GLG 101 – CHAPTER 13 - DIVERGENT BOUNDARIES: THE OCEAN FLOOR

- The depth to the seafloor in any location can be mapped from ships using **echo sounders**. These devices send out sound waves, record the amount of time before they return to the ship after bouncing off the sea floor, and determine the depth from the known velocity of the waves through the water multiplied by the time until the signal returns.
- The ocean floor can be divided into three main topographic provinces: **continental margins** (including the shelves, slopes, and rises), **deep ocean basins** (abyssal plains, seamounts, and trenches), and the **mid-ocean ridges**.
- **Passive continental margins** consist of the **continental shelf**, a gently-sloping continuation of continental crust submerged slightly beneath sea level; the **continental slope**, the true edge of the continent, that has a steep slope that leads from the shelf down to the deep ocean basin. In areas without trenches, the continental shelf merges down into the more gently sloping **continental rise**. The continental rise consists of sediments that have moved downslope from the continental shelf to the deep-ocean floor.
- **Active continental margins** are found primarily around the Pacific Ocean where oceanic plates are subducting down beneath continental plates. The ocean sediments are scraped off of the subducting plate and plastered onto the continental margins in **accretionary wedges**. These margins typically have narrow continental shelves, which slope down into very deep **ocean trenches**.
- **Submarine canyons** are deep, steep-sided valleys that "notch" into the edges of the continental shelves and can extend to depths of up to 3 km below sea level. Although some of these are extensions of large rivers on land (such as the Hudson), most appear to have been formed by **turbidity currents**, downslope movements of dense mixtures of sediments and water produced by undersea landslides. The collections of sediments that result from such landslides are called **turbidites**, and exhibit **graded bedding**.
- The deep ocean basins are located between the continental margins and the mid-ocean ridges, and include the **deep ocean trenches**, located at convergent boundaries where dense oceanic plates sink down into the asthenosphere; the **abyssal plains** (vast areas of deep, flat ocean floor), and the **seamounts** (or "guyots"). The seamounts are isolated, steep-sided volcanic peaks that originated near oceanic ridges or from hotspots and either never built up to the ocean surface or were islands that subsequently eroded and sunk (by gravity) down beneath sea level again.
- **Coral reefs** are found primarily in shallow, warm, sunlit waters of the tropical Pacific and Indian oceans. These huge stacks of limestone are formed over thousands of years from the

accumulation of skeletal remains and secretions of corals and algae. **Atolls** are continuous or broken ring-shaped islands of coral that enclose a central lagoon. They form on the flanks of gradually sinking volcanic islands.

- There are 3 general categories of seafloor sediments: 1) **terrigenous sediments**, which are composed primarily of mineral grains weathered from rocks on continents and transported to the oceans by rivers, wind and/or glaciers; 2) **biogenous sediments**, consisting of the remains (shells and skeletons) of marine animals and plants; and 3) **hydrogenous sediments**, which consist of minerals that crystallize directly from seawater via certain chemical reactions.
- **Mid-ocean ridges** are long, sinuous mountains ranges that run down the centers (or nearly the centers) of the ocean basins. These are the areas where active **seafloor spreading** occurs by volcanism and intrusion of basaltic lavas/magmas to form new oceanic lithosphere. These are the most prominent features of the ocean floors and comprise nearly 20 percent of the surface area of the Earth. They are characterized by 1) being **higher than the surrounding abyssal plain**, sometimes by several kilometers or more; 2) being marked by extensive faulting, both normal (in the central "rift" zone) and transform (the offsets that separate segments of the ridge system); and 3) having widespread volcanic landforms including volcanoes and lava flows. Most of the geologic activity of the mid-ocean ridges occurs at the volcanically and tectonically active central rift zone.
- The new oceanic crust/lithosphere that is formed along mid-ocean ridges is composed of a layer of **basaltic pillow lavas**, overlying **sheeted basaltic dikes**, overlying vast bodies of intrusive **gabbro**. The entire sequence of these mafic igneous rocks, plus any seafloor sediments that overlie them, is known as an **ophiolite complex**. Evidence for past tectonic upheavals includes such ophiolite sequences exposed high in the world's largest mountain belts on land. The top of Mt. Everest is marine limestone!