Tales of the South Pacific

For most people, the lure of the South Pacific islands is sun, romance and mystery. Mystery may have something to do with why geologists and oceanographers from the Deep Sea Drilling Project hang around the islands of the West Philippine Basin. But it's no cloak and dagger stuff that draws them. Rather, it's the mystery of how the islands got there at all.

The Pacific island arcs, such as the Mariana island arc that includes Saipan, Tinian and Guam, the trenches on their seaward side and the basins that separate the island chains and the continent, are some of the most active and interesting parts of the earth's crust. The trenches are the intersection of the continental and oceanic crust. At this tense junction, the oceanic crust is shoved beneath the continental crust, protesting its punishment with earthquakes and volcanoes. The volcanic island chains are a by-product of such fury. The back-arc basins, formed by a different, and as yet undetermined, type of sea-floor spreading, are much deeper than other ocean basins of the same age. The whys and hows of island arc systems are the mystery, however. And that's just why the *Glomar Challenger,* on Leg 59 of the DSDP, dipped its drill into the submerged ridges and basins of the Mariana arc system.

Led by Loren Kroenke of the University of Hawaii and Robert Scott of Texas A & M, the *Challenger* team retrieved core samples from five sites that give away the history of the island chain. Vesicular basalts — ocean crust rock riddled with gas pockets — and the telltale record of the earth's magnetic field reversals imprinted in the ocean bottom show how the islands marched away from the continent.

According to Scott, about 40 million years ago the Mariana trench and arc system was farther west, where the Palau-Kyushu Ridge is now (see map). The vesicular basalts found on the ridge indicate it was a shallow-water volcanic chain. As symmetrical spreading began, the ridge split, forming the Parece Vela Basin and leaving the Palau-Kyushu Ridge as a sinking volcanic remnant. On the east side of the basin, the West Mariana Ridge, active and above water, formed between 32 million and 10 million years ago. Then, about 10 million years ago, the West Mariana Ridge split, part remaining as a subsiding ridge. As the other half moved east, it carved out the Mariana Trough and formed the present-day active Mariana island arc. The trench and volcanic island chain still move eastward, Scott said, though the driving mechanism remains unknown.

Core samples from the ridges also offered a rare glimpse of ore deposit creation. Scott said veins of pure copper laced both sediment and basalt in the samples,

Scripps/DSDP

Sites 447-451: The march of the islands.

meaning that the metal was deposited after the ridge was formed. Ore deposit formation is another geologic mystery, and back arc basins are thought to be where it all begins. Scott conjectures that deposits may form as mineral-sprinkled ridges are "slapped against the continent," concentrating the ore into minable pockets. "These may represent the first steps of turning an uneconomical deposit into an economical deposit," he said. □

Semiconductor laser: Picosecond pulses

Light that comes in very short pulses has a number of scientific and technological uses. Two of the most important are in physical and biological chemistry — the illumination of fast chemical reactions step by step — and in communications, where the pulses would carry messages in a kind of code analogous to Morse. For these and other uses the pulses should come fast, in the range of picoseconds (billionths of a second). In chemistry the swiftness of the reactions mandates such speed; in communications it permits sending many messages over a single channel without having the speakers sense a delay.

Since such pulses must also be coherent, they have to come from lasers. There are picosecond-pulsing lasers, but they are large and cumbersome installations. For chemical applications it is desirable, and for communications it is necessary that fast-pulsing lasers be made small. Communications lasers must be able to couple their beams into the minute optical fibers that serve as waveguides and transmission media. For ease of manufacture, installation and maintenance, communications lasers should use a solid as the lasing material. The Research Laboratory of Electronics at the Massachusetts Institute of Technology now announces a significant step in that direction, a semiconductor diode laser system the size of a facial tissue box that delivers 20-picosecond pulses.

According to Herman A. Haus, Elihu Thomson Professor of Electrical Engineering, who is cooperating on the project with Erich P. Ippen of Bell Laboratories in Holmdel, N.J., "These are the shortest continuous wave pulses from a semiconductor diode laser ever reported." The system was built by two graduate students working with Haus and Ippen, Ping-Tong Ho and Lance A. Glasser.

One of the serious problems in producing a short-pulsing semiconductor laser is the size of the lasers usually made from such materials and the characteristics of the materials. Every laser has a resonant cavity in which the light is amplified while being repeatedly reflected between two mirrors. In previous diode lasers the space between the mirrors is short, and, given the characteristics of the material, the amplification is accomplished too swiftly to build up discrete pulses of the desired length. The MIT researchers solved the problem by adding a third mirror and lengthening the resonator.

A laser pulse 20 picoseconds long takes up 6 millimeters of space. The pulses repeat at a rate of 3 billion per second, which is convenient for communications. What the group was after in doing this was a self-pulsing laser, one that would automatically produce pulses of the desired length. What they got was a mode-locking system, one in which the laser is locked into a particular pulse pattern. MIT has applied for a patent on the mode-locking system. Meanwhile, the research group continues to seek ways to achieve self-pulsing. □

Criminal research

The age-old argument over whether criminal penalties, particularly capital punishment, serve as a deterrent to crime continues to rage largely on the basis of subjective moral and ethical judgments, rather than on solid evidence of cause and effect. While it stopped short of concluding that punishment does not prevent crime, the National Research Council has cast a thumbs down verdict on a recent collection of studies on the death penalty. A council panel reported to the Law Enforcement Assistance Administration that "no useful evidence" as yet exists that conclusively identifies capital punishment as a deterrent to murder. And evidence that imprisonment reduces crime by "incapacitating" a prisoner is based on "as yet untested... assumptions," according to the panel. In its report, the panel found flaws in the design and performance of many such studies. "As long as validity is low," they report, "science cannot contribute much to policy decisions on the use of criminal sanctions." □