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Lighter is faster

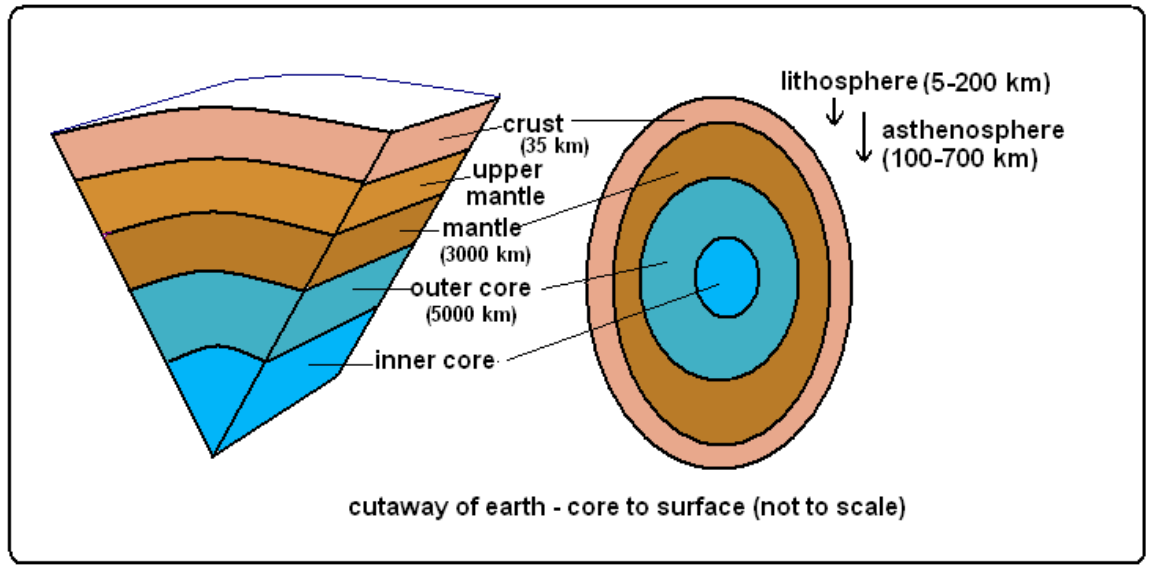
The Indian landmass may have been the faster fragment of ancient Gondwana, says S.Ananthanaryanan.

A team of scientists (including three Indians) in Potsdam, Germany have estimated the thickness of the earth's crust that moved with the Indian land mass and find that it was significantly thinner, as they report in ***Nature***, this week.

Earth structure

The earth's structure can be broadly divided into three parts – the crust, the mantle and the core. The first is the crust, about six km deep under the oceans and about fifty km under the continents. Below the crust are the viscous upper mantle, the mantle, the less viscous outer core and the solid core.

The uppermost, rocky and nearly all solid part of the earth is called the ***lithosphere***, which can be between 5 and 200 km deep. The part just below is the weak or soft, upper mantle, going from 100 km to 700 km deep, in parts. This portion is plastic and non-rigid and permits the plate-movements, or adjustments of the lithosphere and crust. Because this region, known as the ***asthenosphere***, is plastic, it conducts seismic waves very slowly and this is how it got discovered.



Below the asthenosphere are regions of the mantle that are liquid and at high temperature, conducting heat away from the core, which gets its heat from long lived radioactivity. A means of transfer of heat is through ***mantle plumes***, which are rising currents of very hot rock, sometimes seen at the earth's surface as volcanic activity. While mantle plumes are a means for the core to lose energy, the chief means for the mantle to lose heat is through movement of masses in the lithosphere, or ***plate techtonics***.

Gondwanaland

The land masses of Australasia, Antarctica, South Africa, Madagascar, India and South America were once part of a single continent that geologists call Gonwanaland or Gondwana. The evidence of common ancestry is in the flora and fauna common and unique to these present-day continents. For example, marsupials are found in Australia and South America. A family of flowering plants, known as Proteaceae, is found in Australia, South and Central Africa, South and Central America, India, Eastern and South-eastern Asia. Proteaceous pollen is abundant in coal deposits more than 90 milloin years old, which indicates the period when it spread to these then connected land masses.

Great and small land masses on the surface of the globe, consisting of solid rock and earth, in fact float, almost motionless, on the viscous and liquid mantle. The mantle is viscous and seething with heat and more or less capped by the land mass. This is all the more in the case of a large land mass, like Gonwana.

Break-up

About seventy million years ago, the great mass of Gondwana began to break up under the effects of the mantle below. Perhaps ***mantle plumes***, softened thinner parts and caused fissures, perhaps the heat and energy caused stress that cause fractures, but Gondwana began to separate into bits.

To conserve the energy spent, the bits began to drift and large portions formed the continents of Antarctica, Australia, South America and South Africa and the Indian sub-continent. The African continent separated first, and from it the South American mass. Antarctica remained almost stationary, while India-Madasgascar and Australia broke off later. India-Madagascar-Seychelles separated and land masses thus moved considerable distances, some earlier, some later.

The Indian land mass appears to have collided with Asia around 45 million years ago, leading to buckling and the rise of the Himalayas. Australia separated from Antarctica soon after and there were drastic climatic changes as ocean currents found new passages and new oceans formed between new continents.

Speed of drift

Prakash Kumar, Ravi Kumar, Chadda and others in Potsdam analysed data of ancient magnetic rocky sediments and have concluded that the Indian sub-continent attained very high speeds, of 18 to 20 cms a year soon after it broke away from Gondwana. It slowed to nearly 5 cms a year when it collided with the Asian barrier, the 5 cm a year speed being how fast matter was pushed up as the Himalayas, and comparable matter was pushed downwards. The African and Australian land plates moved slower, Africa and South America taking much longer and Australia not moving very far.

The scientists propose that when the land masses broke away from Gondwana, how deep their lithospheric roots dipped into the asthenoshpere was an important factor in determining their speed of drift. The scientists estimate the depth of the lithosphere by a recently developed method related to earthquakes, the analyses of ***sheer waves***. When strata of rock move over adjecent strata, the sheering effect spreads in the form of a wave. The signs that this wave leaves can then help rebuild the movements that caused the waves.

The methods have shown that the Indian sub-continent was comparatively thinner, and could thus move much faster than other Gondwana fragments. The thinning was probably caused by melting of the bottom of the plate by mantle plumes.