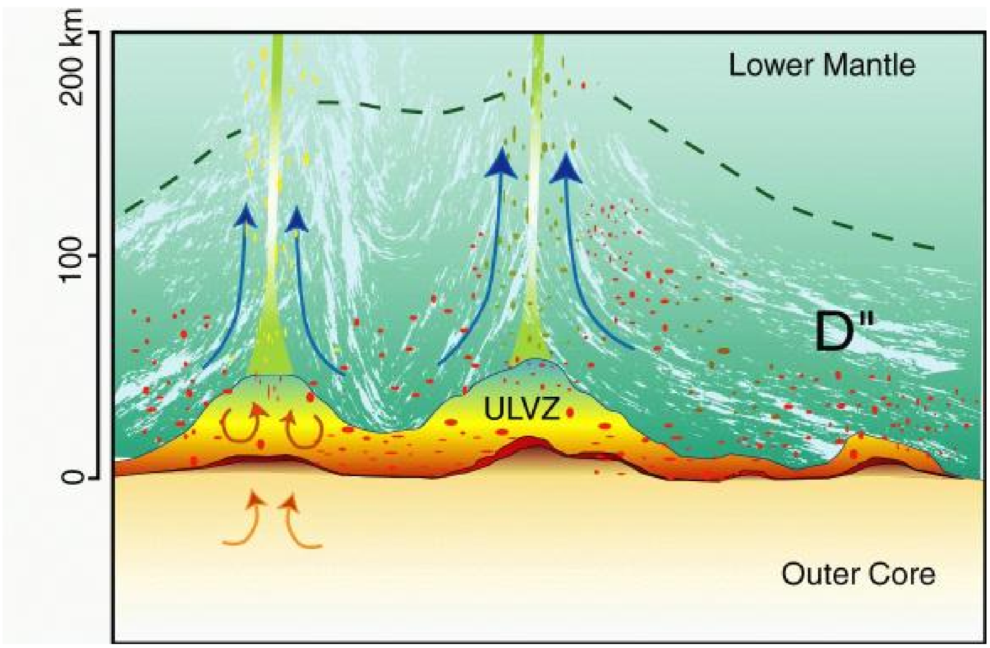
C3.5 The Core

C3.5.1 Core mantle boundary (CMB)

- Major contrast in properties across this boundary
- Some topopgraphy (100m – 10 km?)
- Couples motion of core to mantle
- Decrease in v_p from 13.7 to 8.1 km/s
- Decrease in v_s from 7.3 to 0 km/s



Buffett et al., (2000)

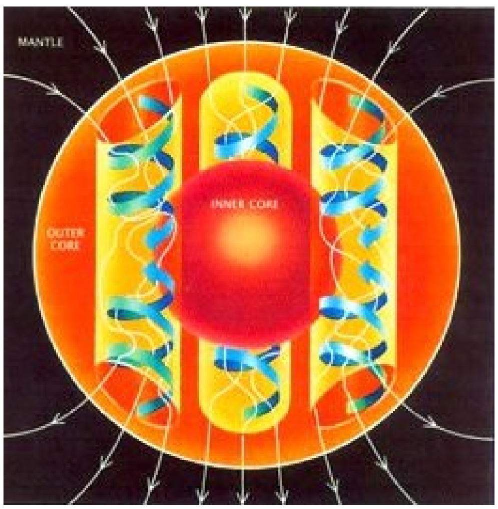
> *"According to current theories about the formation of Earth, the solid inner core has been cooling and solidifying for billions of years. As it cools, the lighter iron alloys separate from the pure iron and move outward to the liquid outer core. The liquid layer must then chemically equilibrate with the lower mantle.*
>
> *Bruce Buffett, a geophysicist from the University of British Columbia in Vancouver, seismologist Edward Garnero of Arizona State University in Tempe, and mineral physicist Raymond Jeanloz of the University of California, Berkeley, reported in the Nov. 17 2000 Science that the light iron alloys will react with the lower silicate mantle to make iron silicates.*
>
> *A slow inverted rain of iron silicate "sediments" moves out from the core because the sediments are less dense than the alloys. The sediments rise and collect unevenly at the boundary between the outer liquid core and lower mantle. However, some liquid iron is still found in spaces between the sediments. This is the key to Buffett's theory. Under the pressure of accumulating sediments, some of the iron will be squeezed out. The remaining iron, however, would provide enough conductivity in the new layer to explain Earth's wobble."*

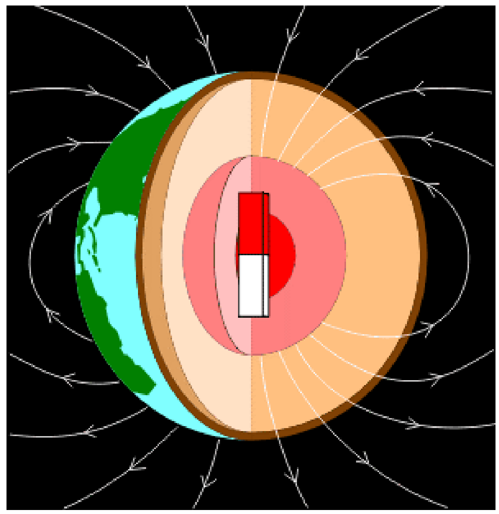
From : http://www.geotimes.org/jan01/earthsinterior.html

See also http://garnero.asu.edu/research_images/interp/garnero_lowmant_scenario1.jpg

C3.5.2 Outer core

- Thickness 2260 km
- Fluid, no shear waves transmitted.
- Discovered by Oldham (1906) through P-wave and S-wave shadow zone.
- Composition Fe + 10% lighter elements
- Viscosity comparable to water
- Source of the Earth's magnetic field.





C3.5.3 Inner core

- Discovered by Inge Lehmann in 1936 on basis of reflections (PKiKP)
- Radius 1220 km and v_p= 11 km/s
- Evidence from free oscillations for solid nature (*Dziewonski and Gilbert*, 1971)
- Difficult to observe S-waves in core. Possible observation by *Julian et al.*, (1972)
- More convincing evidence presented by *Duess et al*., (2000).
- v_s= 3.5 km/s   Poisson's ratio = 0.45. Crystal mush?
- Grows at 0.03 cm per year as liquid core solidifies. Latent heat released drives convection in outer core.
- Inner core is anisotropic. N-S velocity faster that equatorial direction
- Rotating faster than mantle and crust.
- 1° per year. 20 km on surface of inner core

See Song and Richards (1996) and www.ldeo.columbia.edu/~richards/Jefflec.html

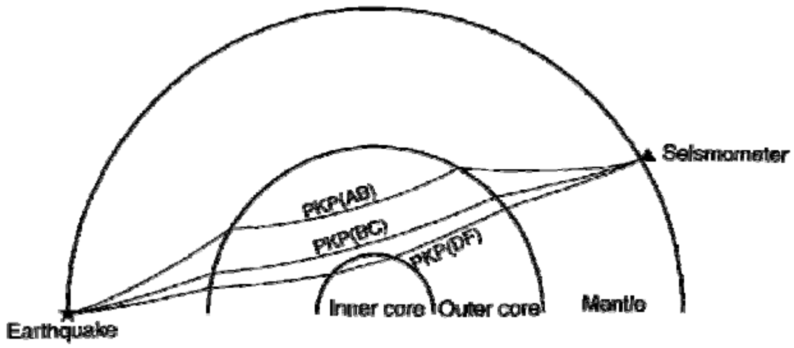
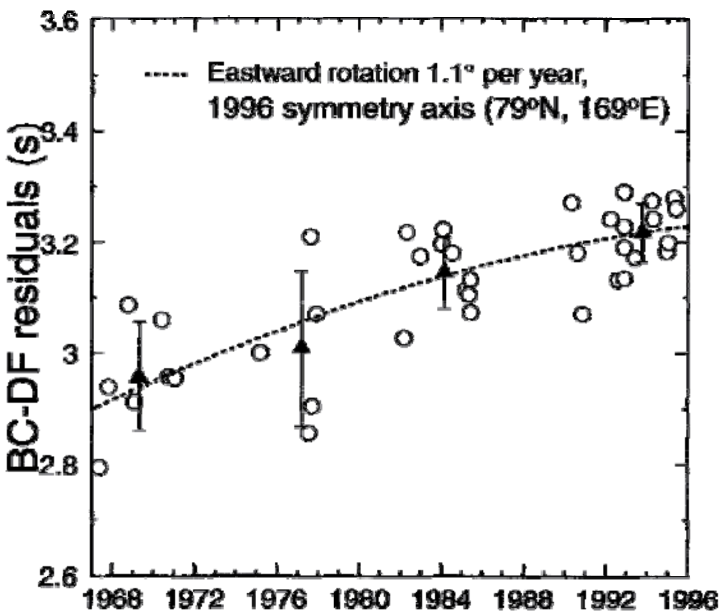


FIG. 1 Ray paths for seismic waves that pass through the Earth's cores.

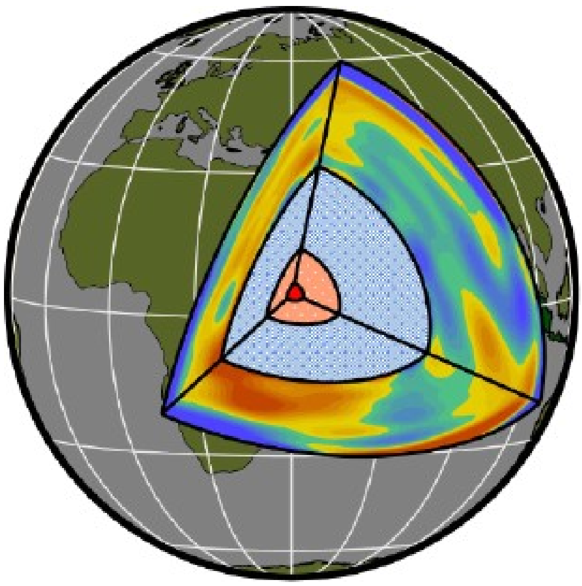


C3.5.4 Inner inner core?

- anomalous zone with radius of 300 km?
- Distinct anisotropy compared to rest of inner core (*Ishii and Dziewonski*, 2002)

"Dziewonski speculates that this innermost iron ball may be a leftover from the original kernel out of which Earth separated into crust, mantle, and core some 4.6 billion years ago. Through subsequent years of meteoric bombardments and geological upheavals, including the ripping off of a big chunk to make the moon, the innermost core survived. If so, it is the oldest unaltered part of our planet.

However, other possibilities exist, albeit not as exciting. Most earth scientists believe the inner core is growing at the expense of the outer core. The solid iron sphere sits in the path of jets and currents roiling the outer core fluids like a big rock in a flowing stream. These patterns of flow might have been altered after the inner core reached a diameter of 360 miles. Afterwards, iron crystals deposited on the inner core surface in a different orientation, creating a different kind of anisotropy.



A third possibility is that at the higher pressure and temperature near the planet's center, iron crystals pack differently. The change in packing pattern could alter the directions of fast and slow speeds traveled by earthquake waves."

From http://www.news.harvard.edu/gazette/2002/10.03/01-inner.html
See also : http://www.gps.caltech.edu/~dla/Commentary-doc2.pdf

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