

Introduction to the Sea Floor and Continental Drift

Oceanographers discovered the shape of the ocean floor by measuring the depth of the ocean in many places. Early tools included lead weights, lowered on marked ropes or cables to the ocean floor. From such depth readings, scientists gradually built a picture of the ocean floor they could not see. These methods were very slow and eventually were replaced by sonar systems which bounced sound waves off the bottom. Today, sophisticated side-scan sonar and satellite data are fed into computers, giving even more detailed pictures of the ocean floor. Maps catalog and display a wealth of information. On land, topographic maps provide images of the shape of the land. At sea, bathymetric maps provide images of the bottom of the oceans. Turning three-dimensional objects like mountains or guyots into accurate two-dimensional representations on a map is a complicated process involving many steps.

All models of the ocean floor show features with vertical exaggeration, taller and steeper than they actually are. This occurs for a very practical reason. If the model or sketch were prepared to exact scale, it would need to be very large. The Pacific Ocean is 6,000 miles wide in some places, but never more than about 6 miles deep. If you made a model of the Pacific Ocean basin accurate with regard to scale, and the deepest portion of the model were one foot deep, then the entire model would have to be 1,000 feet wide, more than 3 football fields wide. Obviously this is not a good way to illustrate the shape of the Pacific. Instead, we exaggerate the vertical axis in order to reduce the model to a workable size.

The theory of plate tectonics and continental drift hypothesizes that the continents are in relative motion. Thus the positions and shapes of the continents we see today were not the same in the past. The internal structure of the earth is, in part, composed of the core, mantle and two types of crust: continental crust and oceanic crust. The continental crust is less dense than the oceanic crust, so it floats higher in the mantle. It is also thicker and, therefore, extends deeper into the mantle. The crusts float on the mantle much like an ice cube floats in a glass of water. The earth's core is thought to be comprised primarily of very dense nickel and iron compounds in a molten state. Radioactive decay reactions occurring deep in the core produce intense heat. The heat causes convection currents to form in the more "plastic" mantle. As mantle material is heated, its density decreases and it moves toward the crust. In some places, where the crust is thin, some of the mantle material seeps through and, as it cools, creates new crust. The Mid-Atlantic Ridge was formed in this manner. Sometimes this new crust rises above the water's surface to form islands. Once it reaches the crust, the mantle material moves laterally beneath the crust. In this manner, it is thought to drag the plates along with it. Cooling of these convection currents results in a downward movement of material under some regions of the continental crust and oceanic crusts. As parts of the oceanic crust move downward under the continental and other oceanic crusts, deep ocean trenches are formed. As the oceanic crust moves downward under the continental crust, remelting of the crust occurs, producing new mantle. In these areas, molten rock is often found rising through the oceanic crust to create volcanic islands. The Philippines, the Marshalls, and Fiji are examples of Pacific volcanic arcs. The Azores are examples of Atlantic volcanic arcs. Hawaii is an example of "hot spot" islands, islands that are formed by volcanic activity due to an outpouring of rising magma through a hole in the plate. For reasons that are not yet clear, "the hot spot" does not change location but the oceanic plate above it moves over time, and new islands are formed over the hot spot, creating an island chain.

As early as 1650, writers commented on the similarities of the coastlines of eastern South America and western Africa, but the idea that continents could change shape or location was unbelievable at that time. Even as late as the 1940's few scientists took the idea of continental drift seriously. No one had been able to explain HOW the continents could move. So where did this theory of drifting continents come from? What gave anyone the idea that certain parts of continents might have been joined to other continents? From the 1700's through the early 1900's scientists had attempted to explain the formation of the earth, its oceans, and its land masses. Three scientists, James Hutton (geologist), Alfred Wegener and Alexander du Toit proposed, somewhat independently, what is today the prevailing theory of how our continents and oceans came to be. This theory is called "the Theory of Plate Tectonics and Continental Drift." In Hutton's time, the thought of drifting continents was considered biblical blasphemy. In Wegener's time, 200 years later, it was just considered ludicrous, because no one could explain how the continents moved. It wasn't until the symmetry of seafloor magnetic anomalies and the midocean ridge spreading zones were discovered on the ocean floor in the 1960's that the continental drift idea was accepted as scientific fact. Continental drift was then unified with the theory of plate tectonics (plate movement) to explain how the Earth's crust is composed of sections, or "plates". These plates move on currents in the mantle below, and carry the continents with them