

The Geologic Earth

Knowledge of the earth's interior has been gathered by three methods: by the analysis of earthquake waves passing through the earth (see [seismology](#)), by analogy with the composition of meteorites, and by consideration of the earth's size, shape, and density. Research by these methods indicates that the earth has a zoned interior, consisting of concentric shells differing from one another by size, chemical makeup, and density. The earth is undoubtedly much denser near the center than it is at the surface, because the average density of rocks near the surface is c.2.8 g/cc, while the average density of the entire earth is c.5.5 g/cc.

The Earth's Crust and the Moho

The outer shell, or crust, varies from 5 to 25 mi (8 to 40 km) in thickness, and consists of the [continents](#) and ocean basins at the surface. The continents are composed of rock types collectively called sial, a classification based on their densities and composition. Beneath the ocean basins and the sial of continents lie denser rock types called sima. The sial and sima together form the crust, beneath which lies a shell called the mantle. The boundary between the crust and the mantle is marked by a sharp alteration in the velocity of earthquake waves passing through that region. This boundary layer is called the Mohorovičić discontinuity, or Moho.

The Earth's Mantle

Extending to a depth of c.1,800 mi (2,900 km), the mantle probably consists of very dense (average c.3.9) rock rich in iron and magnesium minerals. Although temperatures increase with depth, the melting point of the rock is not reached because the melting temperature is raised by the great confining pressure. At depths between c.60 mi and c.125 mi (100 and 200 km) in the mantle, a plastic zone, called the asthenosphere, is found to occur. Presumably the rocks in this region are very close to melting, and the zone represents a fundamental boundary between the moving crustal plates of the earth's surface and the interior regions. The molten magma that intrudes upward into crustal rocks or issues from a volcano in the form of lava may owe its origin to radioactive heating or to the relief of pressure in the lower crust and upper mantle caused by earthquake faulting of the overlying crustal rock. Similarly, it is thought that the heat energy released in the upper part of the mantle has broken the earth's crust into vast plates that slide around on the plastic zone, setting up stresses along the plate margins that result in the formation of folds and faults (see [plate tectonics](#)).

The Earth's Core

Thought to be composed of iron and nickel, the dense (c.11.0) core of the earth lies below the mantle. The abrupt disappearance of direct compressional earthquake waves, which cannot travel through liquids, at depths below c.1,800 mi (2,900 km) indicates that the outer 1,380 mi (2,200 km) of the core are molten. It is thought, however, that the inner 780 mi (1,260 km) of the

core are solid. The outer core is thought to be the source of the earth's magnetic field: In the “dynamo theory” advanced by W. M. Elsasser and E. Bullard, tidal energy or heat is converted to mechanical energy in the form of currents in the liquid core; this mechanical energy is then converted to electromagnetic energy, which we see as the magnetic field. The magnetic field undergoes periodic reversals of its polarity on a timescale that ranges from a few thousand years to 35 million years. The last reversal occurred some 780,000 years ago.