THE EARTH’S CRUST

Plate Tectonics: Looking at Our Ever-Changing Earth

The Earth’s crust is constantly moving, both vertically and horizontally, at rates of up to several inches a year. Sometimes this movement is far greater and faster than that; in 1906, the crust along the San Andreas fault in California suddenly moved about 20 feet (6 m), causing the famous San Francisco earthquake. A widely-used theory that explains these movements is “plate tectonics,” developed in the mid1960s by geophysicists from Canada, the United Kingdom, the United States and Japan.

The term “plate” refers to large rigid blocks of the Earth’s lithosphere, the solid outer 62 mile (100 km) crust of the Earth, that appear to move as a unit. Plates have three types of boundary. One type, like the Mid-Atlantic Ridge which runs along the floor of the Atlantic Ocean, moves apart by seafloor spreading at several inches per year. A second type, found under the Andes Mountains in South America (riding on the South American Plate), marks the site of plate convergence, where moving crust plunges into the Earth’s interior to be recycled. The third type is a boundary where plates move horizontally past each other such as the San Andreas fault located on the North American Plate. Because earthquakes and often volcanoes can be found along all three types of plate boundary, plate tectonic theory not only is important in scientific study it also has significance for people living near those boundaries.

There is no precise number of plates, but most geologists agree on at least nine major ones: North American, African, Pacific, Nazca, Antarctic, Groda, Indian-Australian and Eurasian. These plates may include both continental and oceanic crust. The North American plate, for example, includes the western Atlantic Ocean and most of the North American continent.

The concept of continental drift, proposed before World War I (1914) by German Geologist Alfred Wegener, may be related to plate tectonic theory. According to the theory, moving plates may carry continents with them as passive passengers. Therefore, North America drifts as part of the westward movement of the North American plate. The corresponding eastward movement of the Eurasian plate produces what Wegener called continental drift.

Some mountain ranges can be explained by the collision of continent-bearing plates. Scientists believe the Himalaya mountain range in Asia was formed as a result of the collision of the Indian-Australian and Eurasian plates. In the same way, the Andes Mountains in South America are a result of the convergence of the Nazca and South American plates.

Plate boundaries are marked, in fact defined, by zones of earthquake activity. The catastrophic Japanese earthquake of 1923, which killed approximately 100,000 people, resulted from the convergence of the Pacific plate with the Eurasian plate under the Japanese Islands.

Plate tectonic theory has been highly successful in explaining many geological phenomena. Laser ranging to the Goddard Space Flight Center-managed, Italian Space Agency-built Laser GEOdynamics Satellite (LAGEOS) II, scheduled to launch aboard Space Shuttle Columbia in October 1992, and other reflector-carrying satellites like its predecessor, LAGEOS I launched in 1976, shows that the island of Maui, Hawaii, is moving northwest toward Japan at approximately 3 inches (7 cm) per year.

Plate tectonic theory predicts motion in that direction of approximately 4 inches (9 cm) per year. Maui also is moving away from South America at approximately 3 inches (8 cm) per year, close to the 2 inches (6 cm) per year predicted by plate tectonics.

The LAGEOS I measurements have been verified independently by very long baseline interferometry, using pairs of ground based radio telescopes with quasars as their targets. Many unanswered questions about crustal movements remain, however. For examples tectonic movements in the Mediterranean Basin are unusually complex and poorly understood. This is more than a scientific problem, for the Mediterranean countries are plagued by violent earthquakes and volcanic eruptions. The western boundary of the North American plate is far wider than the San Andreas fault zone, making measurements of plate movement extremely complicated. Continental drift across the Atlantic Ocean, proposed by Wegener, has not been directly verified because there are not enough plate measurements within the Eurasian and North American continents to show that these are in fact part of rigid plates.

The launching of another laser satellite target, LAGEOS II, will enable scientists to accumulate plate motion data more rapidly. Analysis of these data in combination with the data obtained by other techniques of space geodesy, may give us a much clearer picture of the location and nature of plate boundaries, and the rates and directions of plate movements. This should lead to a better understanding of the occurrence of earthquakes at plate boundaries, volcanism, and the cause of mountain building. It may eventually tell us if Wegener's theory of continental drift is related to plate tectonics.

Source: NASA