Free report on principles of plate tectonics

Parts of the World, Africa

The theory of plate tectonics describes the widescale movements of the lithosphere of

the earth. The model is based on the ideas of continental drift, which first gained acceptance in the early 1900s. The geoscientific community granted the theory even more validity after the notion of seafloor spreading appeared in the late 1950s. Basically, the lithosphere is not whole but instead is separated into either seven or eight major plates, depending on the definition that you use. Every meeting point between plates has its own relative movement, either transform, convergent or divergent. Volcanic activity, mountain creation and earthquakes all occur along these edges, and the plates move laterally relative to one another between zero and 100 millimeters annually (Read and Watson).

Tectonic plates have the ability to move because the lithosphere is stronger than the

underlying asthenosphere. Variations in mantle density lead to convection, and when the plates move, it is the result of seafloor movement away from the edge, leading to alterations in gravitational forces, and a downward suction at the subduction zones. The forces that the earth's rotation, in combination with the solar and lunar tidal forces, also have an effect on the

movement of the plates. However, researchers still debate the relative significance of each

factor.

Scientists did not always accept the reality of continental drift. As late as the ealry 1900s,

geologists made the assumption that the major features of the earth were fixed, and that the

majority of geological features like mountain ranges or basin development were attributed to

vertical movement in the crust. The explanation for this was a contracting planet losing heat over

As early as 1596, researchers observed that the opposing coasts of the Atlantic Ocean

have shapes that look as though they fit together at one point (Kious and Tilling). Many theories

came out to explain that oddity, but the overweening assumption of a solid, stable crust made it

difficult to absorb these proposals. However, the discovery of the heating properties of

radioactivity in 1895 prompted a new examination of the age of the planet. In previous estimates,

the cooling rate had been set for the radiation of a black body, or an ideal physical body that absorbs all electromagnetic radiation, no matter the angle of incidence or frequency. Knowing

that the radioactivity could well have provided a new source of heat, the planet could be much

older than a few million years, and the core might still be hot enough to have remained liquid.

In 1912, Alfred Wegener presented a theory of continental drift to the German Geological

Society on the basis of the research of several theorists in the 1800s as well as his own work.

Eduard Suess had posited the existence of the supercontinent Gondwana in 1858, and Roberto

Mantovani had proposed the joining of all of the continents into Pangaea in 1889. Both of these

earlier researchers suggested that thermal expansion had led to volcanic activity that broke the

continent apart, and the continents had drifted apart through further growth of the ripzones,

which is where the major oceans now lie. This inspired Mantovani to suggest the Expanding

Earth theory which later was seen to be flawed (Scalera and Lavecchia). Frank Bursley Taylor

suggested in 1908 that the continents were pulled toward the equator by an increase in lunar

gravity during the Cretaceous, making the Alps and Himalayas form.

Wegener, though, was the

first to formally publish the assertion that the continents had drifted away

from one another.

However, the fact that he was unable to explain the physical forces causing the drift left his

theory still wanting.

Today, evidence for continental movements on tectonic plates is widespread. Similar

animal and plant fossils appear around different continental shores, implying

that they once

shared a connection. For example, the Mesosaurus, a freshwater reptile,

appears in fossil form

on both the coasts of Brazil and South Africa. The Lystrosaurus, a land

reptile, appears in fossil

form in rocks in Antarctica, Africa and South America, all from about the

same time frame. Some

earthworm families still appear in both Africa and South America.

Another piece of evidence of continental drift is the obvious similarity between the facing

sides of Africa and South America. However, those shapes will not always

stay complementary.

The processes of ridgepush and slab pull are just two physical forces that will continue to push

those continents apart, rotating them away from one another.

The widespread incidence of permocarboniferous glacial sediments in Arabia,

Madagascar, Africa, South America, Antarctica, Australia and India was one of the most significant pieces of evidence for the larger theory of continental drift. The continuous nature of glaciers, inferred from tillite deposits and glacial striations, suggested that Gondwana had actually once been a supercontinent. The striations implied a glacial flow toward the poles from the equator, at least in terms of modern cartography, supporting the idea that the planet’s southern continents had once been in very different places and contiguous with one another (Wegener).

However, the fact that Wegener was not even a geologist, along with the fact that he was

missing a driving force to explain the movement, meant that continental drift was still a long way had shown that the floating masses sitting on a rotating planet would gather at the equator.

Second, masses floating within a fluid substratum, such as icebergs, should have a balance

between the forces of gravity and buoyancy, which was not the case throughout the planet.

Finally, some of the planet's crust had hardened while others were still fluid, and the whole

surface should have solidified. Because these conditions meant that the contemporary

assumptions about continental drift had failed, researchers still refused to accept the theory until

geophysicist Jack Oliver provided the first convincing seismologic evidence of tectonics that

contained and recast the theory.

Beginning in 1965, a series of scientific breakthroughs established plate tectonics as the

most viable way to explain the movement of the continents. In 1965, Tuzo Wilson added the

notion of the transform faults to the model. This explained the operation of faults in such a way

as to make plate movement logical. That same year, the Royal Society of London held a

continental drift symposium which officially began the acceptance of the theory within the

scientific community. One of the presentations at the symposium covered the calculations that

show how the continents on the edges of the Atlantic Ocean would fit to bring the ocean to a

close. The next year, Wilson published a paper referring to previous plate tectonic structures, introducing what researchers would call the Wilson Cycle. In 1967, rival proposals were published suggesting the existence of six and 12 plates, respectively.

Currently, geologists know that two types of crust exist, continental and oceanic

crust. The continental variety is lighter by nature and has a different composition, but both types rest above a “ plastic” mantle with much greater depth. At the spreading centers, oceanic crust appears, and this process, coinciding with subduction, causes chaos in the plate system, leading to places with isostatic imbalance. The theory of plate tectonics is currently the best explanation that exists for the drift of the continents.

Scientists now believe that tectonic motion first ensued about three billion years ago

(Zhao). To gauge the movements of the continents, researchers use different types of quantitative and semiquantitative information. Magnetic stripe patterns show relative plate movements going all the way back into the Jurassic period. The tracks of hotspots provide more absolute data, but they only go back to the Cretaceous period. Older proposals rely on paleomagnetic pole data, but the fact that these only constrain latitude and rotation means that these constructions are not far wrong. Researchers combine poles with different ages within a particular plate to generate polar wandering paths to compare movement of different plates over time. The distribution of various types of sedimentary rock, fossil evidence of faunal habitation and the positioning of orogenic belts takes the case for tectonic movement even further.

Current theory suggests that the supercontinent Columbia or Nuna formed about 2 billion

years ago, breaking up about 500 million years later (Zhao). About a billion years ago, rodinia is suggested to have formed, containing most of the planet’s land, breaking into eight continents about 600 million years ago. They reassembled into Pangaea but then broke into Laurasia, which became Eurasia and North America, and Gondwana, which turned into the other continents.

When two major plates collided, the Himalayas are assumed to have appeared. Before that, they

sat under the Tethys Ocean. Today, satellites and ground stations keep an eye on plate movements, with an eye toward predicting coming earthquakes and other disruptions.

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