PLATE TECTONICS

To first detain the reader before novel and amusing objects, that in treading the path of beauty he may arrive effortlessly to that of science.
—Alexandre-Theophile Vandermonde (1735-1796) *vera* Clara Pinto-Correia.[1]

d1 Earth within < 1960s synthesis >

... he [Arngrimus Fitz–Ionas] compiled this briefe commentary, taking his proofes, not out of the vaine fables of the people, but from his owne experience, and many other mens also of sufficient credit. —Gudbrandus Thorliacus, Anno 1592, Iulii 29.[2]

Our present knowledge of Earth's deep interior is by any account a triumph of scientific enquiry. Geology and physics together as geophysics light our way and give us perspective. Earth is layered (***Figure d1.1***). Historically, its description has changed from a pictured cavernous, collapse prone, Earth,[3] to one without hollows at depth, which is, however, dynamic and physically evolving.

Tectonics is the branch of geology concerned with the description, origin, deformation, movement, and arrangement, of Earth's *major structural components*. The theory of *plate tectonics* is a late 1960s synthesis of global geophysical measurements and large-scale geological features as these relate to movements of lithosphere-shell fragments called plates (*see* Topic *d6*). A plate's upper part is Earth's crust. A plate, where it is with oceanic crust, becomes negatively buoyant as it ages and cools. To sink, a plate glides horizontally to where an edge with oceanic crust turns down and "subducts" as a descending slab through the asthenosphere (a shell of readily-yielding mantle below the lithosphere) into the mesosphere (all of the mantle below the asthenosphere).

Below shallow depths affected by surface temperatures, Earth's temperature increases downward. A thermal geogradient of 1 degree per 25 meters depth was first determined in France by Pierre Louis Antoine Cordier (1777-1861) and Ferdinand Reich (1799-1883) who made thermometry measurements of the rock, and not just the ventilating air, in mines.[4] Crustal temperature variations are considerable from place to place, however. Below mine levels, increasing temperatures are evidently with far gentler gradients as mantle rocks (peridotite composition) are solid regionally down to the core boundary (at temperature 3950±200 kelvin (K)) below which is molten iron.[5] Shock wave and static compression experiments indicate that pure iron at core pressures would melt at ~7000 K. So the outer core, which is molten, must be an iron alloy—likely with sulfur, oxygen and hydrogen. As such, it will have a temperature of ~4500 K at its boundary with the inner core, which is solid iron.[6] (For comparison, Sun's photosphere temperature is 5800 K.) (0 K equals –273.15 degrees Celsius.) ❑

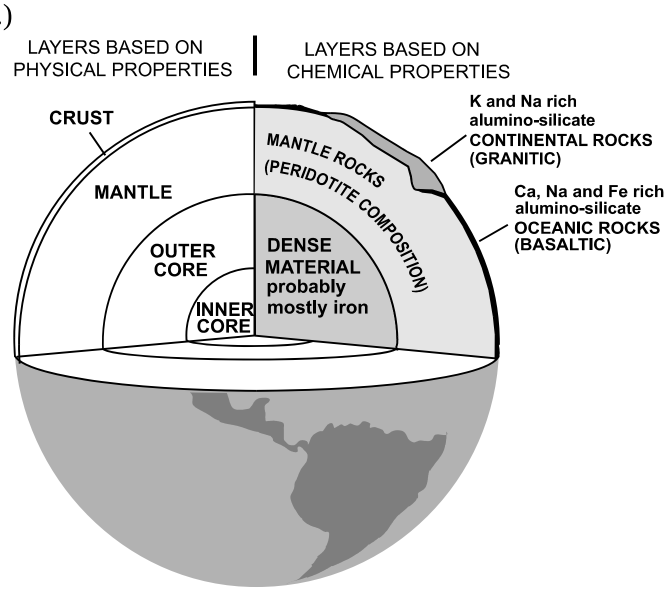

Figure d1.1
Earth's layers are inferred from physical and chemical considerations.

The crust and the mantle are at temperatures close to melting and at relatively shallow depths do melt locally and occasionally but in the long term remain solid. The outer core is molten. The inner core is solid.

Below a relatively thin top layer of marine sediments, the oceanic crust is basalt and gabbro.

The continental crust is only 0.57% of the mass of the mantle but has ~40% of Earth's potassium.[7] It accretes as the silica- and aluminum-rich magmatic differentiate of basalt that is itself a magmatic differentiate. of mantle peridotite.