New Theory Restructures Earth's Interior

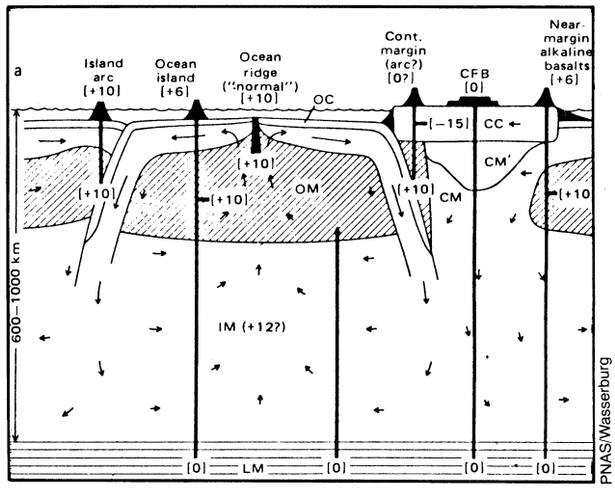
A theory, which researchers are calling as revolutionary as the concept of plate tectonics, is reshaping ideas about the interior of the earth. Traditional views of the mantle, the layer of the earth between the crust and the core, see it as a well-stirred, homogenous pot of nearly molten material. But recent evidence supports the hypothesis that the earth's mantle is two-layered, containing a deep layer of unmelted material unchanged since its creation.

Gerald J. Wasserburg and co-workers at the California Institute of Technology began developing a two-layered mantle model in 1976. With more evidence, Wasserburg, Don J. DePaolo and Stein B. Jacobsen refined their model and its implications in recent papers (PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, Vol. 76, Nos. 7 and 8) and at the recent meeting of the Geological Society of America in San Diego.

The structure of the earth's interior can only be inferred from analysis of rocks that represent samples of mantle material. One such rock type is lava, and a telltale marker of mantle composition is the ratio of the isotopes of neodymium (Nd). When the continents originally formed from the mantle, they depleted it of ^{144}Nd, leaving an excess of ^{143}Nd. According to the current stirred-pot mantle model all lavas should be enriched in ^{143}Nd. But Wasserburg and co-workers found that continental lava samples and ocean bottom lava samples differ markedly in their neodymium isotope ratios. As expected, the ocean bottom lava samples had an excess of ^{143}Nd. But the isotope ratio of the continental lavas indicated they came from a source that had never been altered by the removal of continental crust material.

To the researchers, this argued for the existence of "two widespread mantle reservoirs that have been mutually isolated for more than one aeon." They developed a two-layered model of the mantle, in which the unaltered, unmelted lower mantle is at a depth of approximately 600 to 1,000 kilometers. The shallow mantle is the source of lavas found at mid-ocean ridges, while continental lava flows tap the primordial deep layer. According to the model, other lava types are a mixture of deep and shallow mantle materials. For example, lavas from ocean island volcanoes — such as the Hawaiian Islands — are a mixture of rising plugs of lower mantle material that mixes with the partially molten upper mantle.

The two-tiered model does more than just shift the insides of the earth, say Wasserburg and others. As Asish R. Basu of the University of Rochester says, "Plate tectonics just deals with the earth's surface — this goes to the depths." (At the American Geophysical Union meeting next week, Basu will present further evidence for a primordial mantle layer based on noble gases and 200-meter-deep rocks.) A major impact, for example, will be felt in the long-running debate about convection or churning of the mantle. Mantle convection is assumed to be the force that drives continental drift, but how much of the mantle actually circulates is unknown. An unmelted primordial layer would preclude whole-mantle convection. Wasserburg and co-workers also have found that their model has implications for the growth and age of the continents. A major headache for geologists has been the lack of rocks as old as the earth; the earth is believed to be about 4.5 billion years old but the oldest rocks are about 3.6 billion years old. The researchers went to the source — the depleted ocean mantle — to find the fate of the earlier rocks. They found that depletion — meaning continental formation — began 3.6 billion years ago, indicating that very little early crust ever formed or that early crust was destroyed and restirred into the mantle. □



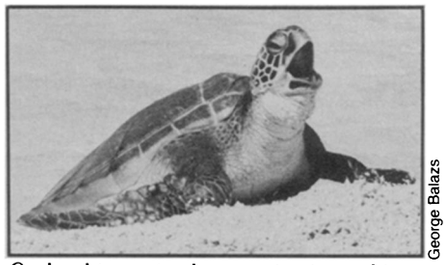
Proposed model for earth's mantle: Researchers believe unaltered lower mantle (LM) is source for continental lavas (CFB), while other lavas (ocean ridge normal) arise only from upper mantle (OM and IM) or from mixture of upper and lower material (ocean island). Arrows mark plausible flow pattern, numbers indicate isotope ratios.

Sea turtles dwindle as trade increases

It's a paradox that has international environmental policymakers worried: Statistics indicate that the quantity of products derived from endangered sea turtles — such as tortoiseshell, soup, meat and tanned hide — is actually growing even though scientific data continue to signal a perilous decline both in the number of existing turtles and in their ability to survive. And to complicate matters, many of the countries carrying out vigorous trade in sea turtles are voluntary signatories of a treaty that has pledged to stamp out commercial trade in endangered species. Seeking ways to cope with the problem, representatives from 40 nations met this week in Washington to attend the World Conference on Sea Turtle Conservation.

The life cycle of these tasty marine behemoths — which can grow to a weight of more than 1,000 pounds and which have been known to precisely navigate distances of 1,000 miles or more to find the exact nesting beach of their birth — remains largely a mystery. Less a mystery is the fact that CITES (SN: 10/20/79, p. 264) — a treaty prohibiting member states from trading in endangered species — is not being enforced with regard to the turtles. At least 23 of the 54 countries that have ratified CITES have "recently" engaged in trade of sea turtle products, according to a detailed statistical study of the sea turtle market by TRAFFIC-USA (Trade Records Analysis of Flora and Fauna in Commerce, funded by the World Wildlife Fund-U.S.).

The report also claims that some exporters mislabel sea turtle products to fool international customs inspectors. But biochemical tests to thwart such efforts are already under development and were described briefly at the Washington meeting; one identifies meat proteins by species, another identifies shell by species. □


George Balazs

On land to nest, when most get caught.