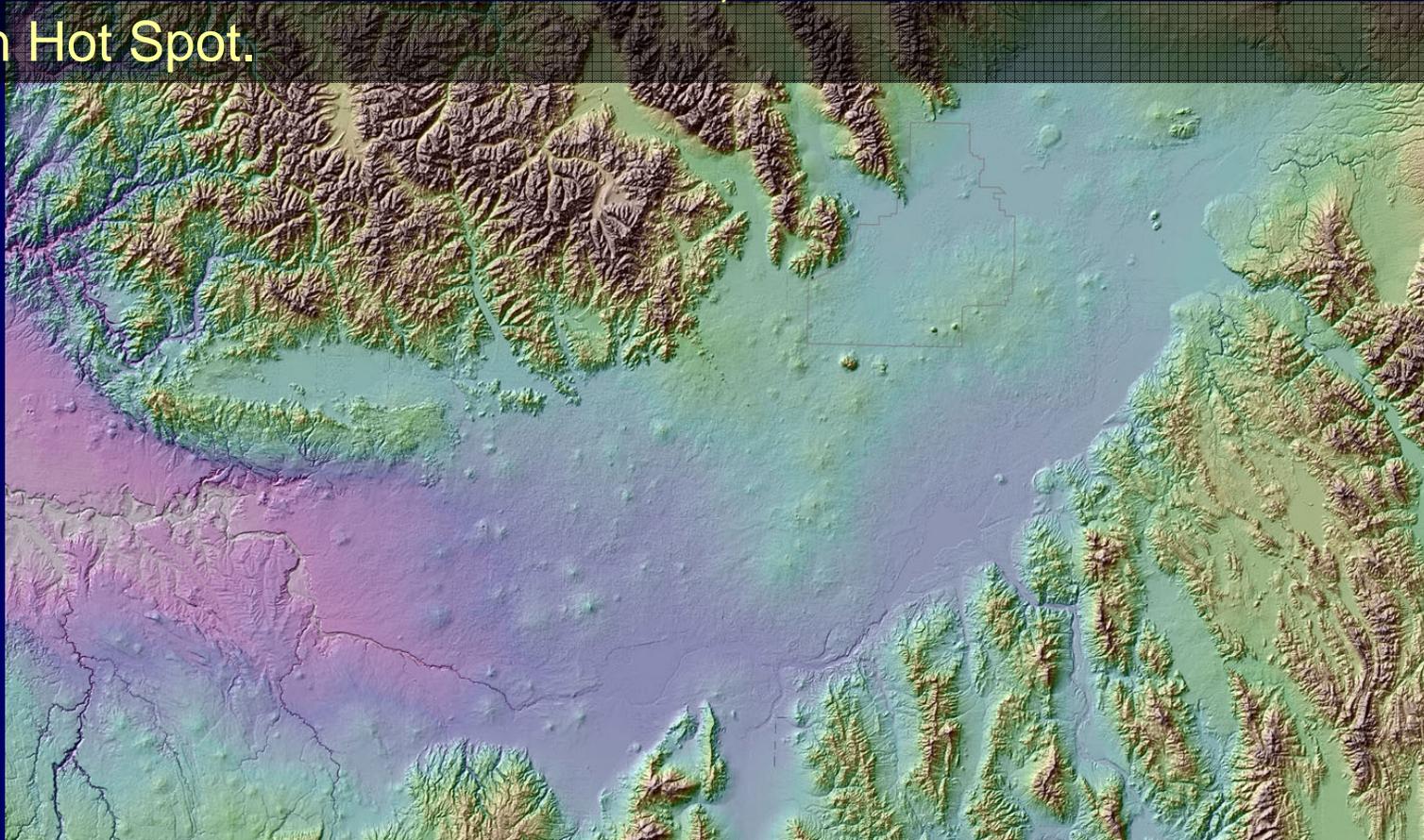


Snake River Plain Topographic Development

The Snake River Plain is a broad west-draining lava plateau, with mountains on its north and south sides. The Plain has the shape of a broad "V" with the top pointing north, and is divided into eastern and western parts, which meet near Hagerman, just west of Twin Falls. The Snake River drains southwestward, fed by drainage off the Yellowstone Plateau, located above the Yellowstone-Snake River Plain Hot Spot.



The eastern Snake River Plain is a lowland underlain by rhyolitic volcanic fields with nested calderas less than 12 million years old, and a thin cover of basalt less than 2 million years old. The volcanic fields are progressively younger to the northeast towards the Yellowstone Plateau, reflecting the southwest movement of North America over a fixed mantle plume or “hotspot). The eastern plain is bounded by steep north-northwest-trending Basin and Range mountains, with agricultural valleys between.

A model for topographic development first proposed by Pierce and Morgan (1992) and corroborated, using evidence from ages of detrital zircon populations by Link et al. (2005) and Beranek et al., (2006) proposes that through the last 12 million years, a dome-shaped topographic high moved northeastward ahead of the hot spot. The model, as with all complex science, requires further testing. Thus the images in this slide show should be considered hypotheses, rather than fact. At the end of the slide show are annotated images from Luke Beranek’s study of the western Snake River Plain

This elevated bulge was inflated by hot-spot derived thermal energy. As the highland moved northeastward, drainage flowed radially away from it, mainly to the south, north, and east. As the bulge subsided, the west-flowing Snake River captured drainages like the Portneuf and Big Lost Rivers, and the Snake River Plain formed. The movement of the bulge also caused the continental divide to migrate eastward.

Phase 1

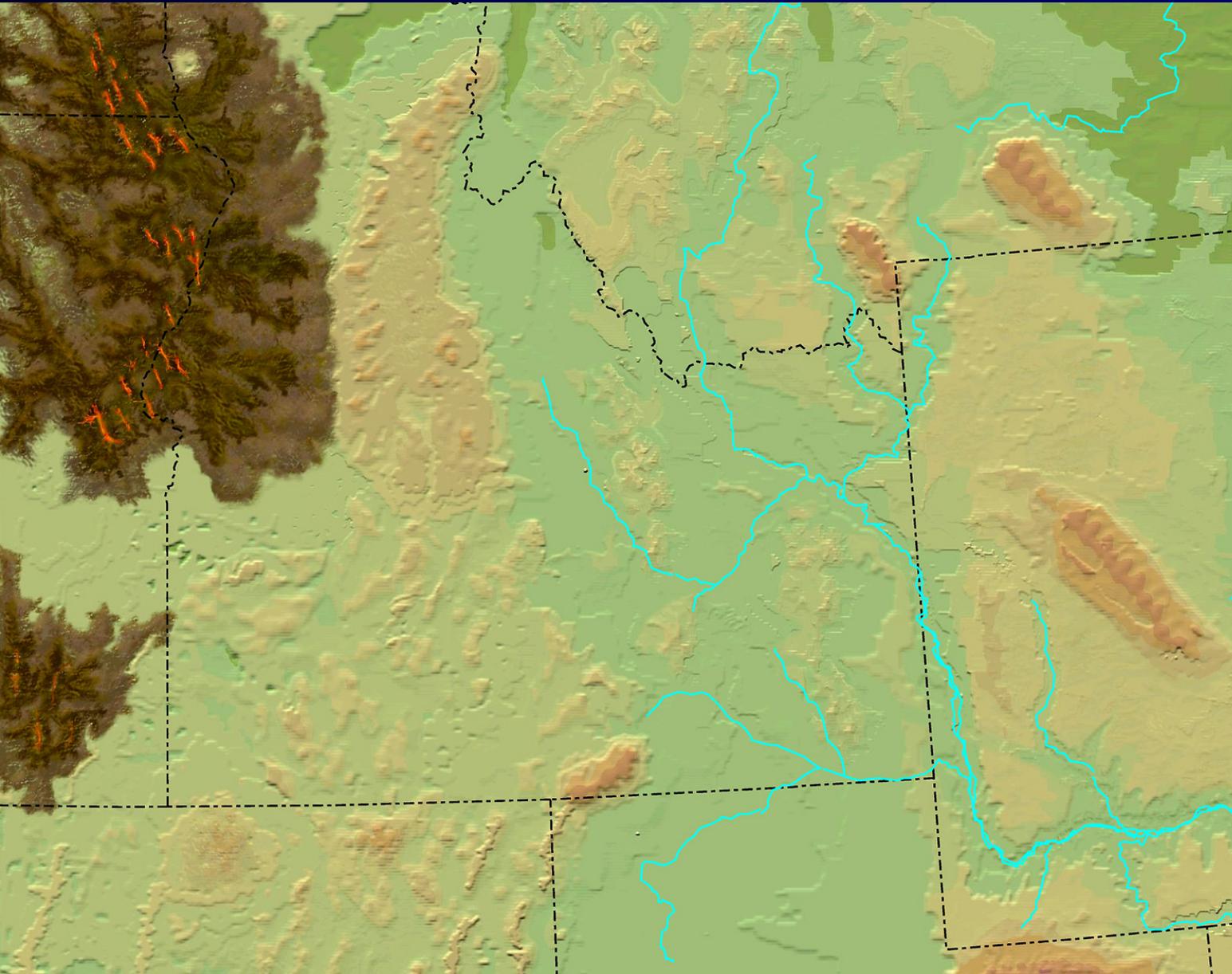
The Yellowstone Hot Spot first appeared about 17 million years ago with rhyolite eruptions on the Owyhee Plateau of southeast Oregon and northern Nevada. At about the same time, the Columbia River Basalts, containing over 150,000 cubic miles of lava, were erupting in eastern Oregon and Washington from north northwest-trending fissures.

Columbia River Basalt
~17 m.y.
(Middle Miocene)



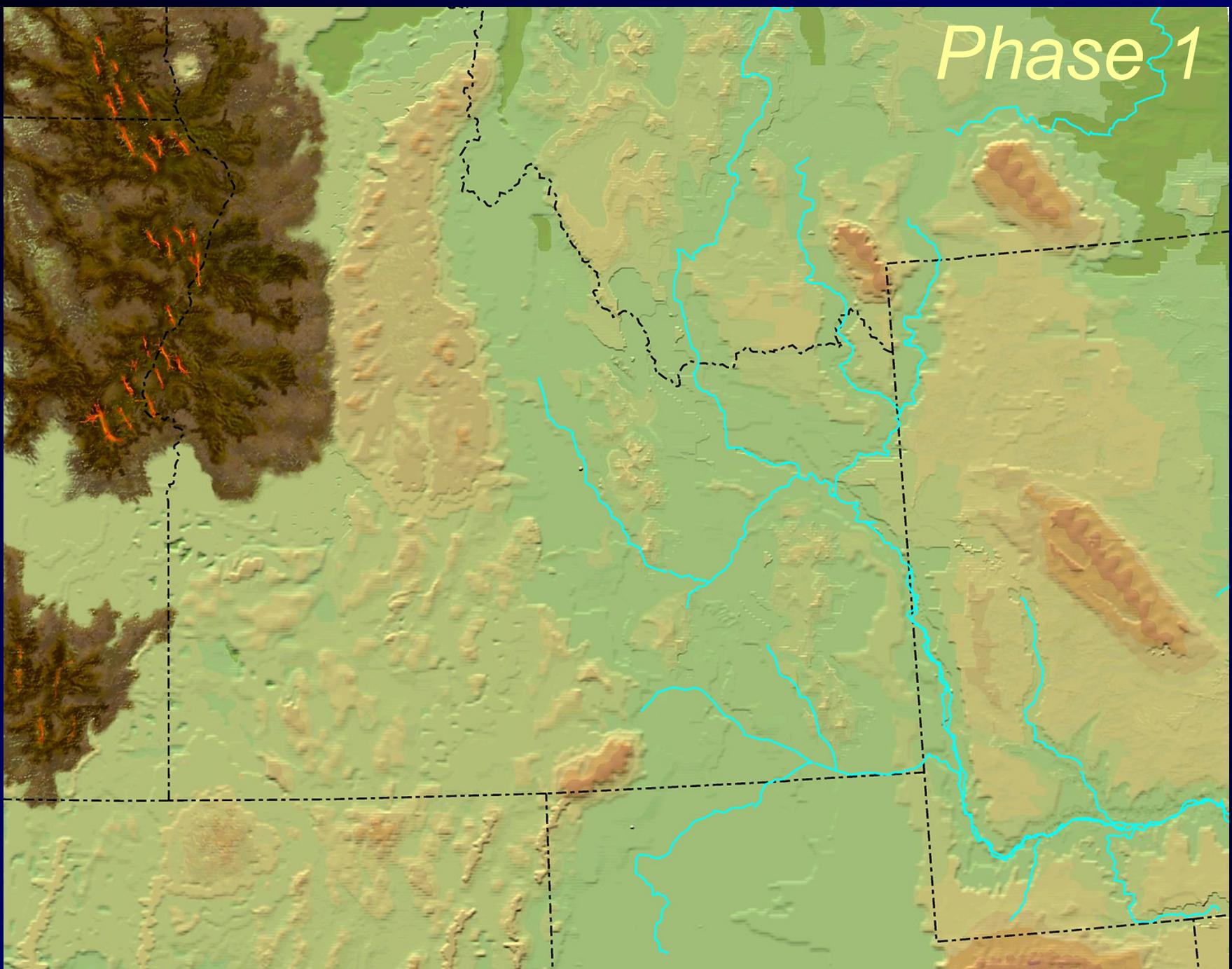
Phase 1

Some of the more extensive lava flows moved westward down the ancestral Columbia River to the Pacific Ocean.



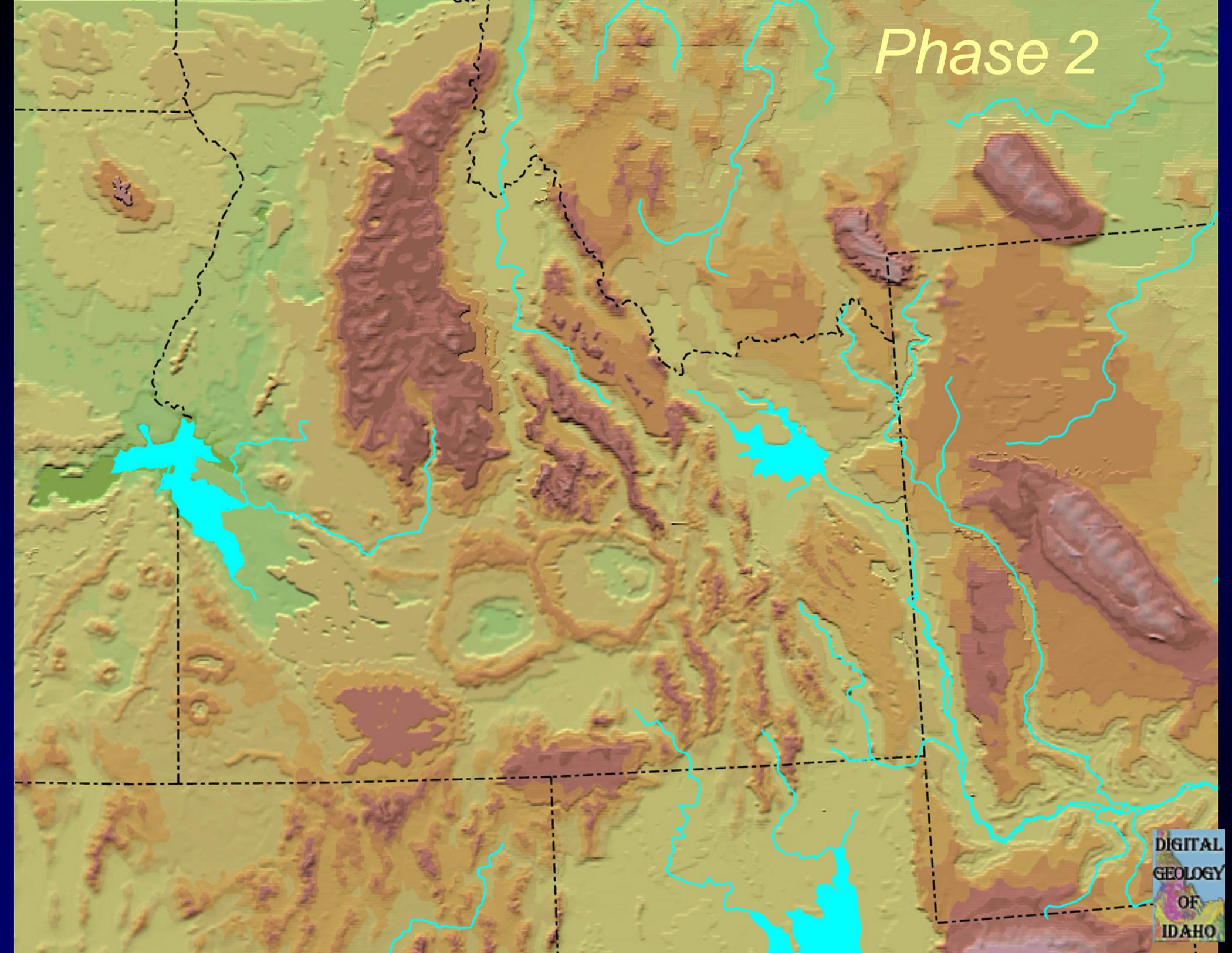
The continental divide was likely located north of Boise in the Salmon River Mountains where the Idaho Batholith formed a resistant topographic high area.

Phase 1



The Albion Range was uplifted near the Nevada-Utah border and drainage in eastern Idaho was eastward across a broad alluvial surface, above the eroded Idaho-Wyoming fold-thrust belt.

Phase 2



Phase 2

The western Snake River Plain is a north-northwest-trending 10 million year old basin bounded by normal faults. It is filled with thick sequences of basalt lava, sediments of Lake Idaho, and stream deposits derived from the Idaho batholith to the north and the Owyhee Mountains to the south. Both arms of the Plain appear to have been strongly shaped by extension of the crust on the North American Plate during the past 17 million years.

About 10 million years ago, the Yellowstone-Snake River Plain Hot Spot system was fully active, forming the Twin Falls and Picabo volcanic fields. The hot spot was located beneath the western edge of the Archean North American continental craton.

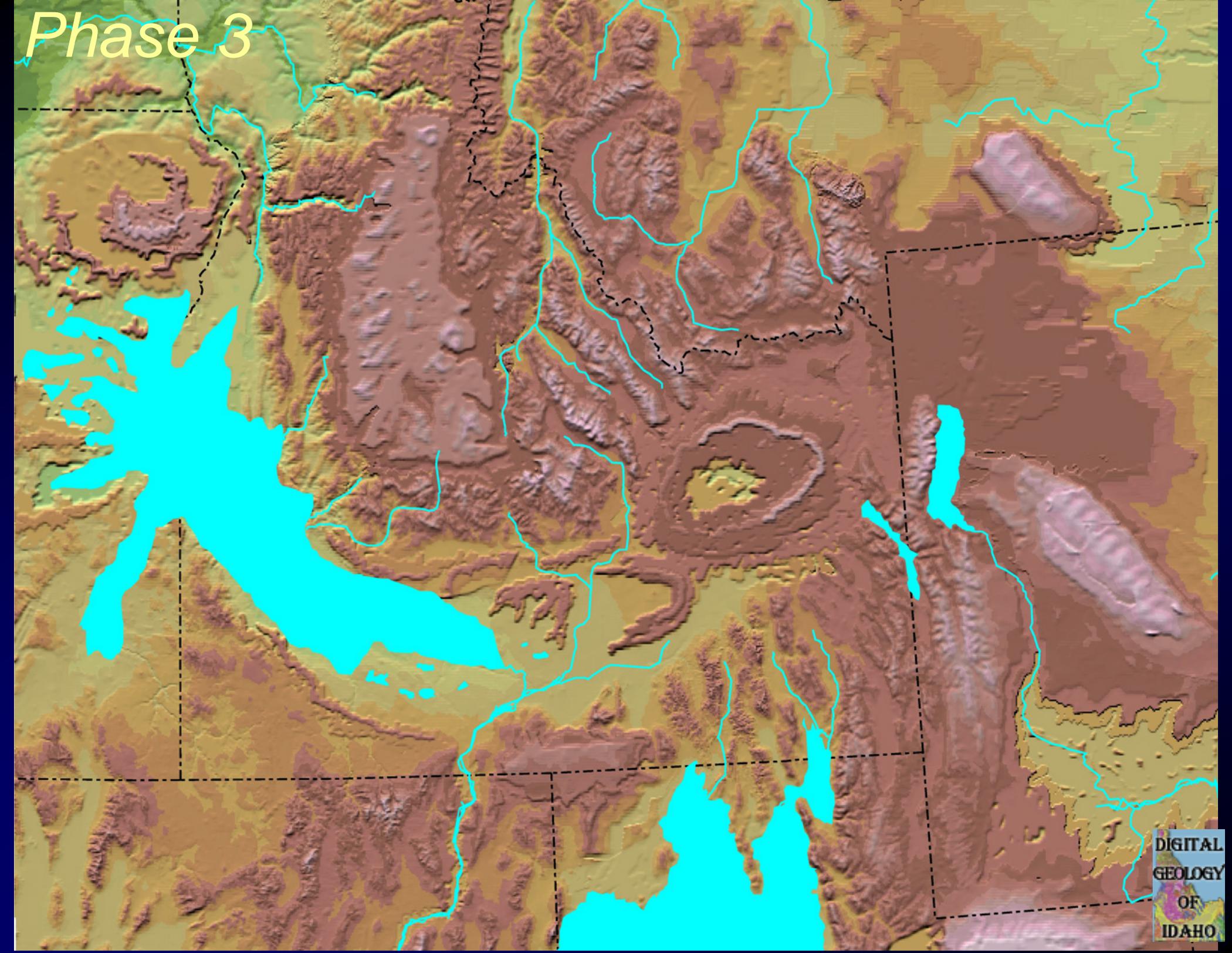
Phase 2

About this time, the rate of plate movement over the hot spot decreased from about 7 cm/yr to about 2.9 cm/yr, and the direction of movement changed by about 25 degrees counterclockwise, eastward to northeastward.

South-central Idaho was topographically uplifted into a tumescent bulge, thermally inflated by volcanic heat. Volcanism on the Owyhee rhyolite plateau had ceased and early Basin and Range faulting produced lacustrine basins east of the hot spot. Lake Idaho, a closed basin lake in the western Snake River Plain, occupied a northeast-tilted half-graben on the northwest shoulder of the topographic bulge.

The continental divide moved northeastward, following the relative movement of the hot spot. South-flowing streams drained into the developing Bonneville basin and the northward drainage of a proto-Salmon River flowed into eastern Montana.

Phase 3



Phase 3

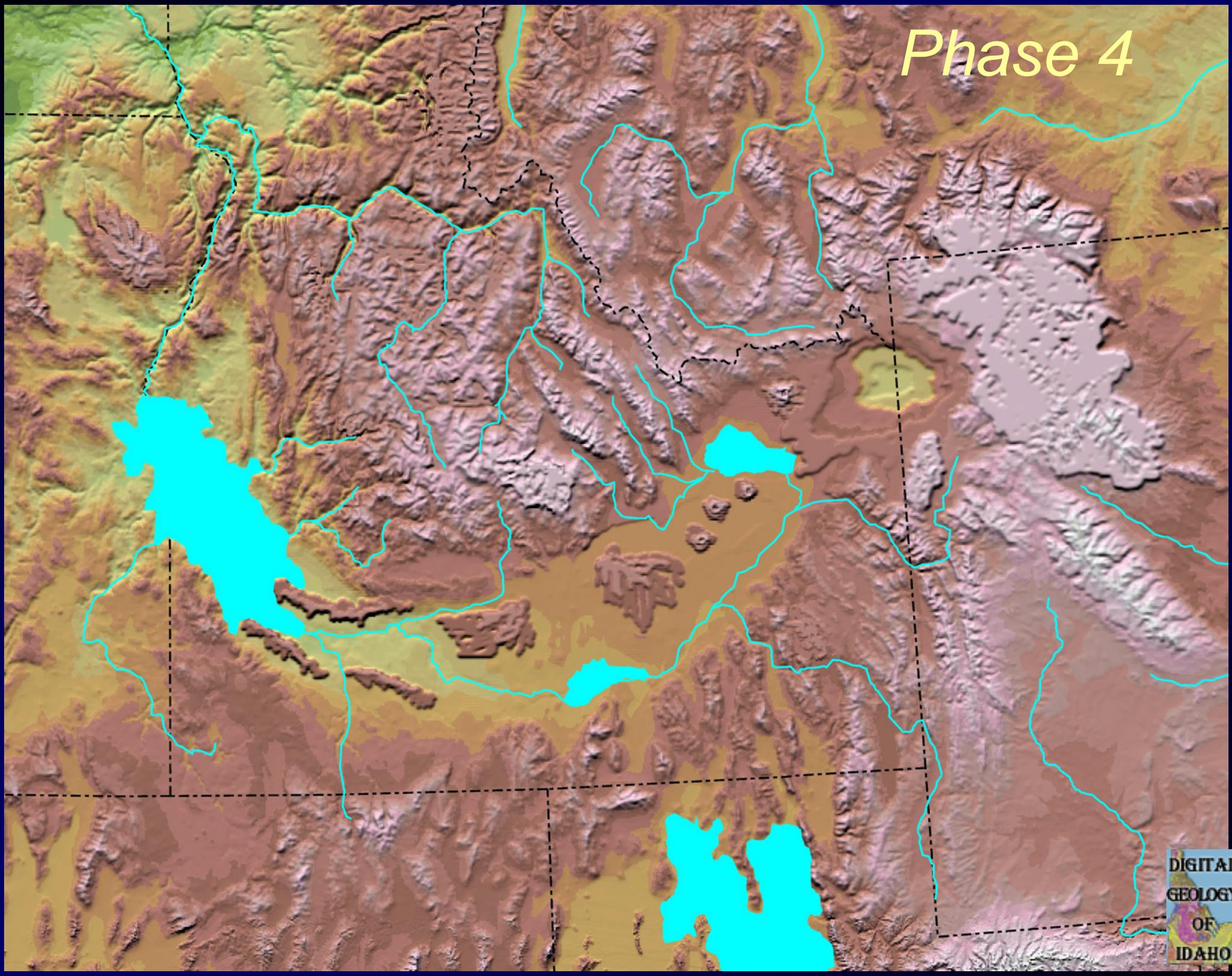
About 4 million years ago the hot spot was located in eastern Idaho, near Rexburg. Lake Idaho, in the subsiding central and western Snake River Plain, was at its maximum extent.

The Centennial and Teton Ranges were uplifted, with normal faults on their northern and eastern margins.

Teewinot Lake occupied present-day Jackson Hole, and the headwaters of the Snake River drained eastward up the Hoback River Canyon to the Green River. In general, drainage was centripetal, away from the hot spot, south to the Bonneville Basin and north to Montana.

Near Hagerman, at the southeast corner of Lake Idaho, streams and marshes were home to a diverse set of Pliocene animals, including the Hagerman horse (the Idaho state fossil). We show Lake Idaho as draining to the south through northern Nevada to the Sacramento River, as suggested by ages of distinctive sedimentary minerals (zircons) and the distribution of giant beaver and pygmy muskrat fossils.

Phase 4



Phase 4

One million years ago the hot spot was located beneath the Yellowstone Volcanic Plateau. Both the Huckleberry Ridge and the Henry's Fork calderas had formed, the latter by the eruption of the Mesa Falls Tuff. The high terrain of the northern Rocky Mountains spread out like an eastward-pointed crescent from the hot spot. The map shows a Pleistocene glaciation at its maximum.

**Yellowstone Volcanic Field
~1 m.y. (Pleistocene)**



Phase 4

Lakes on the Snake River Plain were, from west to east, Lake Idaho, Raft Lake, and Lake Terreton. Continuation of Basin and Range extension had thinned the crust so that basalt magma, melted from mantle lithosphere by the hot spot, reached the surface and produced extensive basalt lava fields across the Snake River Plain.

The Snake River had begun to cut Hells Canyon, its entry into the Salmon-Columbia River system. The Salmon River had begun to cut its steep canyons westward across the Idaho Batholith. Topographic subsidence of the eastern Plain had captured the headwaters of the Snake River in Jackson Hole, thus moving the continental divide northeastward into Montana and Wyoming. The Big Lost River drained southeastward, its water sinking into the basalt and joining the Snake River aquifer. The Bear River near Montpelier likely flowed northward into the Snake, reversing its former southeastward course.

Phase 5 - current

Basalt flows and cinder cones at Craters of the Moon National Monument have periodically erupted from the north end of the Great Rift over the last 15,000 years. The frequency of these eruptions is about once every 2,000 years and the last eruption was about 2,000 years ago.

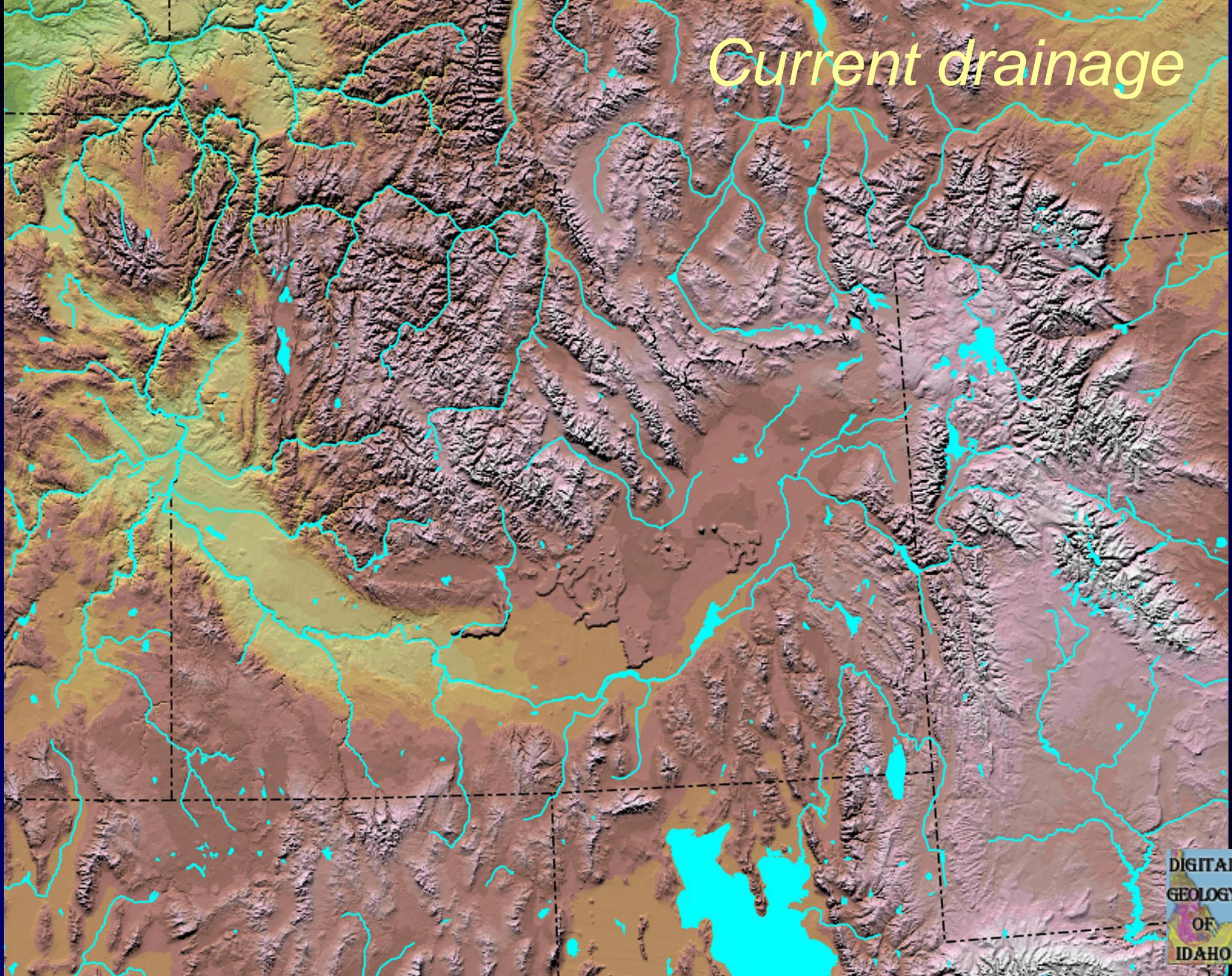
Basalt flows in the Blackfoot-Gem Valley lava field blocked and rerouted the Bear River, forcing it to bend to the south across the Portneuf Range at Oneida Narrows, and to enter the Bonneville Basin. The additional water from the Bear River was probably a major contributor to the rise of Lake Bonneville, which culminated in a catastrophic flood about 14,500 years ago.

Glacial erosion of the central Idaho mountains and the Yellowstone Plateau produced a tremendous volume of silt that was carried out onto the Snake River Plain by meltwater streams.

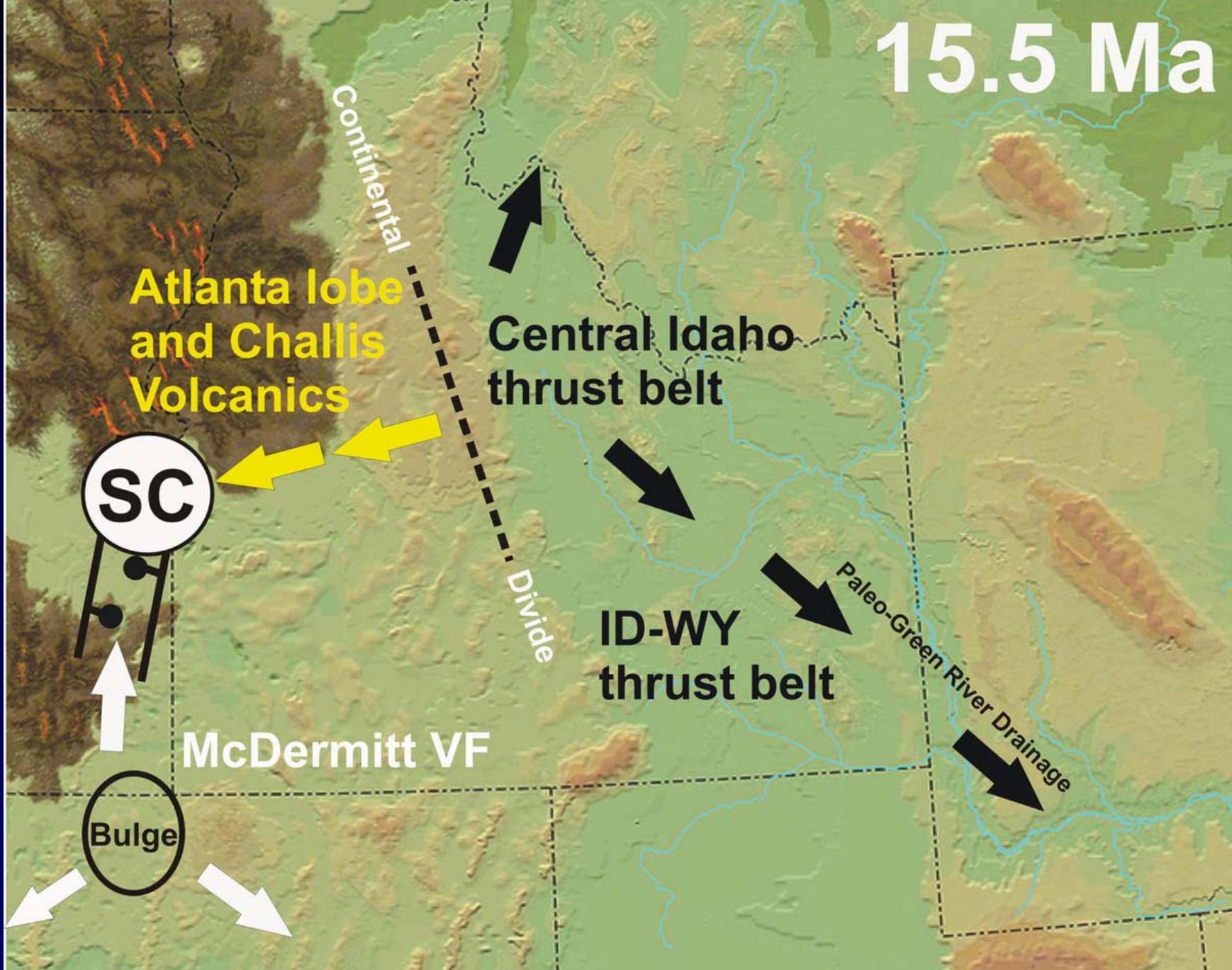
During periods of low flow, in the winter and spring, strong winds blew the silt eastward forming loess deposits. This loess is now the rich soil that grows the "Famous Potatoes" of Idaho.



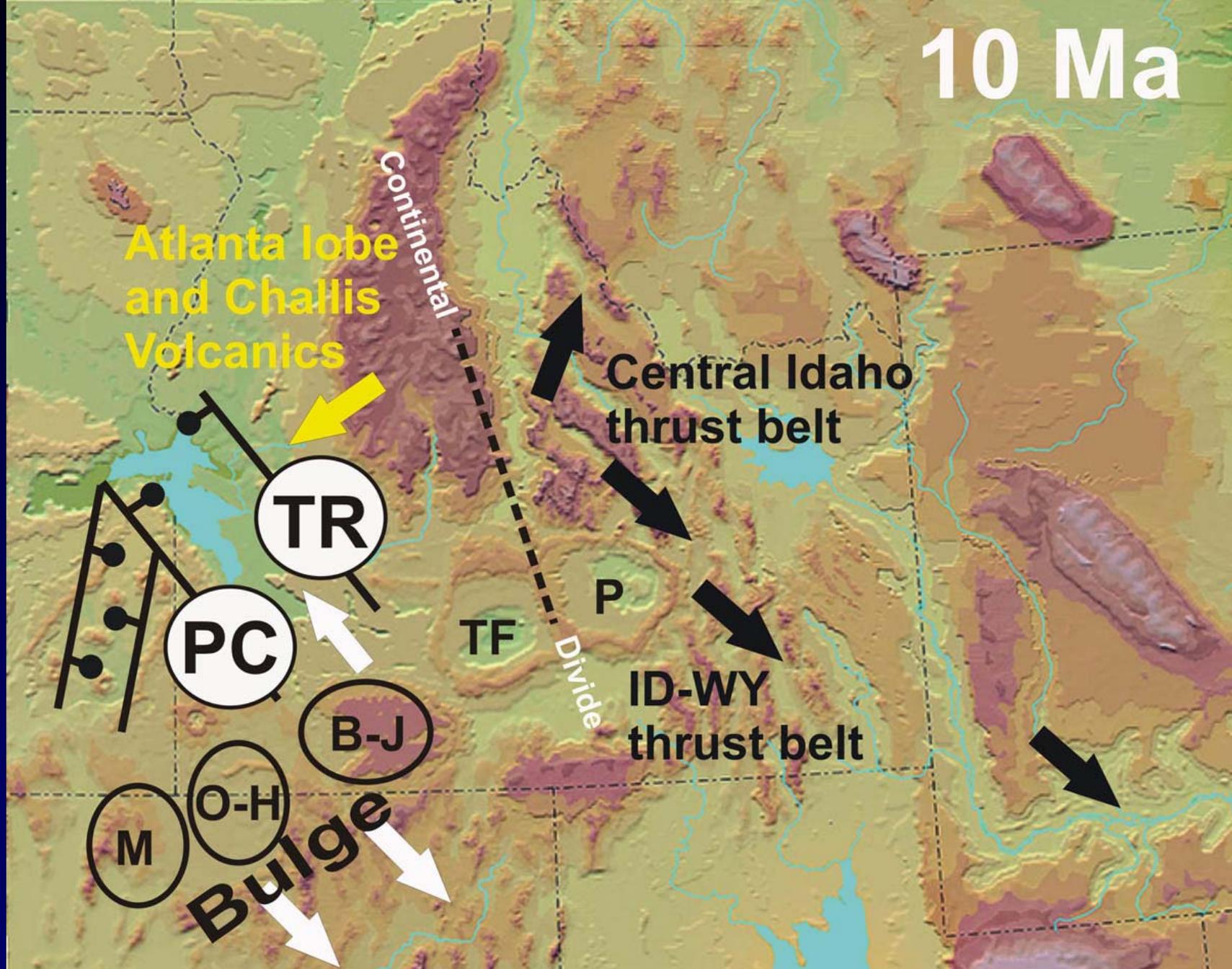
Current drainage



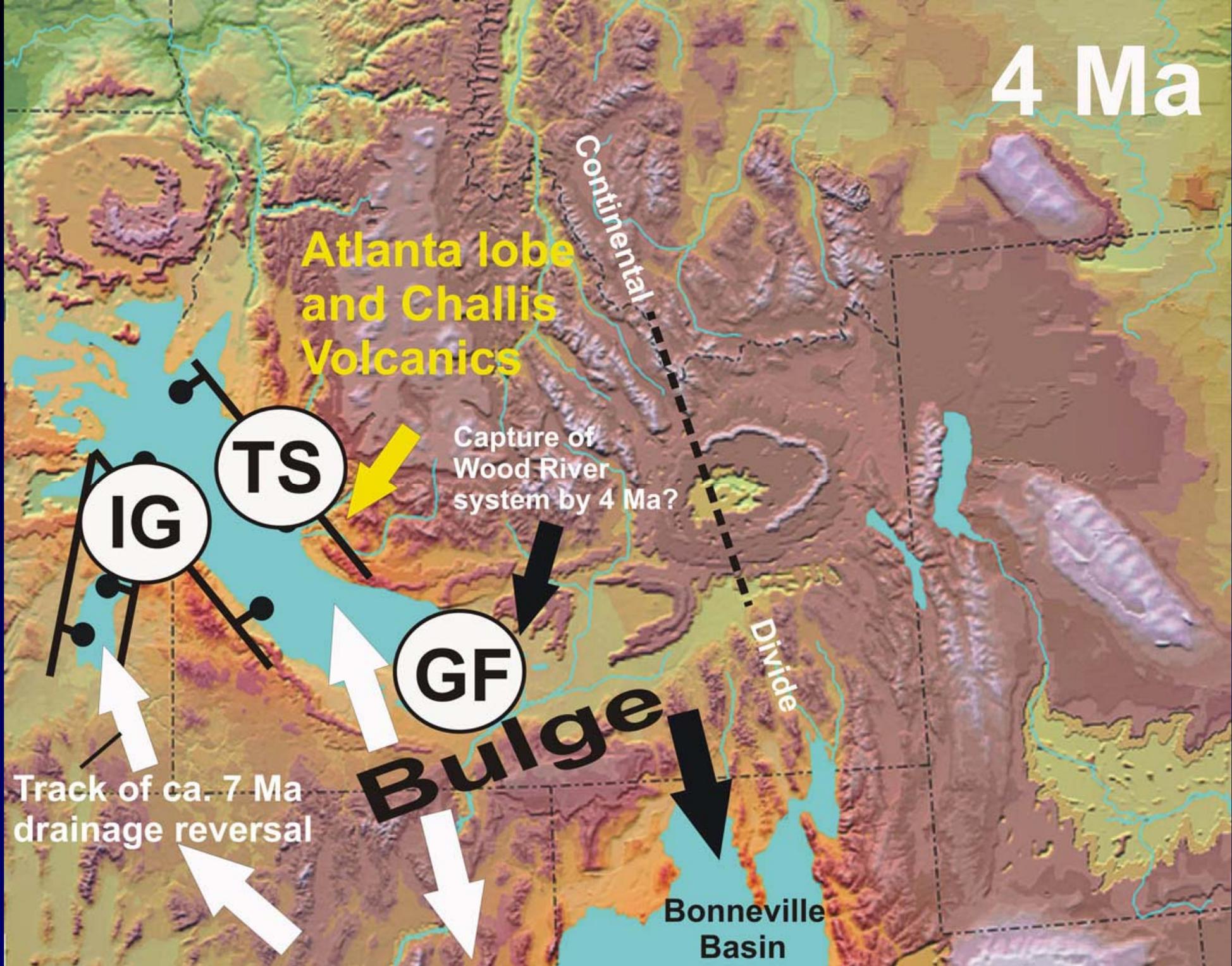
15.5 Ma



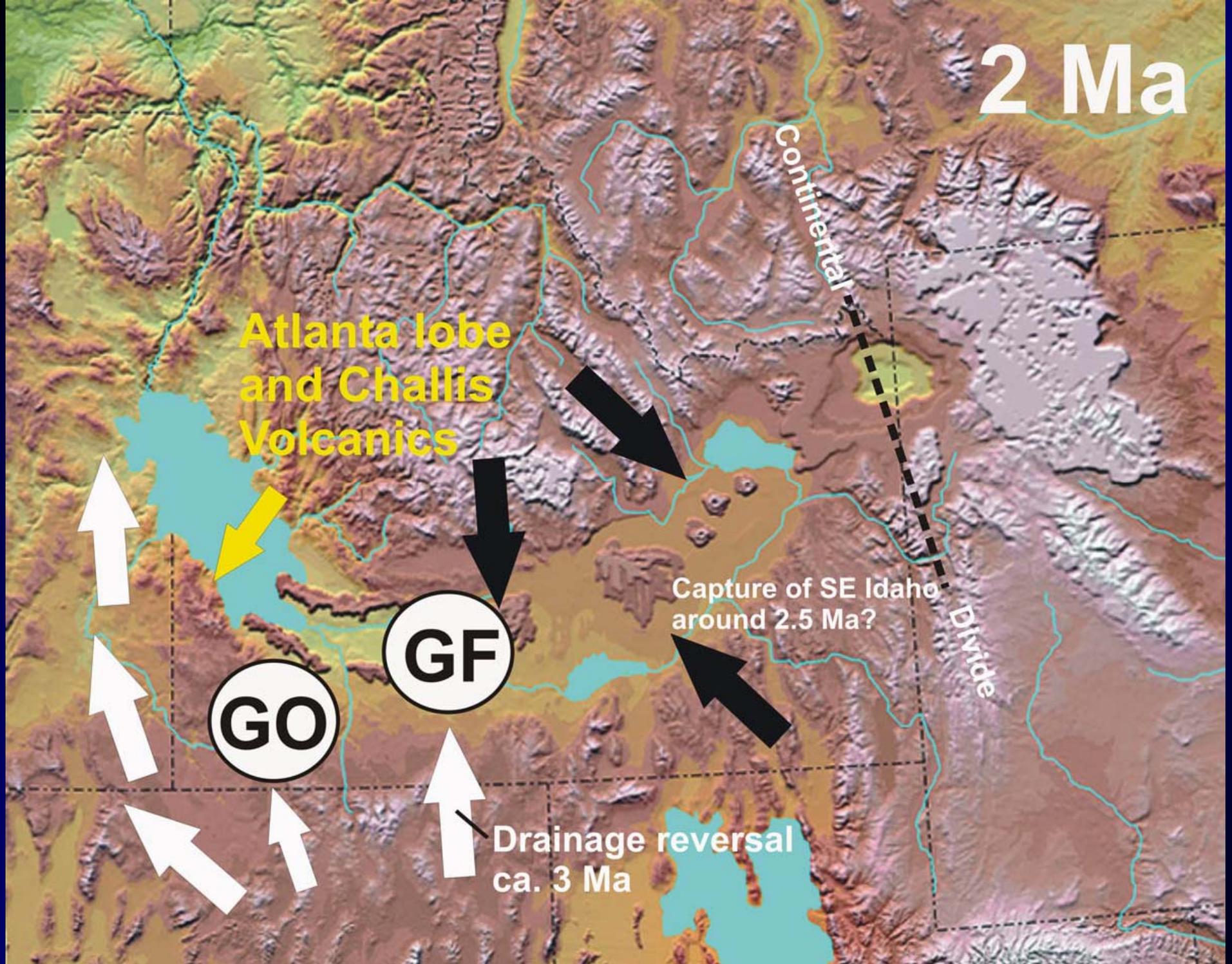
SC=Succor Creek Formation detrital zircon sample, from Beranek et al., 2006, GSA Bulletin



Western Snake River Plain reconstruction (by Luke Beranek) M=McDermott; O-H=Owyhee=Humboldt; B-J=Bruneau-Jarbidge; TF=Twin Falls; P=Picabon; PC=Poison Creek Fm. TR=Table Rock Sandstone



IG=Idaho Group; TS=Terteling Springs Fm.; GF=Glenns Ferry Fm



GO= Glenns Ferry at Oreana GF=Glenns Ferry Formation at Hagerman