Chapter 05: Interiors of Terrestrial Planets and Major Moons

Typical densities:

_____ Ices
_____ Surface rocks
_____ iron-rich minerals
_____ iron-nickel meteorites

_____ Mercury
_____ Earth

Earth is massive enough for the core to experience _____ and thus higher-than-average density.

Earth is also massive enough to have undergone _____ .

The density profile of Earth's interior can be assessed through _____ measurements.

Q: What would the Earth's density profile look like as a function of radius if the density were perfectly uniform throughout?

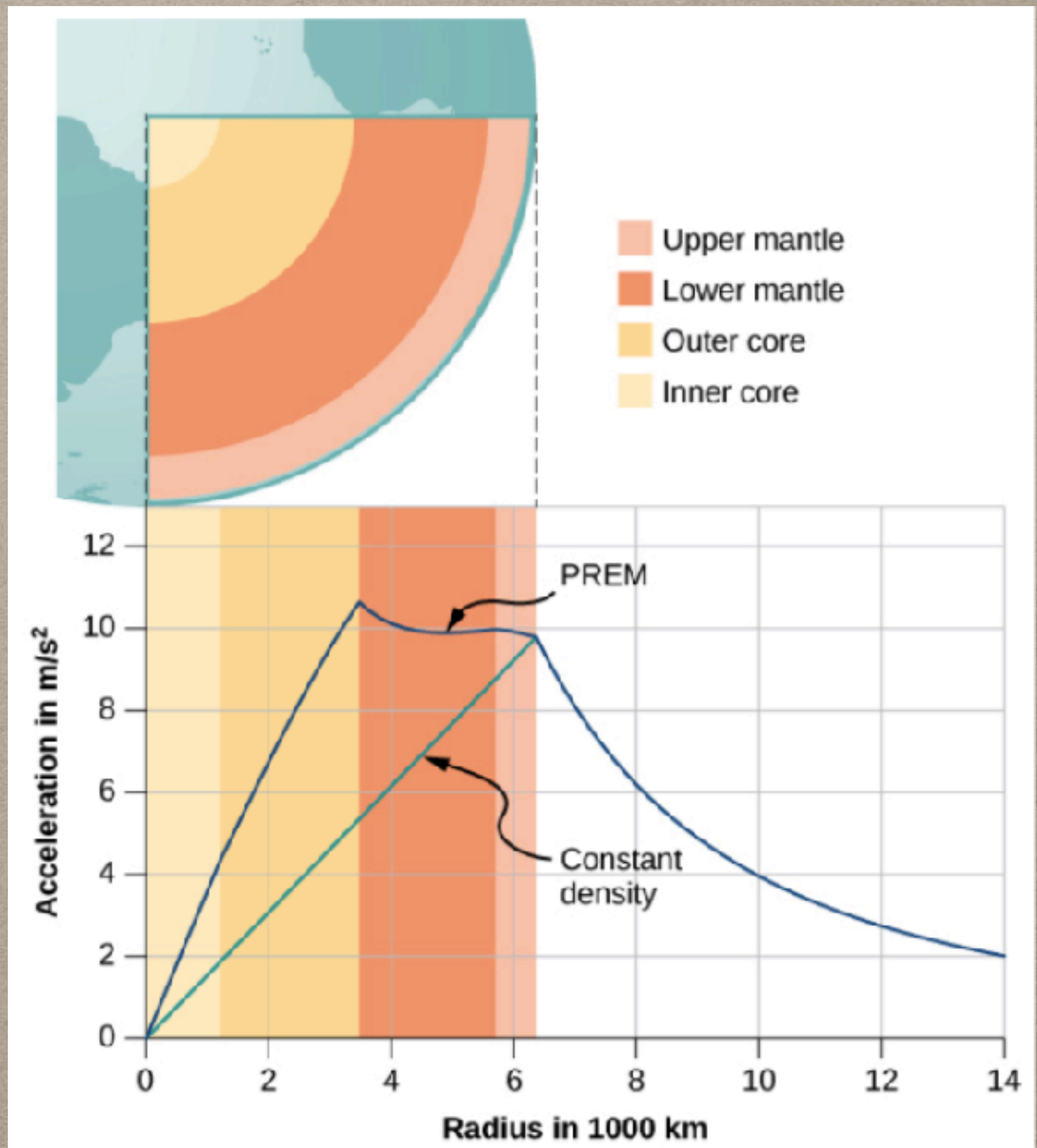
g(r) = Force / mass(r) =

In other words, the gravitational acceleration would be _____ with a slope of _____ .

The slope is steepest in the inner core, implying that the inner core is _____ .

The slope is ~flat for the mantle, implying that the mantle's density is _____ .

What is g(r) at the altitude of the International Space Station?



<u>Internal heat</u>

Smaller masses have less _____ and cool more rapidly because their larger ratio of _____ .
See also <u>Bergmann's Rule</u>

The amount of accretional heating can be estimated via the gravitational internal energy: as a mass grows through accretion, the infalling masses slam into the parent mass and thereby deliver kinetic energy.

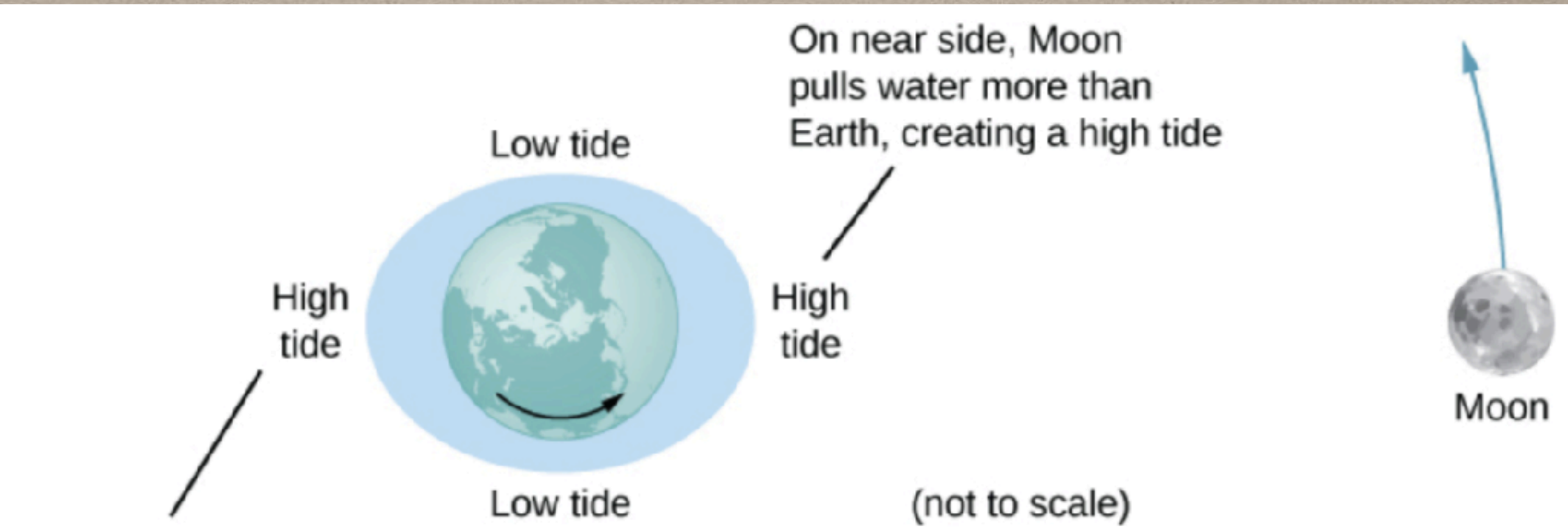
On page 2, Dobson claims that the gravitational energy energy of a massive spherical object is _____ and that the constant of proportionality is _____ . Let's derive this constant!

3/5 GM^2/R is only an approximation for the accretional heating. This value is _____ limit since _____ .

Another important source of heat for planetary interiors is radioactive decay. Relevant isotopes include ^{235}U, ^{238}U, ^{232}Th, and ^{40}K which have half lives of ~$10^{9\text{-}10}$ years. Interestingly, many of these isotopes derive from _____ .

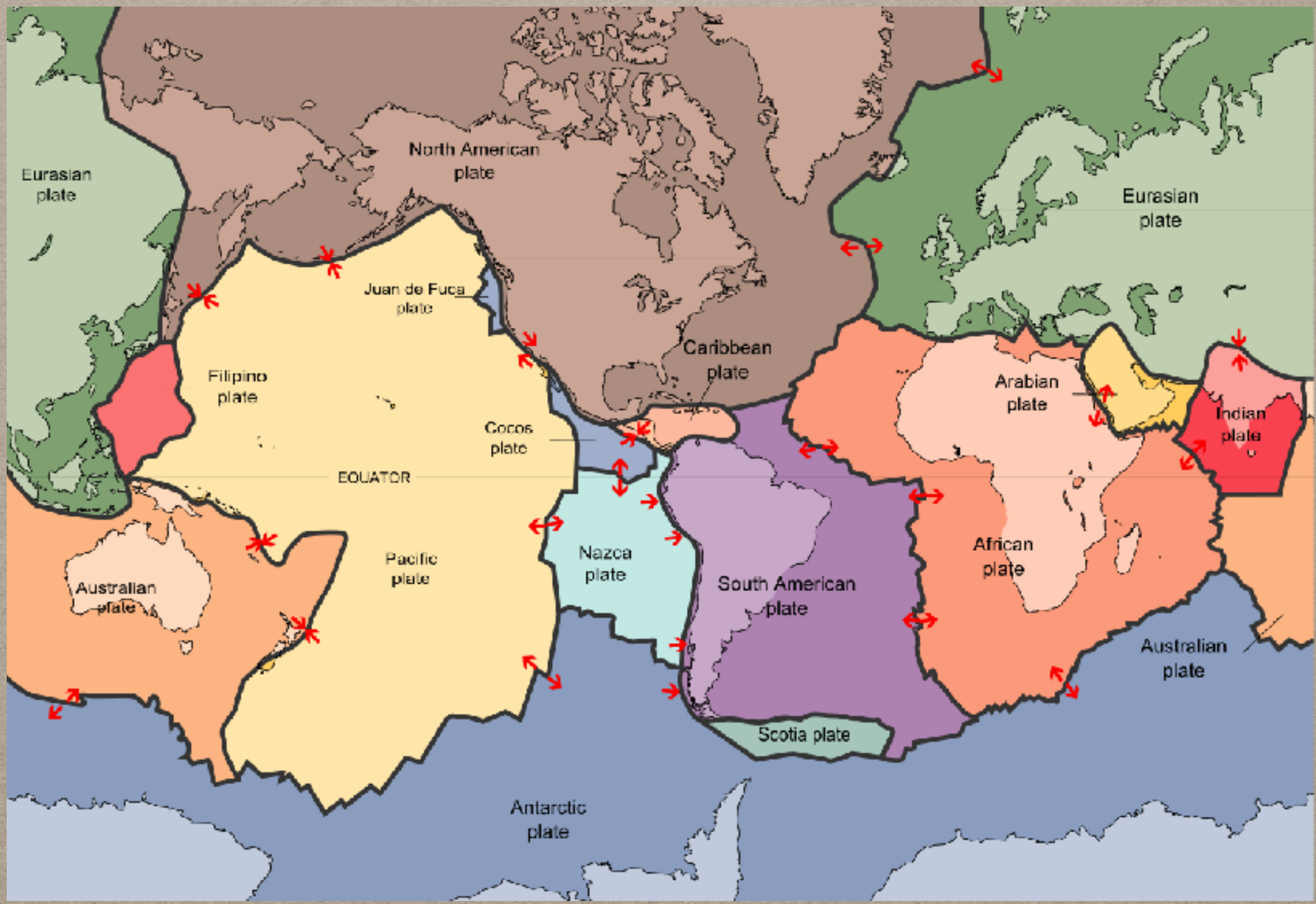
Finally, _____ forces can provide substantial internal heating, especially for _____ .

Gravitational tidal forces

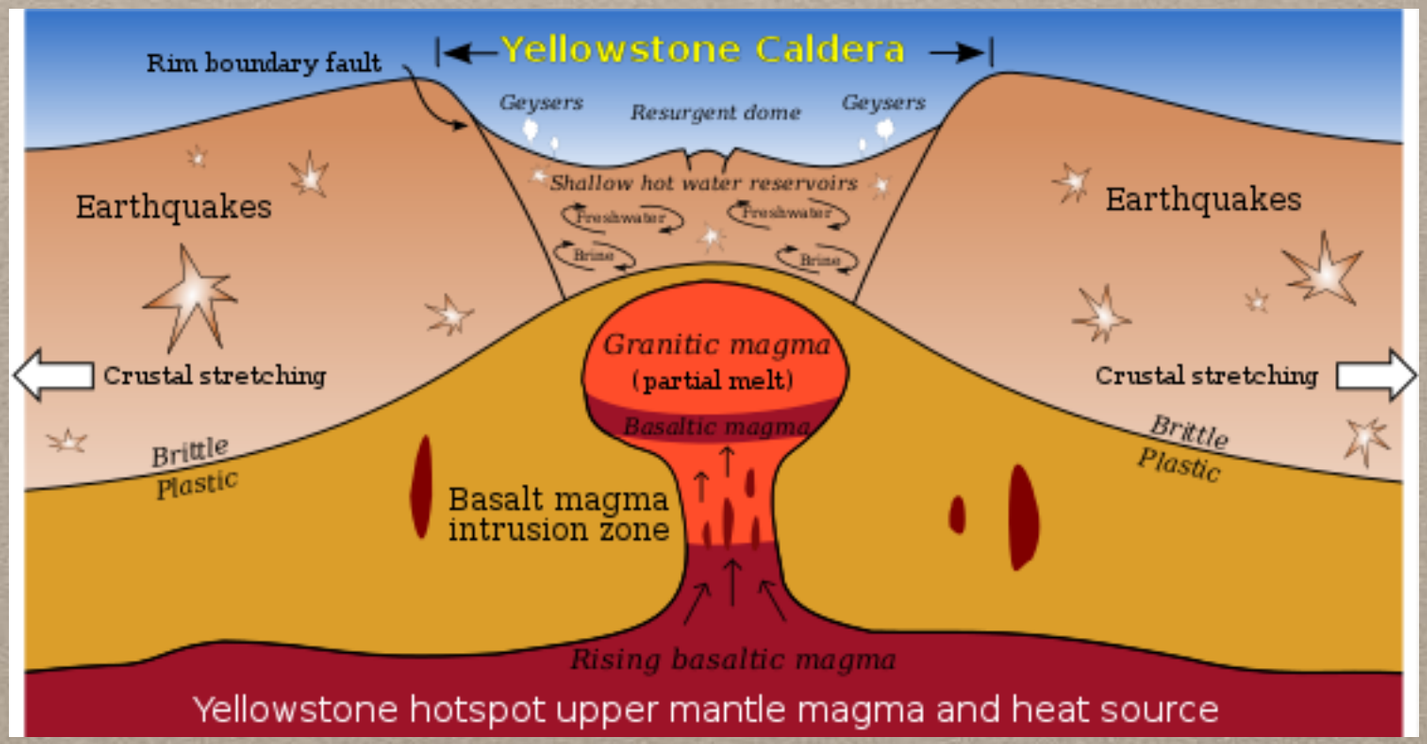


Depending on the local topography, extreme tides can occur on Earth, e.g., 16.3m at the Bay of Fundy on the east coast of Canada.

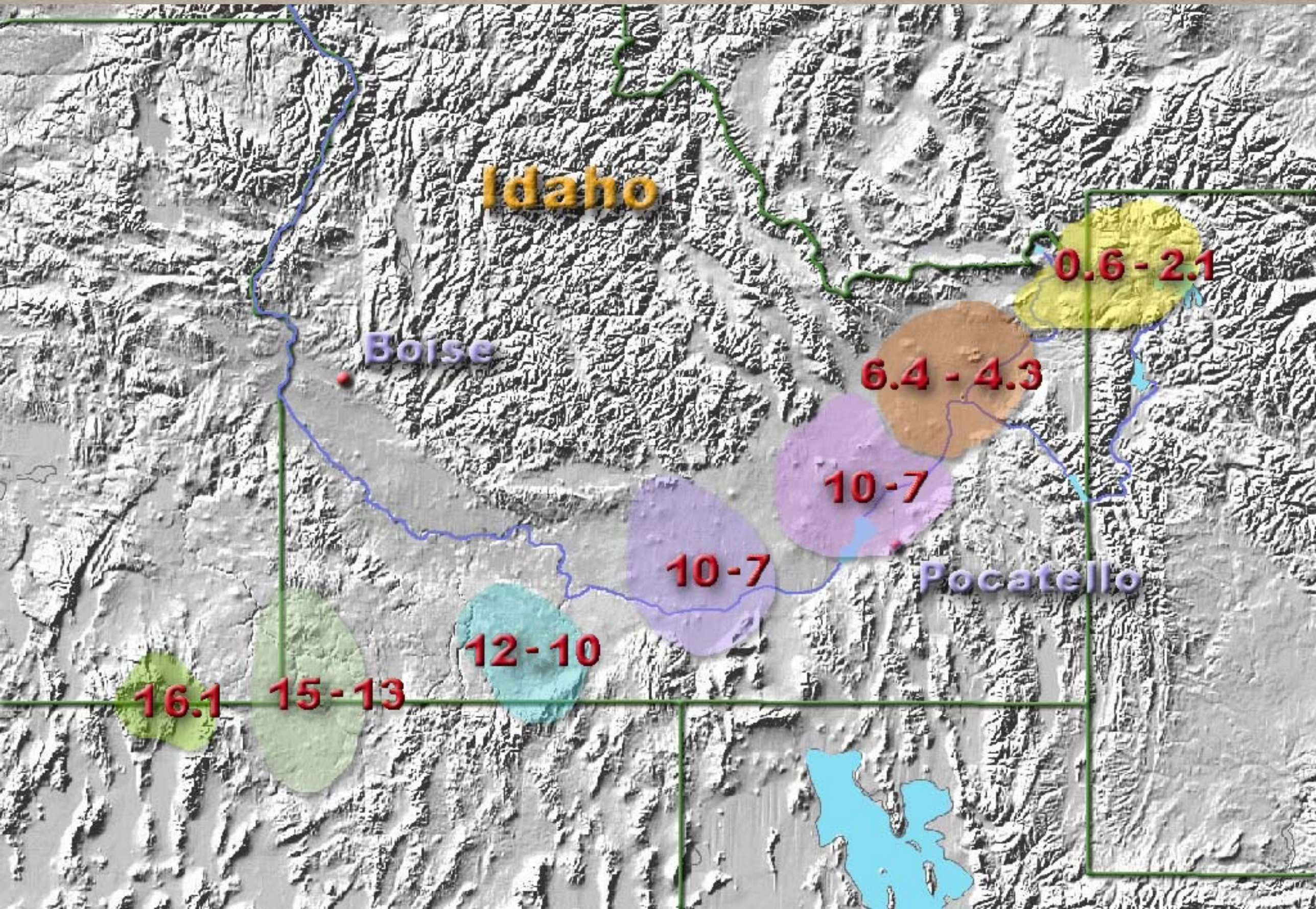
The density profile of the Earth is assessed through seismology. P (primary) and S (secondary) waves trace the propagation of earthquakes, which can be generated through the interactions of tectonic plates as they move past and over/under each other.



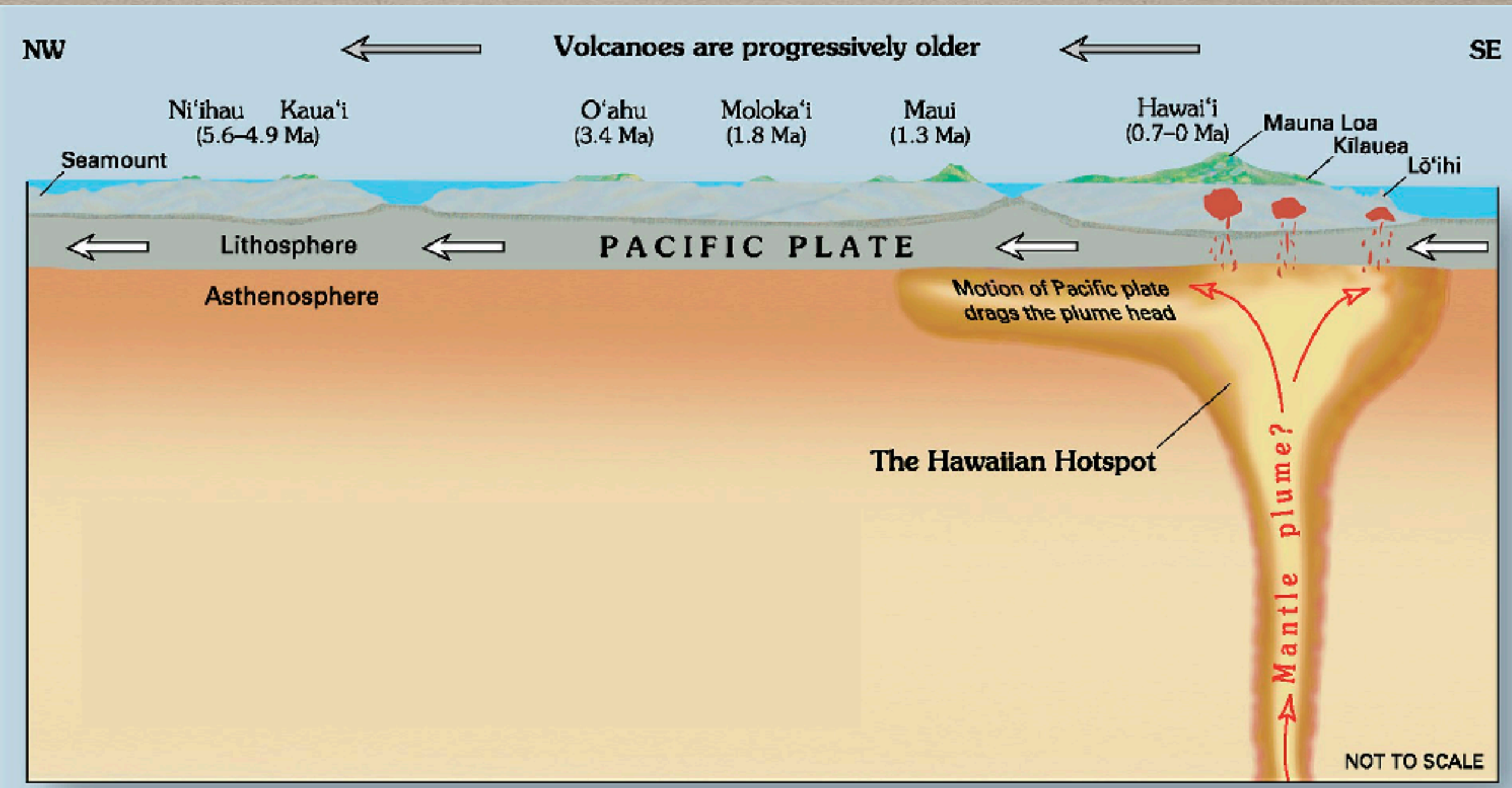
The Yellowstone Hotspot: as the Earth' s lithosphere moves across a hotspot comprised of granitic and basaltic magma, volcanoes erupt occasionally along a path. The most recent eruption was 640,000 years at the present location of Yellowstone Nat'l Park.



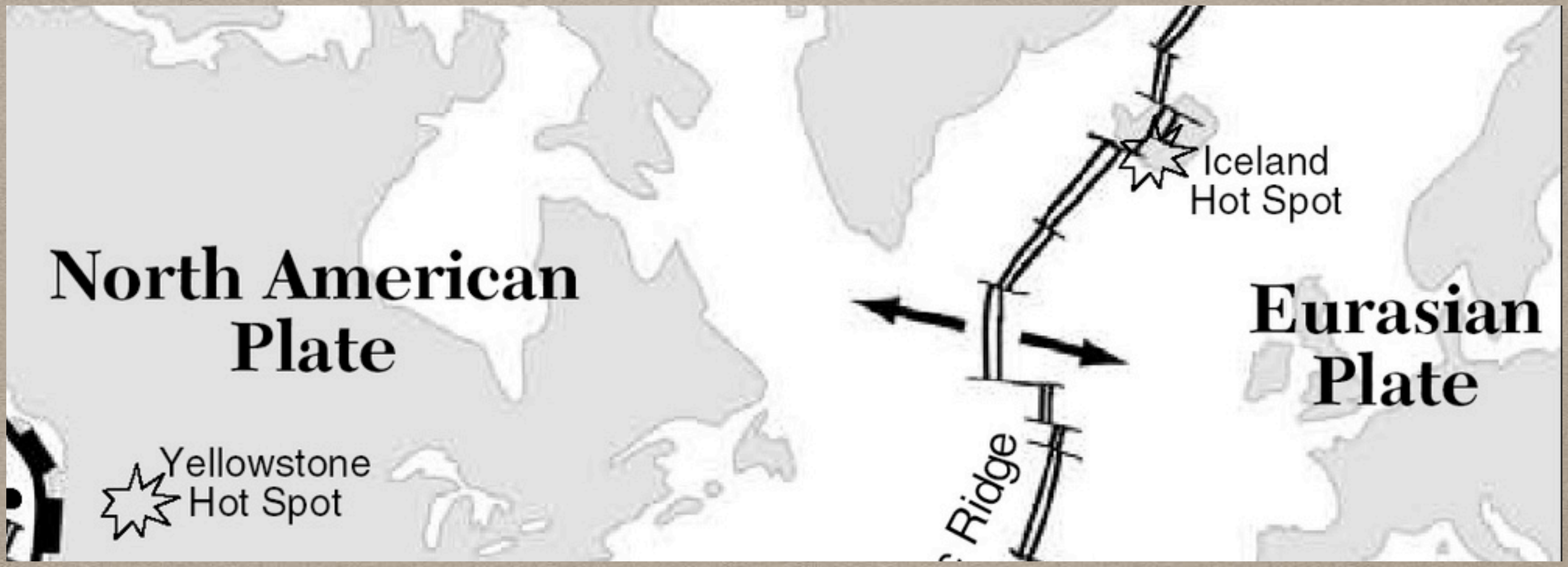
The Yellowstone Hotspot



The Hawaii Hotspot: similar to the Yellowstone Caldera, the Big Island of Hawaii is only 0.7 Myr old (and still growing).



Q: The continent of Europe (on the Eurasian Plate) and the continent of North America (on the North American Plate) are moving apart from each other at 3 cm/yr. Estimate how long it has taken them to attain their current separation of 4500 km.



Do plate tectonics occur on other planets in the Solar System? Perhaps. An argument for the gargantuan size of Mons Olympus on Mars is that _____ .

Further out in the Solar System, the various fissure-like features on Europa may indicate subduction of ice "plates", though it is unclear why some ice plates would be dense enough to sink.