Deep source of magnetic stripes

An oceanographic ship towing a magnetometer in its wake will record a zebralike pattern of magnetic stripes from the ocean floor below. Scientists have long known that lavas coming from mid-ocean ridges where new seafloor is created become magnetized as they cool in the presence of the earth's magnetic field; the series of stripes with different magnetic orientations forms because the earth's field reverses direction from time to time. But what has not been known is exactly which rocks in the oceanic crust contribute to the magnetic pattern.

Now a researcher at the University of Minnesota in Minneapolis has presented the first direct measurements of the magnetic properties of rocks lying below 600 meters of seafloor, providing scientists with the deepest view yet of the magnetic structure of the marine crust. Guy M. Smith in the university's department of geology and geophysics reports in the March GEOLOGY on the magnetic properties of core samples taken from drill hole 504B, which penetrated 1,350 meters into the crust during Leg 83 of the Deep Sea Drilling Project (DSDP).

Smith's paper, writes Kenneth Verosub at the University of California at Davis in the same issue, supersedes a great deal of speculation based primarily on computer modeling and on the study of surrogate samples from ophiolites — slivers of marine crust that have been pushed up onto land. "His work shows that deeper parts of the crust can in fact be a source of magnetic anomalies," Verosub told SCIENCE NEWS.

When seafloor magnetic stripes were first discovered, researchers envisioned a crust that was uniformly magnetized, right down to the mantle. But studies of ophiolites suggested that the structure of the crust was more complex: The basalts in the upper, extrusive layer had different compositions and magnetic properties than the underlying layer of so-called sheeted dikes (relicts of the channels used by lavas to get to the surface). Moreover, says Smith, if all of the oceanic crust had a magnetic field as high as that measured in rock samples taken from the very top, the total magnetic field would be greater than what is actually observed.

So while ophiolites helped scientists understand that the magnetization of the crust was not uniform and probably decreased with depth, they could not give a reliable picture of the exact magnetic structure of oceanic crust because their magnetic properties had probably been altered during their excursions on to land. That's why core samples are so important. But until Leg 83, the deepest the DSDP ever drilled was 600 meters — reaching down through only part of the extrusive layer. "The unique thing about Leg 83," says Smith, "is that it was able to get the top 300 meters of the sheeted dike complex. These are the first samples we've had of this major unit in the marine crust."

According to Smith, the magnetic field strength of rocks from the dike layers is three to four times higher than predicted by the ophiolite studies. And since the magnetization of the dike layer is also comparable to (although slightly less than) that of rocks in the upper part of the extrusive layer, Smith concludes that it must contribute to the total magnetic field of the crust.

Work by Smith and others has also shown that between the dike and upper extrusive layers is a transition region containing rocks that have been chemically altered by what the scientists think was the circulation of hot seawater. "There's a sudden, very sharp break in the properties of these rocks right about the point where the Leg 83 section started," says Smith. "Exactly why it's so sharp is a good question." Smith found that the magnetic strengths of rocks from this 200-meter transition zone had values ranging from that found in the dike region to strengths 1,000 times weaker, making the zone's contribution to the total magnetic field of the crust relatively small.

Smith warns that the data provided by one drill hole should not be used to draw conclusions about the magnetic structure of marine crust in general, especially since magnetic properties of rocks are so easily changed by thermal and chemical processes, which can be limited to very small areas. A series of drill holes might not only increase understanding of crustal magnetics but also help researchers learn about the processes that work on the crust as it moves away from a spreading ridge.

Verosub notes that the recent findings support the theoretical work he did with Eldridge Moores, also at U.C.-Davis, showing that even if the upper layers of the crust have been altered, the crust can still display a magnetic field. In an upcoming paper in the JOURNAL OF GEOPHYSICAL RESEARCH, these researchers also argue that blocks in the extrusive layer may have been rotated about a horizontal line.

— S. Weisburd

A balancing act for chemical purity

Anyone who has ever tried to use the spray from a hose to keep a Ping-Pong ball suspended in the air knows that it's hard to keep the ball in place for very long. This kind of stability problem also faced biochemist Patrick H. O'Farrell when he first thought of his scheme for purifying proteins by balancing the flow of a liquid against the opposing pull of an electrical force. Nevertheless, he found an answer, and the result is a versatile purification method that may be of considerable interest to biotechnology companies and others interested in recovering, on a large scale, pure compounds from complex mixtures.

O'Farrell, a researcher at the University of California at San Francisco, describes the results of his "initial investigations" into this new group of separation methods in the March 29 SCIENCE.

Essentially, O'Farrell combines two well-known and widely used separation methods: electrophoresis and chromatography. In electrophoresis, large molecules with a net electric charge migrate through a solution under the influence of an applied voltage. Different proteins (the solute), for instance, move at different speeds. In chromatography, a solution trickles through a bed of tiny beads that selectively retard the passage of molecules. Again, different molecules move through at different speeds but rarely at rates that match those in electrophoresis. By combining these two separation techniques, O'Farrell invented a purification method that he calls "counteracting chromatographic electrophoresis."

The trick to making this technique work is careful selection of the porous resin beads or gel beds (the chromatographic matrix) that go into a separation column. "A chromatographic matrix can influence solute movement with a flowing solvent differently from the way it influences solute electrophoresis," reports O'Farrell, "and thereby can bring about a balance between these opposing forces."

In its simplest form, the technique involves packing a glass cylinder with an upper layer of beads through which a particular protein passes quickly and a lower layer through which it travels more slowly. The applied voltage is carefully selected so that it drives molecules upward at a rate greater than the protein's flow rate downward through the lower bed, but less than its flow rate in the top layer. Hence, the protein is concentrated at an equilibrium position at the interface between the two different gel beds.

"The approach is very general and adaptable," says O'Farrell. By adjusting the voltage or by selecting different types of beads, different proteins can be concentrated. It is also possible to create a column with several interfaces so that more than one compound can be purified at the same time.

Although O'Farrell's paper is only now appearing in a scientific journal, he actually invented and patented this separation technique several years ago. "It's just now that the people involved in biotechnology are beginning to realize the importance of purification procedures for eventually producing something for market," he says. "So, all of a sudden, there's this big interest in this area." *—I. Peterson*