Plate Tectonics

Definition: **plate tectonics** from *Dictionary of Energy Earth Science*. A modern geological theory according to which the earth's crust is divided into a limited number of large, rigid plates whose independent movements relative to one another cause intense geologic activity along their margins, such as deformation, volcanism, earthquakes, and mountain building.

Summary Article: **plate tectonics**

From *The Hutchinson Unabridged Encyclopedia with Atlas and Weather Guide*

Theory formulated in the 1960s to explain the phenomena of continental drift and sea-floor spreading, and the formation of the major physical features of the Earth's surface. The Earth's outermost layer, the lithosphere, is seen as a jigsaw puzzle of rigid major and minor plates that move relative to each other, probably under the influence of convection currents in the mantle beneath. At the margins of the plates, where they collide or move apart or slide past one another, major landforms such as mountains, rift valleys, volcanoes, ocean trenches, and mid-ocean ridges are created. The rate of plate movement is on average 2–3 cm/1 in per year and at most 15 cm/6 in per year.

The concept of plate tectonics brings together under one unifying theory many phenomena observed in the Earth's crust that were previously thought to be unrelated. The size of the crust plates is variable, as they are constantly changing, but six or seven large plates now cover much of the Earth's surface, the remainder being occupied by a number of smaller plates. Each large plate may include both continental and ocean lithosphere. As a result of seismic studies it is known that the lithosphere is a rigid layer extending to depths of about 50–100 km/30–60 mi, overlying the upper part of the mantle (the asthenosphere), which is composed of rocks very close to melting point. This zone of mechanical weakness allows the movement of the overlying plates. The margins of the plates are defined by major earthquake zones and belts of volcanic and tectonic activity. Almost all earthquake, volcanic, and tectonic activity is confined to the margins of plates, and shows that the plates are in constant motion (see plate margin).

**Sea-floor spreading** New plate material is generated along the mid-ocean ridges, where basaltic lava is poured out by submarine volcanoes. The theory of sea-floor spreading has demonstrated the way in which the basaltic lava spreads outwards away from the ridge crest at 1–6 cm/0.5–2.5 in per year. Plate material is consumed at a rate of 5–15 cm/2–6 in per year at the site of the deep ocean trenches, for example along the Pacific coast of South America. The trenches are sites where two plates of lithosphere meet; the one bearing ocean-floor basalts plunges beneath the adjacent continental mass at an angle of 45°, giving rise to shallow earthquakes near the coast and progressively deeper earthquakes inland. In places the sinking plate may descend beneath an island arc of offshore islands, as in the Aleutian Islands (Alaska) and Japan, and in this case the shallow earthquakes occur beneath the island arc. The destruction of ocean crust in this way accounts for another well-known geological fact – that there are no old rocks found in the ocean basins. The oldest sediments found are 200 million years old, but the vast majority are less than 80 million years old. This suggests that plate...
Tectonics has been operating for at least the last 200 million years. In other areas plates slide past each other along fault zones, giving rise to shallow earthquakes. Sites where three plates meet are known as triple junctions.

**Causes of plate movement** The causes of plate movement are all very hypothetical. It has been known for some time that heat flow from the interior of the Earth is high over the mid-ocean ridges, and so various models of thermal convection in the mantle have been proposed; the geometry of the flow in any convective system must be complex, as there is no symmetry to the arrangement of ridges and trench systems over the Earth's surface. It seems likely that a plume of hot, molten material rises below the ridges and is extruded at the surface as basaltic lava. In zones of descending flow, at deep ocean trenches, the surface sediment is scraped off the descending plate onto the margin of the static plate, causing it to grow outwards towards the ocean, while the basaltic rocks of the descending plateau, together with any remaining sediment, undergo partial fusion as they descend. This gives rise to large volumes of molten rock material, or magma, which ascends to form andesitic lavas and intrusions of diorite or granodiorite at the margin of the overlying continent. These theories of plate tectonics may provide explanations for the formation of the Earth's crust; oceanic crust is generated at the mid-ocean ridges by partial fusion of the mantle, while below active continental margins partial fusion generates the more silica-rich continental rocks. Oceanic crust is continually produced by, and returned to, the mantle, but the continental crust rocks, once formed, remain on the surface and are not returned to the mantle.

**Development of plate tectonics theory** The concept of continental drift was set out in 1915 in a book entitled *The Origin of Continents and Oceans* by the German meteorologist Alfred Wegener, who recognized that continental plates rupture, drift apart, and eventually collide with one another. Wegener's theory explained why the shape of the east coast of the Americas and that of the west coast of Africa seem to fit together like pieces of a jigsaw puzzle; evidence for the drift came from the presence of certain rock deposits which indicated that continents have changed position over time. In the early 1960s scientists discovered that most earthquakes occur along lines that are parallel to ocean trenches and ridges, and in 1965 the theory of plate tectonics was formulated by Canadian geophysicist John Tuzo Wilson; it has now gained widespread acceptance among earth scientists who have traced the movements of tectonic plates millions of years into the past. The widely accepted belief is that all the continents originally formed part of an enormous single land mass, known as Pangaea. This land was surrounded by a giant ocean known as Panthalassa. About 200 million years ago, Pangaea began to break up into two large masses called Gondwanaland and Laurasia, which in turn separated into the continents as they are today, and which have drifted to their present locations. In 1995 US and French geophysicists produced the first direct evidence that the Indo-Australian plate has split in two in the middle of the Indian Ocean, just south of the Equator. They believe the split began about 8 million years ago.

**essays**

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