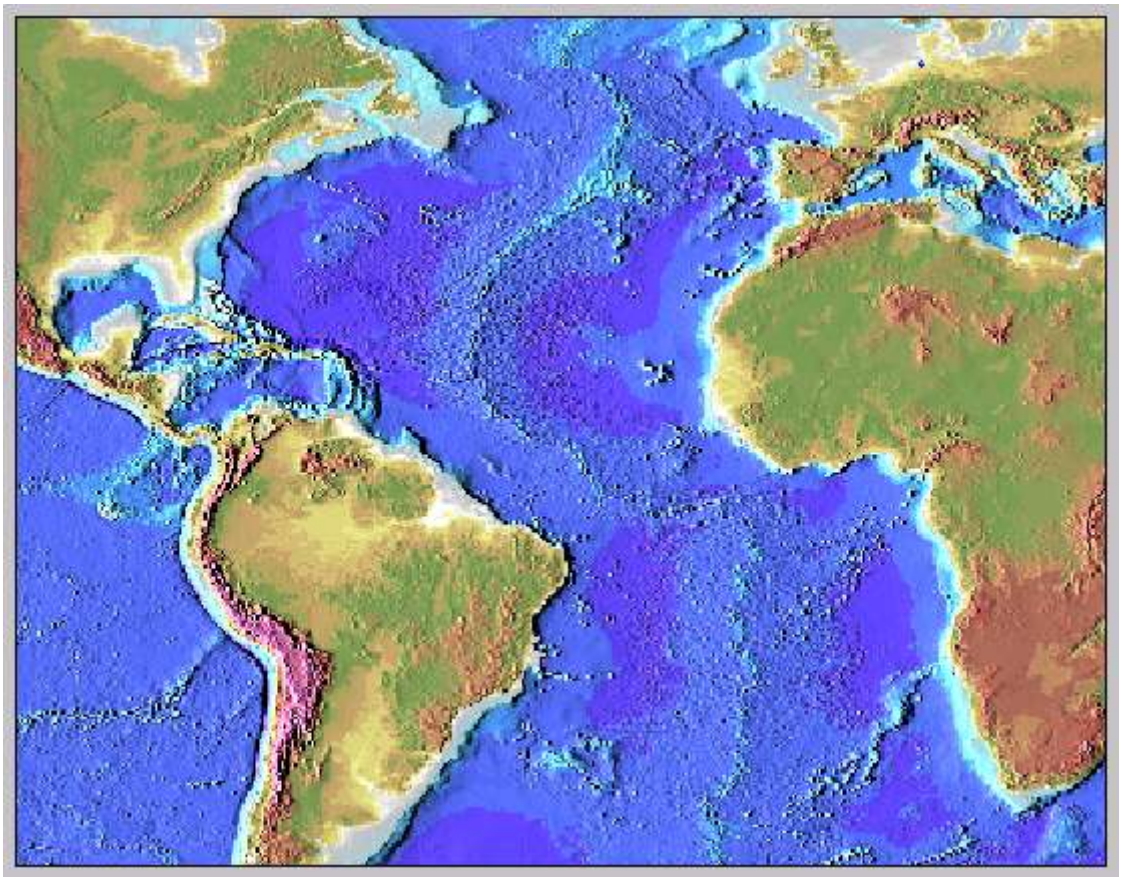
Plate Tectonics

by
Felix Hagen Zaphod Malsch



ISP Project Report
2006

Plate Tectonics

History

The German scientist Alfred Wegener published in 1912 a work that described his idea of what now commonly is called plate tectonics. He recognized as he looked on a map, how nicely all the continents fit together. In his book, called „Die Herkunft der Kontinente und der Ozeane“, meaning „The Origin of Continents and the Oceans“, he stated that all continents once were one single continent, called Pangea. According to Wegener, Pangea broke apart about 250 million years ago, during the mesozoic era.

Alfred Wegener

Wegener' s theory had some good points; at his time, the question how mountains were formed generally was explained the following: The earth' s surface cracked open and folded up, while earth, once being a molten ball, cooled down, since the cooling down caused the surface to shrink. The problem of this theory was that this way, logically all mountains would have to be of the same age, which already back then was known not to be true. Wegener now explained the forming of mountains by tectonic plates pushing together, so that the pressure is released upward, and mountains form.
Wegener had a few tries of explaining his theory, all of them were rejected. He believed that Pangea originally was at the south pole, and broke apart due to the centrifugal forces that grow towards the equator, so that the, now more than one, continental plates drifted toward the equator. The explanation was rejected because the centrifugal forces were calculated, and known as to small to move continents.
He also proposed that the westward drift of America was caused by the gravitation of sun and moon.
Wegener' s inability to explain his theory made people sceptical and disbelieving, so that the theory of plate tectonics was not accepted for a long time.
In 1929, when almost all of Wegener' s ideas were rejected, Arthur Holmes began explaining the theory of plate tectonics differently: He explained the moving of plates by „thermal convections“, or, as today it is called „convection currents“ (see section „Nowaday' s Theories“).
Holmes Idea wasn't accepted either until 1960.

Evidences

Animalic Evidences: The mesosaurus (which lived during the mesozoic era, as the name states), was found both in Africa and South America, which, nowadays, have no land connection. The same phenomenon occurs with a type of early ape.

Geologic Evidences: It appears more than once that mountain chains of a certain age, end at the coastline of one continent, and continue at a different continent, which would also fit into the other continent, jig-saw-puzzlelike.

Geomagnetic Anomalies: It is known, that the earth's magnetic field reverses periodically. Rocks can record the magnetic orientation. It was discovered, that parallel to the mid-oceanic ridges, where magma comes out, are „stripes“ of rock, which are symmetrical to both sides, showing the magnetic orientation.

Nowaday' s Theories

Todays most largely believed theories are:

-Convection Currents
-Gravitation

Convection Currents:
The theory of Convection Currents is originally the theory of Arthur Holmes, as said before.
This theory states that plate movements are caused by the circulation of magma beneath the earth' s crust. This diagramm shows (schemelike) how some suppose it looks:

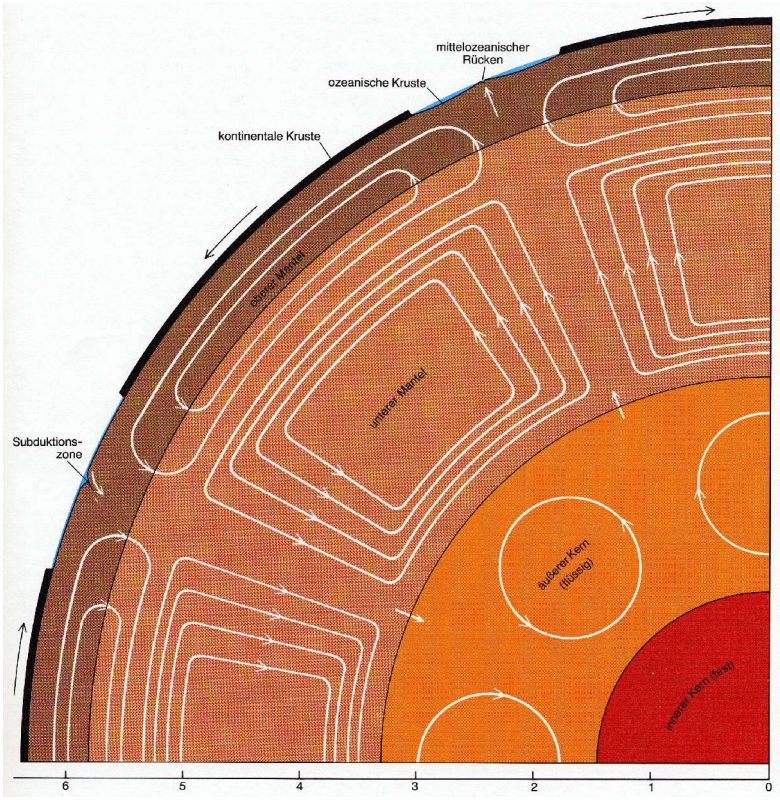


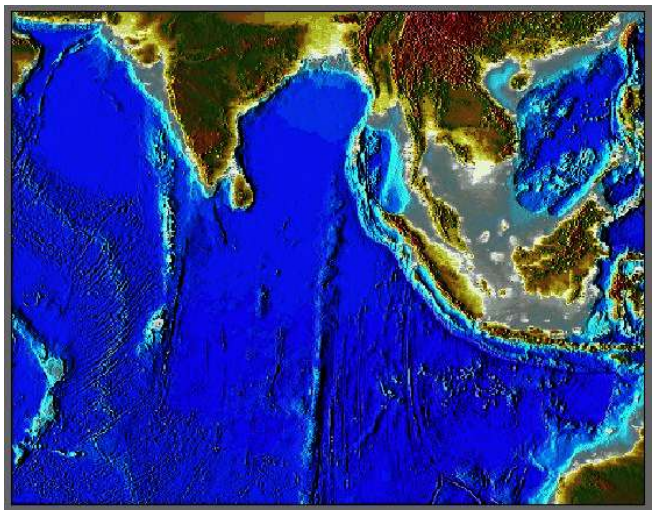
Diagramm of Convection Currents

The diagramm shows three types of circulations that are on top of each other. Those repeat various times. The circulations exist because the magma gets heated up, looses density, rises, and cools down again. The magma gets denser again as it cooled down, and goes back down. These circles transport the continental plates through the friction of magma and plates.

Problems with Convection Currents:

Although there are things that hold against the convection theory, it probably is the most often taught theory. Alone the diagramm is not entirely right: If one might look at the circulations in one column, they are all turning into the same direction (anti-clockwise). This would mean that the circulations stop each other, since the forces push against each other.

Also, there is some evidence that the convection theory cannot be true: In this physical map of India and Indonesia, and the ocean floor around it, you can see something like scratches, that occur on the top of the oceanic crust:

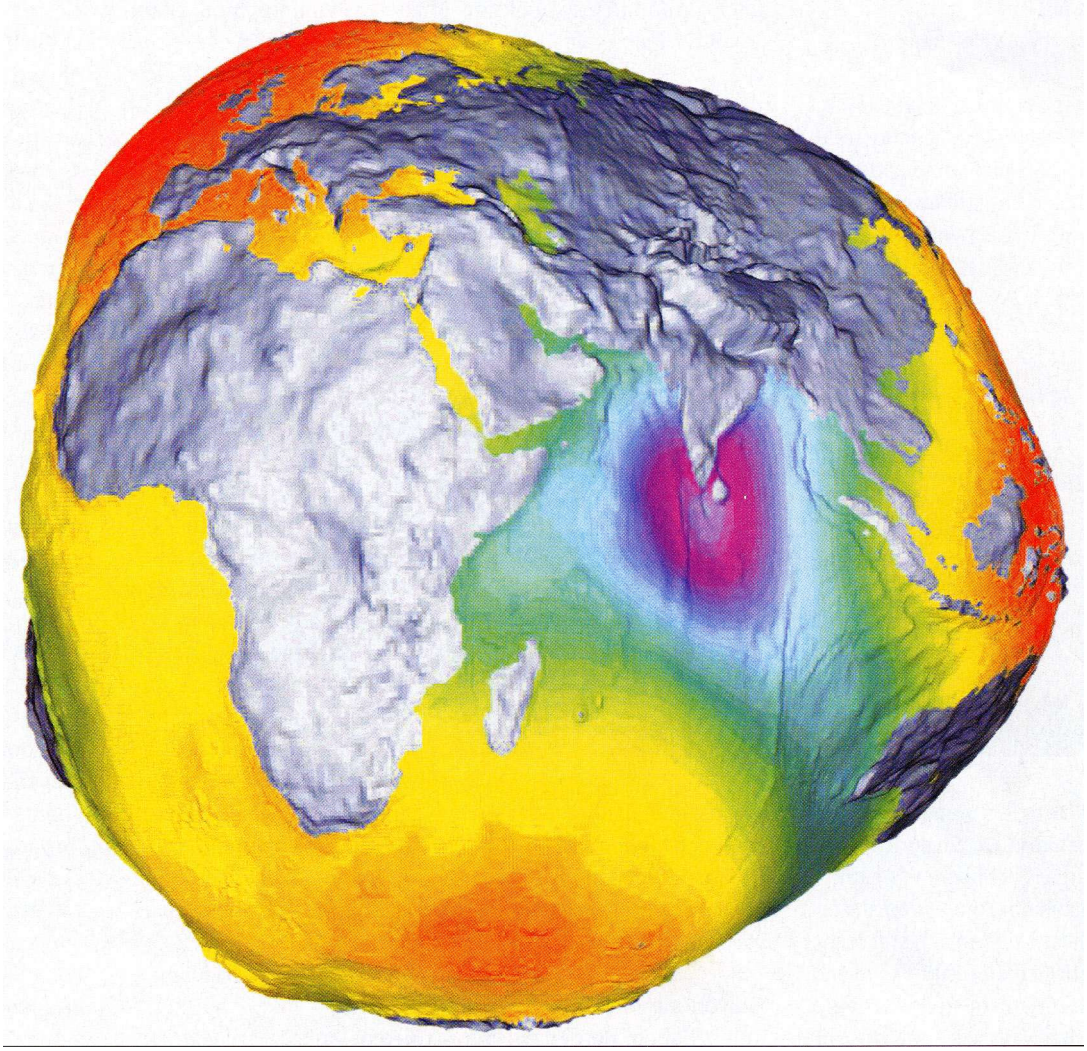


Map of India and Indonesia

You can clearly see the scratches on the oceanic crust. These scratches mean that India and Indonesia must have been moving around on the seafloor, which would not be possible if the magma convections are moving them, because those would be moving the entire plates, including oceanic crust, and not only the continental plates. If everything was moving, there would be no scratches.

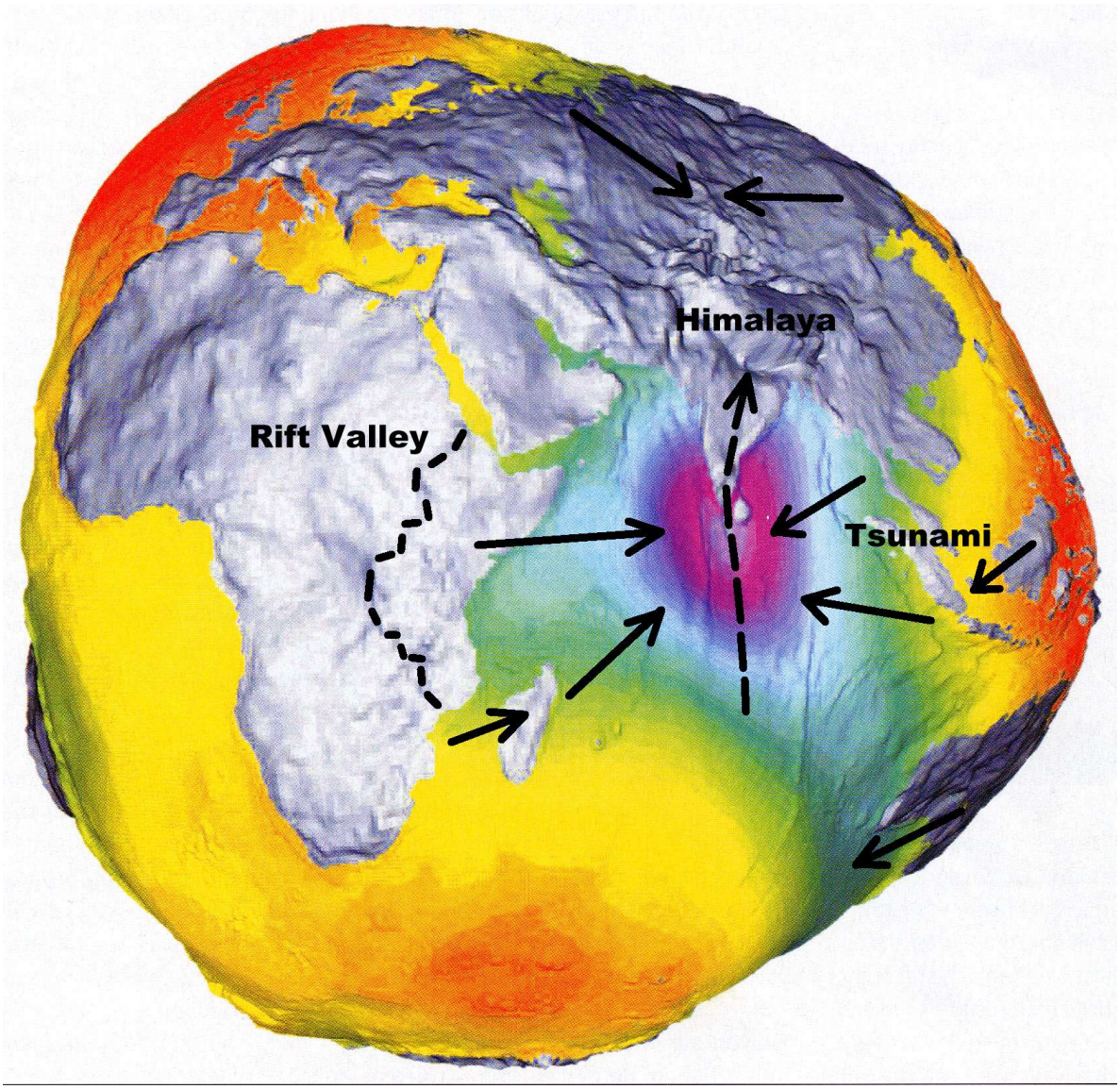
Also there is the same problem for which Wegener' s centrifugal theory was rejected; the energy of the convection currents is less, than there is in the movement of the continental plates. This would be wrong after the first law of thermodynamics, which would make plate tectonics to a perpetuum mobile.

Gravitation:
The gravitational explanation of plate tectonics is fairly simple to understand:
It is known, that the earth is not a perfect sphere, but also, that it is not a perfect oblate sphereoid.



The Geoid

This picture shows how earth would look like, if all deviations from a perfect oblate sphereoid were highly enlargend (the highest point on this model would only differ 65 meters from the perfect oblate sphereoid. Those bulges and trenches maybe are cause by convection currents, so convection currents affect tectonic plates movement indirectly). The theory now simply is that the continental plates slide down the slopes of the surface of earth.
This might at first sight seem unrealistic. But there are examples enough that fit into this theory, that makes it believable:



Examples of Evidence for the Gravitational Explanation

You can see, that a huge landmass (Asia) in a dent of the earth' s form. Also, Madagascar fits into the coastline of Africa, and apparently broke out, to drift towards the dent in the middle of the Indian Ocean. Indonesia should according to the theory also drift toward the big dent, and as the tsunami in Indonesia in 2004 shows, there must be tectonic activity in that area. The theory should allow one to think that the east (the „nose“) of Africa should also break off in the future. And, in fact, in „Rift Valley“, the land is cracking up that bad, that the streets have to be renewed very often. A theory about the movement of India, since it is moving away from the big trench, and is pushing against the Himalaya, is that India actually came from south of the trench, fell into it, and from the great force went up the other side again. Maybe India will go back and forth for a while, until it gets pushed away by another continental plate.

Known Facts:

- Pangea broke apart 180 million years ago
- The continental plates move at a speed of 15cm per year

Information Sources:

Online Information:

Weil, A. „Plate Tectonics: „The Rocky History of an Idea“, UCMP, 22.8.1997, <http://www.ucmp.berkeley.edu/geology/techist.html>

[No Name given], „Plattentekonik“, Wikipedia, <http://de.wikipedia.org/wiki/Plattentektonik>

Books:

Price, L.G. „An Introduction to Grand Canyon Geology“, Arizona, Grand Canyon Association, 1999

Felix Hagen Zaphod Malsch, 9.22.06, AZ
EFHS, ISP 4