Engineering and Geosciences

Engineering and Geosciences research aids the development of tools and knowledge essential for improved understanding of our physical world. This gives rise to improved engineering practices, better control over heat and fluid systems, and efficient searches for energy-related resources.

ISOTOPIC GEOLOGY

Who would think that measuring the age of geologically "young" rocks would prove that the world's continents and its associated seafloors are actually drifting like gigantic rafts on oceans of semi-molten rock? Such was the connection, however, between Basic Energy Sciences research focused on sensitive measurements of the relative abundances of certain atomic species, called isotopes, and the idea of continental drift, today known more formally in the field of geology as plate tectonics.

As a curious observer of a world globe might wonder, the shapes of South America and Africa appear to fit together like pieces of a jigsaw puzzle. Important geological features of both continents, such as rocks of identical age and certain geological uplifts, faults, and mountain ranges, also seem to line up when fitted together.

These observations led to speculations that the two continents long ago were joined as one. Resistance to such notions, however, ran high. There was no known process which could credibly explain how this might have happened.

Then, in the mid-1960's, the theory of plate tectonics gained almost immediate worldwide acceptance. Compelling evidence emerged from several sources, aided by an instrument developed by Basic Energy Sciences, that confirmed the phenomenon of continental drift.

The theory of plate tectonics holds that the continents and their associated undersea land masses form enormous crustal plates, which collectively "tile" the surface of earth. They float on underlying "oceans" of hot, viscous rock, believed to constitute much of the earth's interior volume. Convective currents in the upper reaches of this regime are believed to cause the plates to move slowly and continuously.

According to theory, earthquakes evidence the bumping and grinding of plate edges as they rub past each other. Where leading edges collide, one plate may thrust over or dive under another, creating mountain ranges or deep ocean trenches. At trailing edges, where plates drift apart, upwelling molten rock, or magma, forms new crust to fill the spreading gap.

Proponents of this theory felt that the latter phenomenon, called seafloor spreading, might be susceptible to scientific testing. The formation of new crust should be observable, leaving behind a large geologic feature, such as a mid-ocean ridge, thousands of miles in length.

Further, seafloor spreading would exhibit three testable characteristics. First, the youngest rocks would lie closest to the ridge where the new rock was believed to be forming. Second, the age of the seafloor rocks would increase with distance from the ridge. Finally, the age-related patterns observed on one side of the ridge would tend to mirror those on the other.

Credence to this hypothesis was added when oceanographers using sonar located and confirmed the existence of mid-ocean ridges. As the data continued to gather over the years, maps began to trace out long, continuous ridges, rising about 8,000 feet above the seafloor, running along the approximate center of all the earth's oceans. Curving up and down the globe, joining one ocean with another like seams on a baseball, its total length was eventually determined to be 38,000 miles—more than half again the length of the earth's equator.