

105 Chapter 2 Review Notes

- The composition of the differentiated layers of the Earth (crust, mantle, core) has been determined using both direct and indirect means
- The composition of the *lithosphere* (crust and uppermost mantle) can be determined by direct sampling of rocks at or near the surface, particularly in mountain belts
- The compositions of the rest of the mantle and the core have been determined using indirect methods such as seismic waves (vibrations from earthquakes), and determining the total mass, average density, and moment of inertia of the Earth
- The *asthenosphere* of a planet, just below its brittle lithosphere, is warm enough to flow slowly over time (and may even be partially molten), which allows heat to rise by convection – the convection in the Earth’s asthenosphere is at least partially responsible for driving tectonic plate motions
- Heat is transferred across the brittle (by definition) lithosphere of a planet by conduction. When active volcanism is present, the erupted lavas transfer heat to the surface by a process known as *advection*
- Recycling of the lithosphere of the Earth by *plate tectonics* also transfers heat from the interior to the surface
- Earth’s lithosphere is composed of basaltic oceanic crust, largely granitic continental crust, the uppermost mantle (probably peridotite)
- Convective and conductive heat transfer can occur equally well in icy bodies as in silicate rock bodies like the Earth
- Accretion and differentiation is believed to have occurred in larger (> several hundred km in diameter) planetary bodies throughout the solar system in a manner similar to what occurred on the Earth. The resultant layered structure appear to be the result density partitioning where heavier elements sink to the center of a body that is partially to completely molten as a result of heat obtained primarily from impacts during the final stages of accretion
- Primordial heat, retained from processes operating in the earliest stages of planetary evolution, includes that from impactors during accretion *and* gravitational potential energy released as denser components sunk to the center of the differentiating body. Other important (and ongoing) heat sources include *radiogenic heating* and *tidal heating*
- Radiogenic heating within the rocky (silicate) planetary bodies (like Earth) is primarily the result of the decay of unstable isotopes such as ^{235}U , ^{238}U , ^{232}Th , and ^{40}K in their silicate rich mantle and crustal layers. Radiogenic heating would have been even more significant early in planetary history because much more radioactive material was present then (prior to subsequent decay over the billions of years to follow), including extremely radioactive (and, hence, short-lived) isotopes like ^{26}Al .
- For large satellites orbiting enormous planets (notably, Jupiter’s inner Galilean satellites), tidal heating can become a significant (and even dominant) ongoing source of internal heating
- Geologically active bodies (i.e., those that have ongoing volcanic and tectonic activity) are “powered” by the loss of remaining internal heat. This heat can be primordial, having been retained more efficiently by the larger bodies due to their lower surface area to volume ratio, or actively generated (tidal heating)
- The amount of heat retained or generated within a planetary body over time directly controls the nature of (and processes occurring on) a planetary surface. The rate and extent of planetary resurfacing over time is directly related to the amount of internal heat in a planet