essentially lateral, and they appear to have moved in many different directions in the last 2.5 billion years. It is rather like a game of bumper cars, only without the bumpers. When continental plates collide, they wrinkle and buckle up the crust to form mountains. When a heavy oceanic plate collides with a continental plate, the oceanic plate is carried beneath the lighter continental plate to be remelted. The continental plate is lifted or jacked up to form huge mountain chains like the Andes of western South America (see figure 5.5). Some remelted material from the oceanic plate may also be carried upward through cracks to form new coastal mountain volcanoes or add material to old ones.

Heat sources in the upper mantle create new basaltic sea-floor material in a process known as *sea-floor spreading*. This process is thought to initiate the various plate movements. Remember that the interior of the Earth is a giant heat engine that is slowing down as its radioactive fuel continues to decay. Like a hot car engine, it must be cooled. One of the ways the Earth's engine cools itself is to vent hot molten basaltic magma from the mantle to the crust. This magma rises through cracks in the crust to create new sea-floor material. As the magma cools, it fills the rift in the crust left by the movement of plates away from one another.

The Mid-Atlantic Ridge is a current example of this sea-floor spreading process (see figures 5.6 and 5.7). The land masses of the Americas are effectively being moved away from Europe and Africa.

At the other end of the outward moving oceanic plates, deposited sediments and oozes are carried beneath the lighter continental bearing plates to be reheated to form new continental material (see figure 5.5). Thus, much of the Earth's crust, with the exception of the stable continental cratons, is recycled over time in the same way that the

FIGURE 5.6.

Stages in the development of a divergent junction and sea-floor spreading. The lithosphere breaks, *left*, and a rift develops under a continent. Molten basalt from the asthenosphere spills out. The rift continues to open, *right*, separating the two parts of the continent -- in this case, America and Africa. The active rift is marked by a mid-ocean ridge, with earthquakes and volcanism as characteristic features. (After "The Breakup of Pangaea" by R. S. Dietz and I. C. Holden. Copyright © 1970 by Scientific American, Inc. All rights reserved.)