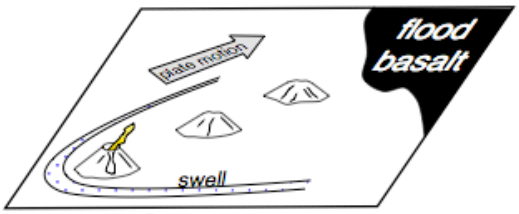
Name:_____

Yellowstone and the theory of hotspots

The Yellowstone hotspot is a curious thing, and it provides great opportunity to think about scientific inquiry.

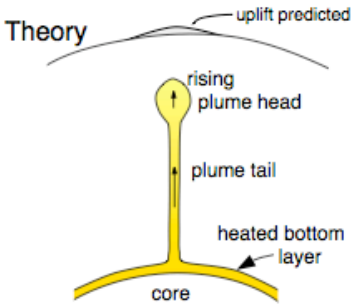
The context in which we consider Yellowstone is a *theory* for hotspots, which is based on observations from around the world.

Hotspots are observed to be:
- -focused spots of volcanism not associated with a plate boundary,
- -areas where the plate is uplifted, producing a "swell"
- -stationary relative to one another
  (when a plate moves, it leaves behind a track of old volcanoes)
- -In addition, when their starting point can be found, it is a large flood basalt eruption.



Observations

To account for these observations, the theory (i.e., a comprehensive explanation) for hotspots is:
- -they are made of the convectively rising heated bottom layer.
- -hot, low viscosity mantle rises within a cylindical conduit (the plume tail).
- -they are stationary because the lower mantle is highly viscous.
- -the uplifted surface is caused by buoyant mantle beneath the plate.
- -The flood basalt represents arrival of the plume's head; the track represents the tail.



Without this explanation it is difficult to explain the sudden and continued supply of unusually hot mantle, or the hotspot being stationary.

Q: Two of the best Earth scientists are vigorously opposed to this theory. Does this cast doubt on the theory?
A1:

If this is what hotspots are, the predictions of this account should be true. For instance, one prediction is that about 1 km of uplift proceeds the flood basalt event, caused by approach of the buoyant plume head. The Siberian flood basalt event didn't do this.
Q: What do you think about this? Does this invalidate the theory?
A2:

From its surface manifestations Yellowstone is acting like a hotspot:
- -it is a focused site of volcanism not associated with a plate boundary
- -it is stationary relative to other hotspots
- -it has a track and a swell
- -it has a flood basalt initiation

However, the flood basalt eruptions occurred in the wrong place, far north of the track. (An explanation has been proposed that has the flood basalt being caused by accumulated plume tail pounded beneath a subducting plate, which dragged ponded mantle to the north. The plate subducting at the time is known to have a northward component of motion.)

Considering Yellowstone and the Columbia River flood basalt flows as the most recent and best-studied example of a hotspot initiation… which side are you on? That is, if you had to choose a side, would you say the Yellowstone example was caused by a mantle plume, or not?

What are the main two observations that support your conclusion? Why (in about 200 words, i.e., not "because it is off track." I would ask: "Is this a problem?").

What do you consider the strongest argument for the other side (i.e., the side you did not choose)?