silica resulted in less deformation but still prevented water to circulate freely.

The scientists also drilled into Aoba Basin, a depression in the seafloor that acts as a repository for volcanic ashes spewed from adjacent island volcanoes. Scientists drill into these kinds of formations because the ash layers are like the rings of a tree; the layers can be read to determine the history of volcanic activity in the region. The scientists for ODP were surprised, however, to discover that the Aoba Basin served as a giant cauldron, concocting the most altered and concentrated fluids ever drilled.

The volcanic sediment in Aoba Basin, interacting with seawater, is stewing in its own juices, creating an exotic brew with high concentrations of calcium, chloride and potassium but with very little evidence of organic matter.

Scientists also retrieved from the guyot a trove of the best preserved Pleistocene corals ever recovered. These corals will help scientists determine the sea-level changes and climatic conditions of the region over the past 2 million years.

Co-chief scientist- were Dr. Gary Greene of the U.S. Geological

Survey, Menlo Park, Calif., and Dr. Jean-Yves Collot, Laboratorie de Geodynamique, Villefranche-sur-mer, France. Dr. Laura Stokking, Ocean Drilling Program, Texas A&M University, College Station, was staff scientist.

JOIDES Resolution, registered as Sedco/BP 71, 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, curate 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.

"The ship, after drilling off northeast New Zealand, will make its way to the East Pacific where it will drill during 1991," said Dr. Philip D. Rabinowitz, Director.

Note: JOIDES Institutions are: University of California at San Diego; Colombia 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.

Scientists participating on the cruise were: Jean-Yves Collot, co-chief scientist, ORSTOM, Villefranche-sur-mer, France; H. Gary Greene, co-chief scientist, U.S. Geological Survey, Menlo Park, Calif.; Laura Stokking, ODP staff scientist, Texas A&M University, College Station; Kazumi Akimoto, Nagoya Jiyu Gakuin Junior College, Aichi Prefecture, Japan; Maria V. S. Ask, Lulea University of Technology, Sweden; Peter Edward Baker, University of Leeds, United Kingdom; Louis Briqueu, C.N.R.S., Montepellier, France; Thierry Chabernaud, Lamont-poherty Geological Observatory, Palisades, N.Y.; Massimo Coltorti, Universita degli Studi de Ferrara, Italy; Michael A. Fisher, U.S. Geological Survey, Menlo Park, Calif.; Margaret Goud, Woods Hole Oceanographic Institution, Mass.; Toshiaki Hasenaka, Tohoku University, Miyagi, Japan; Michael A. Hobart, Lamont-Doherty Geological Observatory; Anton Krammer, Geophysical Institute, Karlsruhe, Federal Republic of Germany; John Leonard, Texas A&M University; Jonathan B. Martin, Scripps Institute of Oceanography, La Jolla, Calif.; Jose I. Martinez-Rodriquez, Australian National University, Canberra City, Australia; Steve Menger, Institute fur Angewandte Geophysik, Bochum, Federal Republic of Germany; Martin Meschede, Universitat Tubingen, Federal Republic of Germany; Bernard Pelletier, ORSTOM, Noumea, New Caledonia; Russell C. B. Perembo, University of Western Australia, Nedlands; Terrence M. Quinn, University of Michigan, Ann Arbor; Pamela Reid, University of Miami, Fla.; William R. Riedel, Scripps Institute of Oceanography, La Jolla, Calif.; Pierrick Roperch, ORSTOM, Villefrance-sur mer, France; Thomas Scott Staerker, Florida State University, Tallahassee;

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