GLY 47/511 - Plate Tectonics
Hotpsots Lecture Summary
Summary of Lecture on 3/14/10

Hotspots and Mantle Plumes

the difference between: hotspot, hotspot track, mantle plume
intraplate volcanism - hotspots don't generally coincide with plate boundaries
age-progressive volcanism
    active volcano is at the end of a chain of volcanoes or seamounts
    youngest at the active volcano, progressively older away from the active volcano
seamounts and guyots (flat-topped seamounts)
formation of coral atolls (first explained, generally, by Charles Darwin)
if hotspots are caused by stationary, deep-seated mantle plumes, then you should be able to determine the absolute direction and velocity of the plate
but mantle convection should deflect rising plumes

So, are mantle plumes stationary?

hotspots in the Atlantic and Indian Oceans may not have moved significantly relative to one another (outside the error limits)
must compare with the Pacific hotspots, especially the Hawaiian-Emperor hotspot track since it is the longest, best resolved, best studied hotspot track
comparison of Indo-Atlantic hotspots with the Hawaiian-Emperor hotspot has shown a big discrepancy and therefore motion between them - assuming the plate circuit connecting them is known accurately enough
the seafloor spreading parameters on intervening midocean ridges are known reasonably well, but
the connection through Antarctica (the only way to go) was thought to probably be the cause of the discrepancy because East and West Antarctica appear to have rifted and moved independently at one time
a paleomagnetic study showed that the Marie Byrd Land portion of West Antarctia (the most important part for the plate circuit) has indeed moved relative to East Antarctica since 100 m.y. ago - could that motion account for the apparent motion between the Indo-Atlantic and Hawaiian-Emperor hotspots???
it is not possible to account for post 100 m.y. Marie Byrd Land - East Antarctic relative motion and the post 65 m.y. hotspot discrepancy
    therefore the Hawaiian-Emperor plume has moved relative to the Indo-Atlantic hotspots
    therefore, mantle plumes are not, as a general rule, fixed and stationary

large igneous provinces (LIPs)

hotspot tracks often begin with major flood basalt eruptions (LIPs)

numerous LIPs erupted along the line of breakup of Pangea as each part was rifting

laboratory and computer modeling of plumes indicates that they should begin with a large mushroom head that rises through the mantle with a narrow conduit following the mushroom head should spread out when it reaches the base of the lithosphere this gives rise to the initial flood basalt

examples: Rajmahal traps, Deccan traps, Parana-Etendeka flood basalts, Columbia River flood basalts and their trailing hotspot tracks

The Cretaceous Superplume

high seafloor spreading rate, mantle plume activity, high sea level, warm climate of the Cretaceous, and lack of magnetic field reversals may all be the result of a great pulse in the amount of heat coming out of the mantle in the Jurassic and Cretaceous as Pangea was rifting and drifting apart

rapid seafloor spreading results in shallowing of average ocean depth, raising sea level

rapid seafloor spreading and hotspot volcanism releases more CO_2 into the atmosphere, warming climate

much heat may have been removed from the lower mantle (D" layer) by the initiation of many mantle plumes which would have cooled the core-mantle boundary (CMB), increasing the thermal gradient from the bottom to the top of the outer core

this should increase the convection in the molten iron outer core (which generates the Earth's magnetic field)

more robust convection in the outer core should mean fewer (or no) magnetic reversals (which are presumably produced by turbulent eddies in the outer core)