GLG 101 – CHAPTER 2 - PLATE TECTONICS

- The first glimmer of what later became the theory of Plate Tectonics was the **Continental Drift** hypothesis, set forth by Alfred Wegener in the early 1900s. This hypothesis held that a supercontinent called "Pangaea" ("all lands") began breaking apart into smaller continents about 200 million years ago. Wegener used the fit of Africa and South America, fossil evidence, similar rock types and structures, and similar ancient climates to demonstrate that the continents had once been joined. A major objection to Continental Drift was the lack of a suitable driving force or mechanism to move something as large as a continent.
- In 1962, Harry Hess proposed **Seafloor Spreading**, which states that new seafloor crust is being generated at mid-ocean ridges and that old seafloor is being consumed back down into the mantle at ocean trenches. Support for this hypothesis included "stripes" of alternating normal (same as present magnetic field) and reverse-magnetized rocks on either side of the mid-ocean ridges in a mirror-image pattern, as well as the progressively older age of ocean crust rocks away from the mid-ocean ridges.
- **Paleomagnetism** (the direction of magnetism recorded in the rocks when they formed; different from the direction to the current magnetic pole) of rocks on the continents suggested that they had, in fact, moved around quite a bit over time.
- In the late 1960s, Continental Drift and Seafloor Spreading were united into the more comprehensive theory of **Plate Tectonics**. This theory describes the brittle upper **lithosphere** as floating in a more fluid region known as the **Asthenosphere**. The lithosphere is divided into fragments called plates, which move independently of each other, sometimes colliding, other times moving away from each other, and deforming primarily along their edges or "margins".
- There are three types of plate margins or "boundaries": 1) **divergent** plate boundaries, where new crust is created from hot upwelling mantle material, primarily along mid-oceanic ridges; basaltic volcanism is common at divergent boundaries; new divergent boundaries may form within continents, such as at the East-African Rift Valley, and divide the continent into two or more fragments; 2) **convergent** plate boundaries occur where plates collide; continent-continent collisions produce large mountain belts, such as the Alps and Himalayas; ocean-continent collisions produce ocean trenches and continental mountain belts of crumpled crustal rocks and arcs of (primarily) andesitic composite cone volcanoes, such as the Andes of South America; ocean-ocean collisions produce very deep trenches where the older/colder/denser plate is forced beneath the younger plate, and a volcanic island arc of andesitic volcanoes forms above and forward of the **subduction zone**, such as the Phillipines and Marianas islands; and 3) **transform fault** boundaries, where plates grind by each other laterally without production or destruction of lithosphere. Most transform faults are located between offset segments of the mid-ocean ridges, but the San Andreas Fault is such a boundary between the Pacific and North American plates along coastal California.
- The theory of Plate Tectonics is supported by the global distribution of earthquakes and volcanoes and their close associations with plate boundaries, the ages and thickness of sediments from deep ocean basins, and the existence of island chains formed by the movement of plates over mantle hotspots. These island chains allow determination of the long-term rates and directions of plate motion.
- Suggested driving mechanisms for the plate motions include the **convection current**, **slab-pull**, **slab-push**, and narrow **hot plume** hypotheses. All involve the transport of heat from within the Earth to the surface, and no one of these is likely to be the sole cause. It is likely that all of these hypothetical mechanisms contribute to plate motions.