ACTIVITY 3— WHAT DRIVES THE PLATES?

Background Information

The internal structure of the Earth has probably been taught to the students in terms of a solid inner core, a liquid (molten) outer core, a "semi-solid" mantle, and an outer solid crust. What may surprise students in this activity is to discover that the crust and the mantle, although well defined, really are much more complex than is usually taught. Any horizontally layered material in a gravitational field, like the interior of the Earth, tends to stay the way it is if it is stratified by density in such a way that the density of the material increases uniformly with depth. By the principle of buoyancy, if for some reason a region of such a stratified material becomes less dense than the material that overlies it, then that region tends to rise upward until it reaches a higher level with the same density. This happens provided that the material can flow like a fluid, as is now known to be the case with the Earth's mantle on long time scales. Some regions of the mantle are less dense than other regions at the same depth, either because their temperature is higher or because their composition is different. The cause of temperature differences is usually attributed to differing concentrations of radioactive materials or to unequal heating from the underlying core, or to the downward movement of originally cool lithospheric plates. Differences in composition come about by subduction of lithospheric plates and eventual resorption into the mantle.

Density differences from place to place in a fluid medium produce convection currents, by which cooler, denser materials move downward and warmer, less dense materials rise upward. These motions tend to establish a state of buoyant equilibrium, in which the density increases uniformly downward and no region of the material has any tendency to either rise or sink. Convection is a basic mechanism of heat transfer whereby heat is transferred by the movement of material. This is in contrast to the other mechanisms of heat transfer: conduction and radiation. Convection becomes organized into elements, or cells, with some regular or rather irregular arrangement of rising and sinking regions. The phenomenon of convection is one of the most complicated topics in the mechanics of fluids; the scale, the geometry, and the degree of regularity of the convection patterns varies greatly, depending upon many variables. Convection currents within the mantle drive the flow of matter and energy within the Earth and create the "dynamic geosphere." The problem of mantle convection is an active area of research in geoscience, and much is still not well understood.

The *EarthComm* web site, www.agiweb.org/earthcomm/, contains a variety of carefully selected links to web sites that will help you to deepen your understanding of content and prepare you to teach this activity. Many of the sites also contain images which can be downloaded and made into overheads for later incorporation into class discussions.