Earth’s Internal Structure

Earth’s Layered Structure In the preceding section, you learned that the segregation of material that began early inEarth’s history resulted in the formation of three layers defined by their chemical composition—the crust, mantle, and core. In addition to these compositionally distinct layers, Earth can be divided into layers based on physical properties. The physical properties used to define such zones include whether the layer is solid or liquid and how weak or strong it is. Knowledge of both types of layered structures is essential to our understanding of basic geologic processes, such as volcanism, earthquakes, and mountain building.

**Earth’s Crust**

The crust, Earth’s relatively thin, rocky outer skin, is of two different types—continentalcrust and oceanic crust. Both share the word “crust,” but the similarity ends there. Theoceanic crust is roughly 7 kilometers (5 miles) thick and composed of the dark igneousrock *basalt*. By contrast, the continental crust averages about 35 kilometers (22 miles) thickbut may exceed 70 kilometers (40 miles) in some mountainous regions such as the Rockies and Himalayas. Unlike the oceanic crust, which has a relatively homogeneous chemical composition, the continental crust consists of many rock types. Although the upper crust has an average composition of a *granitic rock* called *granodiorite*, it varies considerably from place to place. Continental rocks have an averagedensity of about 2.7 g/cm3, and some havebeen discovered that are 4 billion years old. The rocks of the oceanic crust are younger(180 million years or less) and denser (about 3.0 g/cm3) than continental rocks.

**Earth’s Mantle**

More than 82 percent of Earth’s volume is contained in the mantle, a solid, rocky shell

that extends to a depth of nearly 2900 kilometers (1800 miles). The boundary between the crust and mantle represents a significant change in chemical composition.The dominant rock type in the uppermost mantle is *peridotite*, which is richer in the metals magnesium and iron than the

minerals found in either the continental or oceanic crust.

**THE UPPER MANTLE.** The upper mantle extends from the crust-mantle boundarydown to a depth of about 660 kilometers(410 miles). The upper mantle can be divided into two different parts. The top portion of the upper mantle is part of the stiff *lithosphere*, and beneath that is theweaker asthenosphere**.** The lithosphere (sphere of rock)consists of the entire crust and uppermostmantle and forms Earth’s relatively cool, rigid outer shell. Averaging about 100 kilometersin thickness, the lithosphere is morethan 250 kilometers thick below the oldest portions of the continents. Beneath this stiff layer to a depth of about 350 kilometers lies a soft, comparatively weak layer known as the *asthenosphere* (“weak sphere”).

It is important to emphasize that the strength of various Earth materials is a function of both their composition and the temperature and pressure of their environment. You should not get the idea that the entire lithosphere behaves like a brittle solid similar to rocks found on the surface. Rather, the rocks of the lithosphere get progressively hotter and weaker (more easily deformed) with increasing depth. At the depth of the uppermost asthenosphere, the rocks are close enough to their melting temperature (some melting may actually occur) that they are very easily deformed Thus, the uppermost asthenosphere is weak because it is near its melting point.

**THE LOWER MANTLE.** From a depth of 660 kilometers (nearly 410 miles) to the top of the core, at a depth of 2900 kilometers (1800 miles), is the lower mantle**.** Because of an increase in pressure (caused by the weight of the rock above) the mantle gradually strengthens with depth. Despite their strength however, the rocks within the lower mantle are very hot and capable of very gradual flow.

Earth’s Core

The composition of the core is thought to be an iron-nickel alloy with minor amounts of oxygen, silicon, and sulfur—elements that readily form compounds with iron. At the extreme pressure found in the core, this iron-rich material has an average density of nearly 11 g/cm3 and approaches 14 times the density of water at Earth’s center. The core is divided into two regions

that exhibit very different mechanical strengths. The outer core is a *liquid layer* 2270 kilometers (1410 miles) thick. It is the movement of metallic iron within this zone that generates Earth’s magnetic field. The inner core is a sphere having a radius of 1216 kilometers (754 miles). Despite its higher temperature, the iron in the inner core is *solid* due to the immense pressures that exist in the center of the planet.

