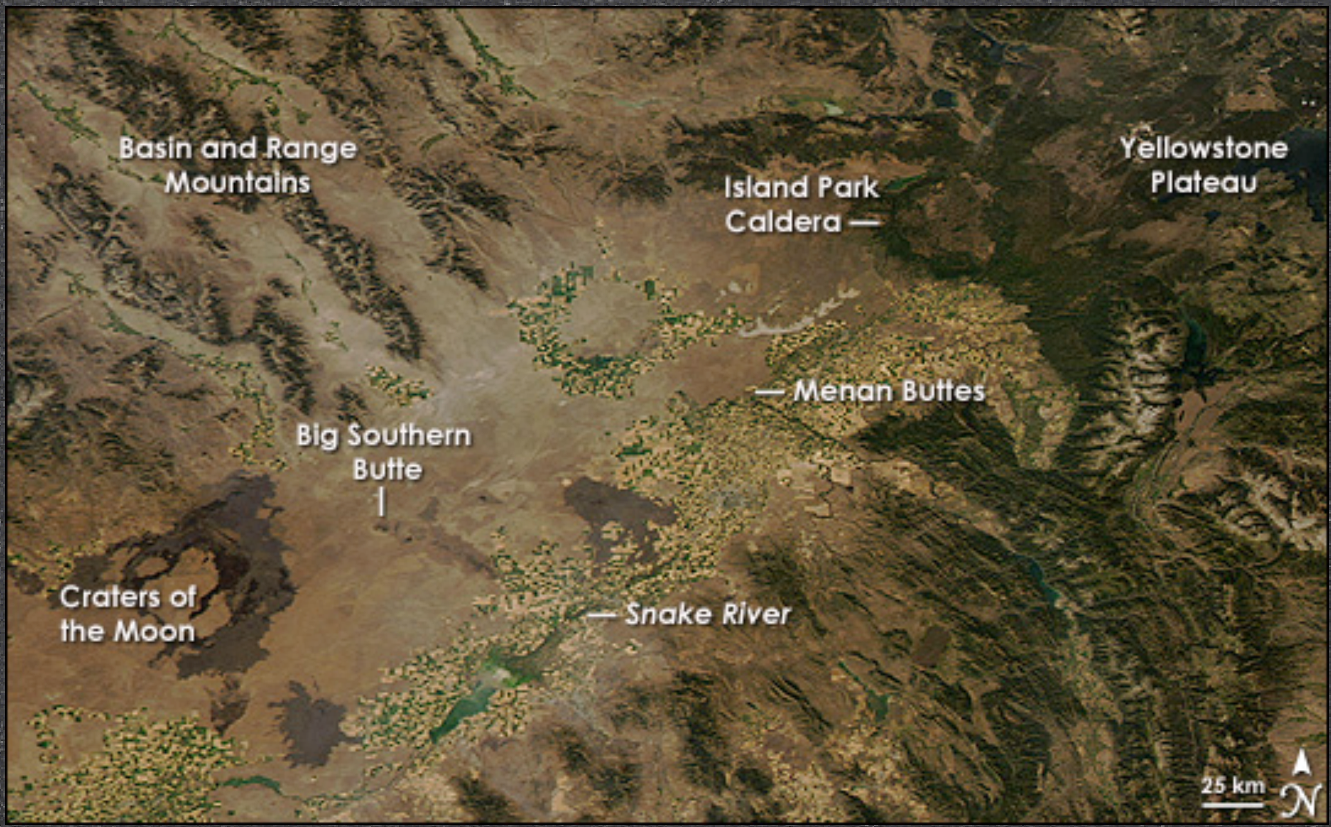
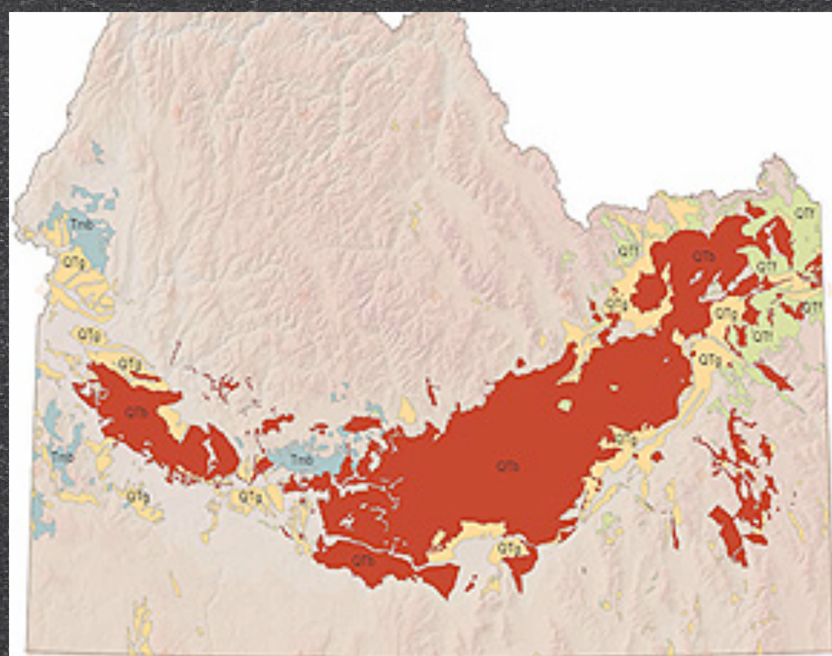
Snake River Plain

Hot Spot in America



Moving Hotspot

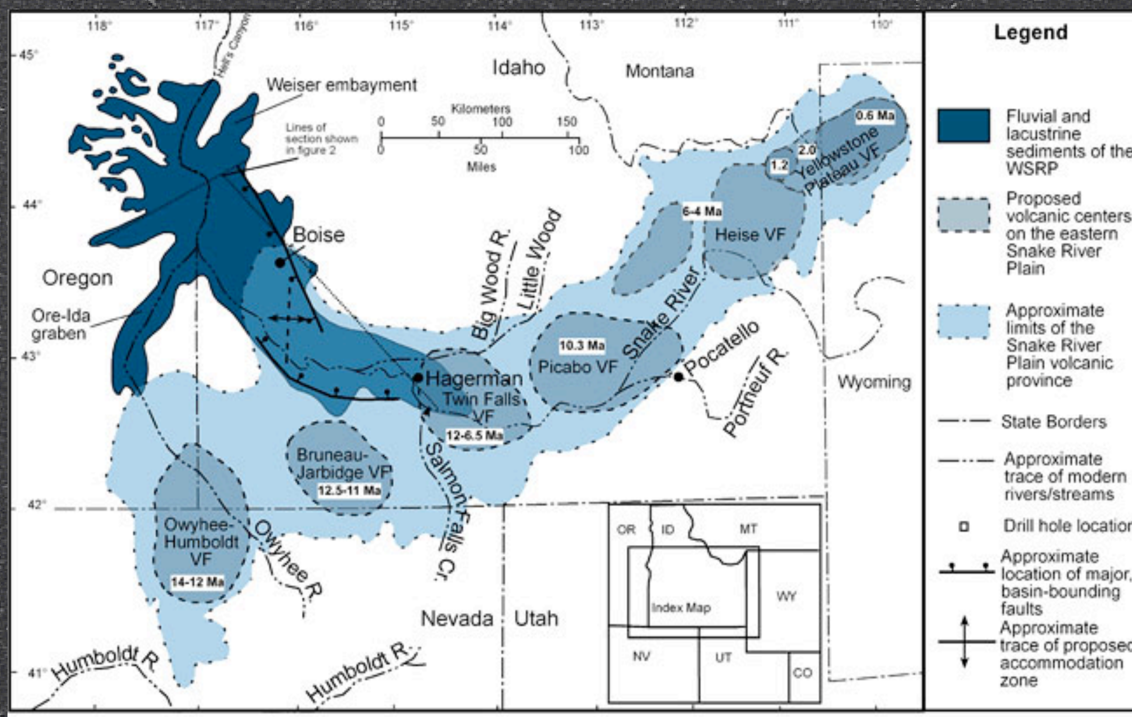
- The Snake River Plain is a prominent depression across southern Idaho extending 400 miles in an east-west direction. It is arc shaped with the concave side to the north. The width ranges from 50 to 125 miles with the widest part in the cast. The Eastern Snake River Plain, a linear downwarp or graben that has been a locus for basaltic volcanism since middle Miocene time. According to one popular model, the rhyolitic Yellowstone Plateau marks the current location of a "hotspot" or melting anomaly in the upper mantle, and the basaltic Snake River Plain records the hotspot's northeastward track across the mobile North American Plate.



- Large volcanoes appear as bumps on the otherwise smooth surface of Snake River Plain, a kidney-shaped expanse in southern Idaho. These volcanoes are made of a lava known as rhyolite, which produces very explosive eruptions and cone-shaped volcanoes. The oldest of these volcanoes, about 17 million years old, are in the western and southern parts of the Plain. The age of the rhyolite volcanoes in the Snake River Plain decreases from the southwest to the northeast.
  As recently as 2,000 years ago, a different type of lava known as basalt flowed onto the surface and covered the rhyolitic flows. Basalt is a very fluid type of lava which produces low, smooth volcanoes.

- Such hot spots or plumes rise into the Earth's crust from the underlying mantle. Yellowstone National Park in northwest Wyoming lies above the current location of the hot spot. A similar hot spot formed the Hawaiian Islands.

- The hotspot origin model of the Snake River Plain is the commonly accepted model. Pierce and Morgan (1992) suggest three main lines of evidence that support the hotspot model. The first line of evidence is the time transgressive record of silicic volcanism interpreted to be the result of the movement of the North American Plate over a stationary mantle plume. The second line of evidence is the four zones of increasing seismic activity that form the intermountain seismic belt around the current location of hotspot activity. The third line of evidence is topographic changes resulting from the passage of North America over the hotspot. The land rose due to thermal uplift. As the hotspot migrated to the northeast, the highlands subsided due to cooling of the underlying crust and crustal loading from the eruption of post-hotspot basalts.



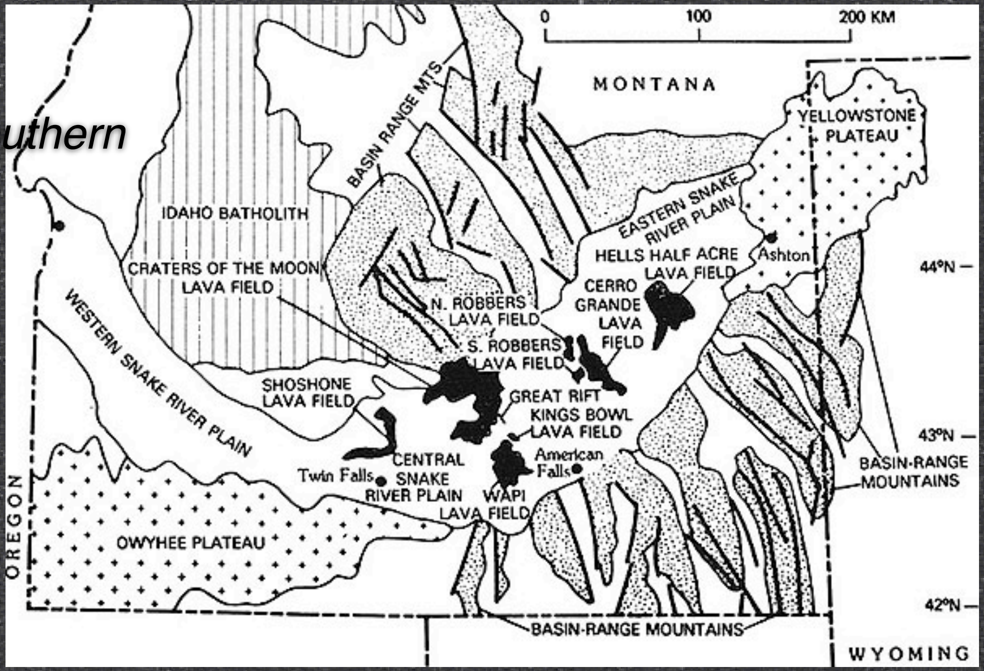
- Current silicic volcanic activity is centered in the Yellowstone area. Previous silicic volcanic centers produced a topographic bulge that coincided with the continental divide. As the North American plate migrated to the southeast and volcanic activity shifted to new regions, the extinct calderas gradually subsided to their present elevations due to thermal and gravitational effects.

- Four zones of seismic activity are associated with the migration of the hotspot. Zone II contains active Holocene faults that are thought to be connected with current volcanic activity of the Yellowstone Hotspot. Zone III contains late Pleistocene faults that are decreasing in activity. Zone IV contains faults that are no longer active. The zones form belts which curve around the hotspot track

Features of the Plain

- The western Snake River Plain graben in southwestern Idaho includes a large hydrovolcanic field which was produced in late Miocene to Pleistocene time by the interaction of rising basaltic magmas with the waters and water-saturated deposits of an enormous freshwater lake, Lake Idaho. The phreatomagmatic volcanoes in this field may be grouped into three types: emergent, subaqueous and subaerial. Emergent volcanoes, which began erupting under water and built up above the lake level, are relatively large and symmetrical, are dominated by bedded tuffs and late magmatic deposits, and are excellent indicators of water depth at the time of the eruption.

- *Igneous features of southern Idaho.*

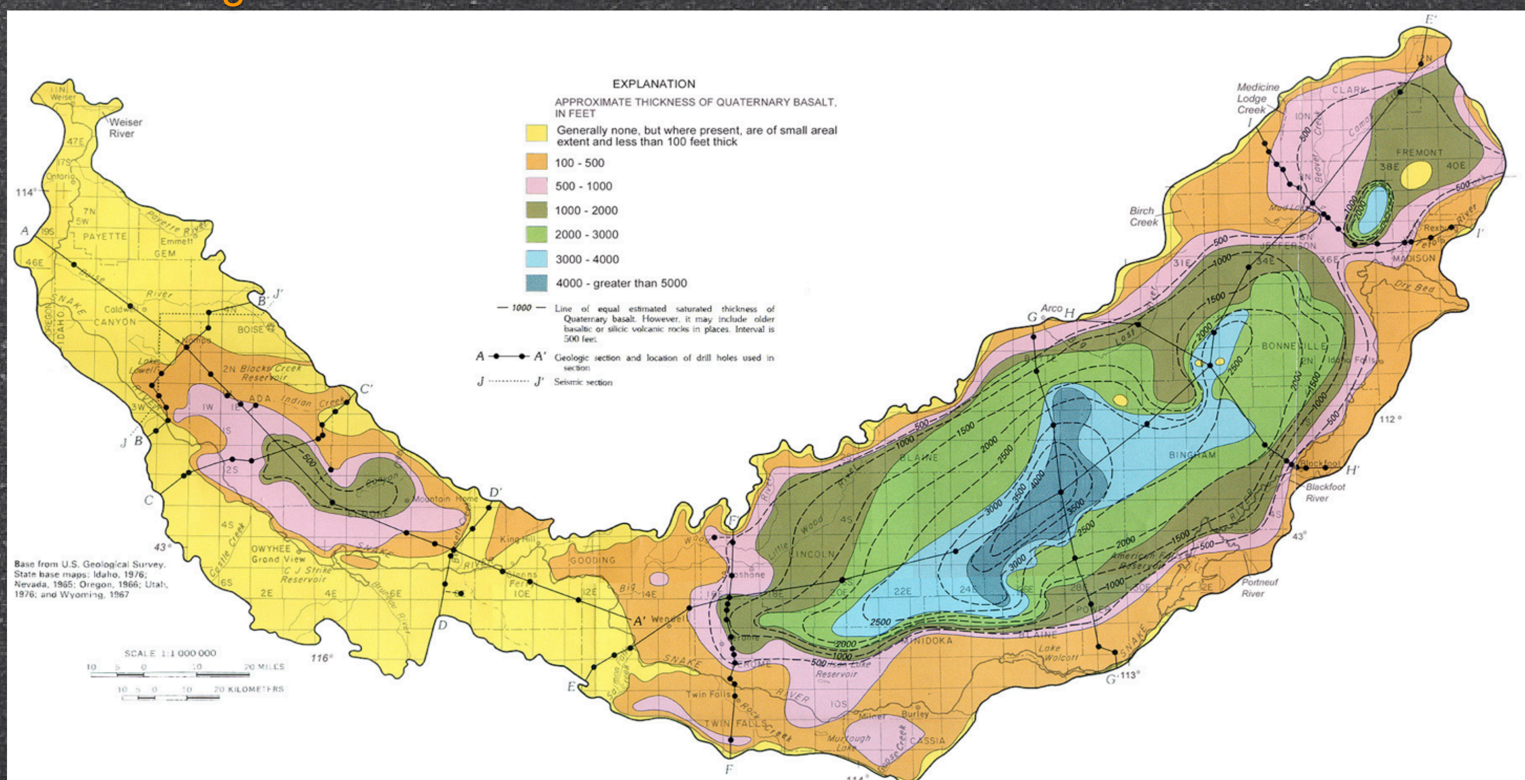


- The western and eastern Snake River Plains are topographically continuous and seem similar; however, they are structurally quite different. The western Snake River Plain is a NW trending graben; both the land surface and the rock layers dip towards the axis of the plain. The rocks that occupy the WSRP are rhyolitic tuffs and ash flows of the Idavada Volcanic Group , and fluvial and lacustrine sediments with interbedded basalt flows of the Idaho Group. Lake Idaho occupied the WSRP during the Pliocene epoch, as the WSRP subsided and the hotspot continued to the northeast.The eastern Snake River Plain is underlain by silicic and mafic volcanic rocks with local interbeds of continental sediments. Quaternary basalt flows cover ~95% of the surface of the ESRP. The Idavada silicic volcanics of the ESRP are lithologically similar to those of the WSRP but are younger in age. The tuffs at Yellowstone represent the youngest pulse of silicic volcanic activity associated with the hotspot.

- There is no evidence of faulting along the margins of the ESRP even though the Basin and Range province borders its northern and southern margins. Basin and Range faults are oriented perpendicular to the axis the eastern Snake River Plain

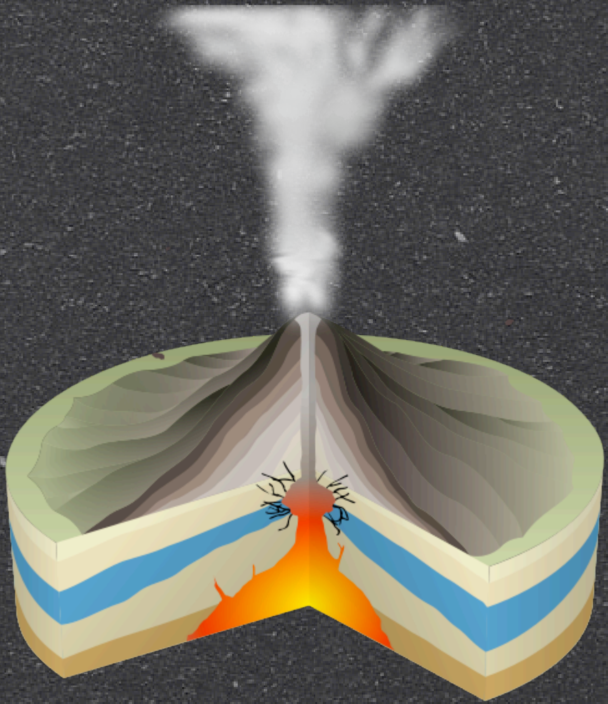
- In the Miocene epoch, when Snake River Plain volcanism began, the continental divide was located west of its current position and local streams drained toward the Atlantic Ocean; sediments were transported eastward, northward and southward away from the location of the volcanic high.

- As the continental divide moved eastward across southern Idaho, rivers south of the Snake River Plain began to flow south and east. Subsidence in the wake of hotspot migration caused a drop in the base level of the Snake River Plain which initiated headward erosion toward the modern Snake River channel. This eventually led to stream capture and the shift of drainage to the Pacific Ocean.



Volcanism

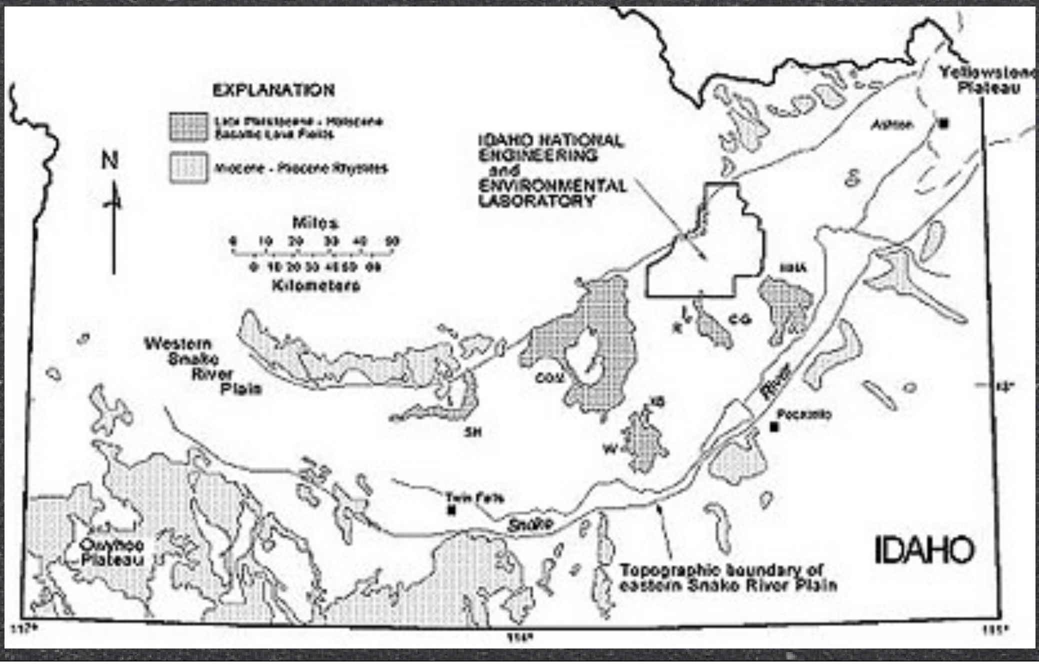
- Phreatic explosions can be accompanied by carbon dioxide or hydrogen sulfide gas emissions. The former can asphyxiate at sufficient concentration; the latter is a broad spectrum poison.
- A Phreatic eruption, also called an ultravulcanian eruption, occurs when rising magma makes contact with ground or surface water.



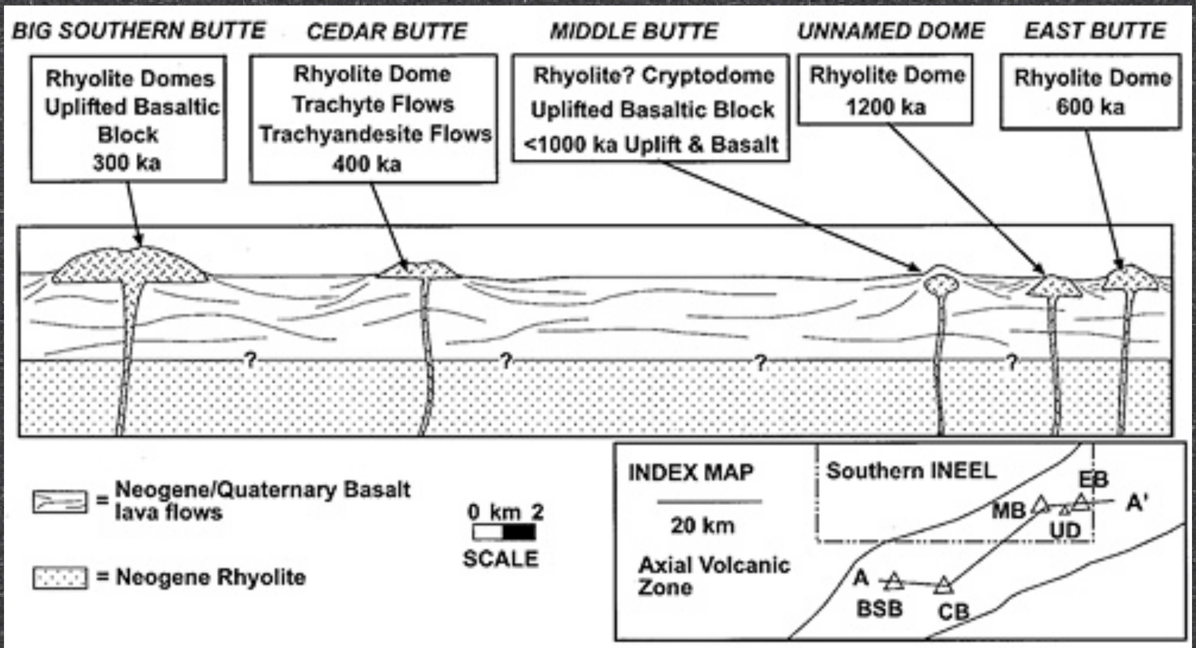
Movement

- Ignimbrite and tuff deposits marginal to the Snake River Plain record the path of the movement. Basaltic lava fields, polygenetic eruptive centers, and rhyolite domes that spatially and temporally overlie Yellowstone Hotspot volcanism comprise the upper 1-2 km of ESRP (Eastern Snake River Plain) stratigraphy. Many of the basalts of the ESRP erupted along volcanic rift zones (VRZ) that are oriented parallel to the direction of regional basin and range extension.

- *Map 1 showing the locations of Late Pleistocene to Holocene basaltic lava flows as well as older rhyolites associated with the Snake River Plain volcanism.*



- Five major rhyolite domes are present on the ESRP; Big Southern Butte, Cedar Butte, Middle Butte, Unnamed Butte, and East Butte. They are located near the extinct Picabo and Heise volcanic centers but are not directly associated with Yellowstone Hotspot volcanism.



- Geologic sections show the predominance of quaternary and tertiary volcanic rocks in the upper several thousand feet of the eastern Snake River Plain. Sedimentary rocks of equivalent age predominate in the western plain. Structurally, the western plain is a graben; bounding faults shown on the sections as single lines represent fault zones. In much of the plain, most wells are completed in the upper several hundred feet of the aquifer; thus, little is known about deeper parts of the aquifer. Where deep drill holes were lacking, rock distribution was estimated using geophysical methods.

View from East Butte looking west: Middle Butte and Big Southern Butte rhyolitic domes on the eastern Snake River Plain. Middle Butte is a cryptodome covered by Quaternary basaltic lavas that were uplifted during emplacement.

- Earthquake and Volcanic Hazards

    - The probability of inundation by lava flows increases towards volcanic rift zones and the axial volcanic zone. Impacts from ground deformation and volcanic gases are even lower. The hazard due to seismicity associated with dike intrusion and volcanism is less than the hazard due to seismicity due to tectonic processes.