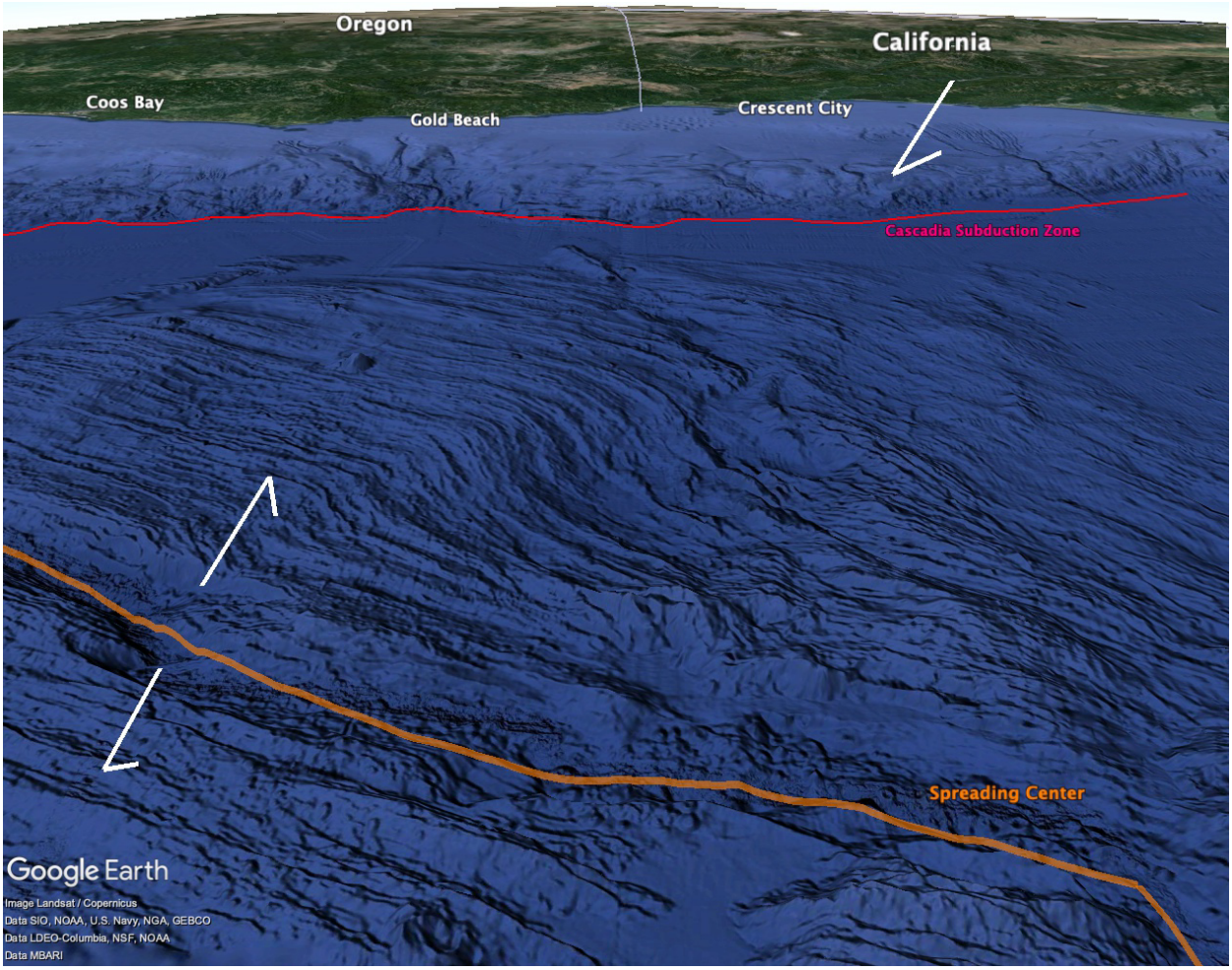
Geology Rocks Cycle Oregon 2024

Collision and Fire

The geology of the 2024 Rally route is fairly simple, with two main types of rock present; Columbia River Flood Basalt, and the Wallowa exotic terrane. However, each of these has an amazing story, recording truly dramatic and unique events in geologic history. Each is the result of plate tectonics, the movement of continent-sized pieces of the earth's crust as they slowly slide across the surface of the planet.

For hundreds of millions of years, the Pacific Northwest and Oregon have been an active part of the planetary plate tectonic machine, which is driven by vast slow currents in the soft hot rock of the earth's mantle that push thin plates of rigid crust around the face of the globe. The crust beneath the earth's oceans is split by long chains of underwater volcanic mountains that encircle the globe. At their crest is a spreading center, a crack in the crust thousands of miles long that periodically opens, allowing magma to erupt, building new oceanic crust. The newly formed crust is pushed away from the fissure as more magma erupts, forming slow conveyor belts of crust that move away the spreading center at a pace of a few inches a year. The moving oceanic plates eventually collide with a continental plate, and the denser oceanic crust slides beneath the edge of the continent and slowly sinks back into the hot mantle of the earth where it is consumed. Normally, the oceanic plate slides smoothly beneath the edge of the continent, and literally thousands of miles of oceanic crust have disappeared down the subduction zone in the Pacific Northwest.

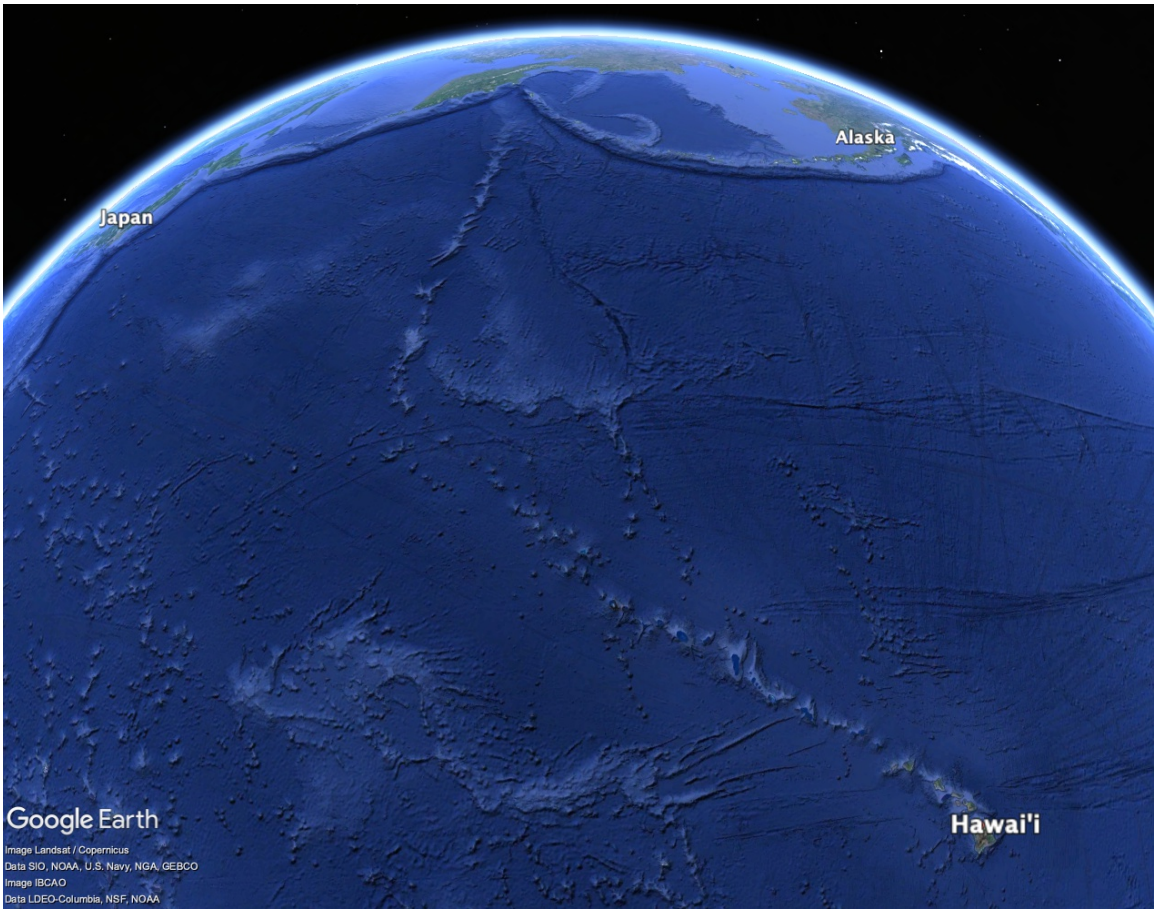


3D view of the SW Oregon-NW California Coast. The trough on the seafloor in the foreground is a spreading center, where volcanic eruptions create new oceanic crust which moves we3st into the Pacific and east towards the coast. The sharp transition from the flat ocean floor to the broad shelf of shallow water on the edge of the continent is the subduction zone, where oceanic crust slides under the continent and sinks into the mantle.

Sometimes, there is a body of rock, perhaps a volcanic island chain like Hawaii or Japan, being rafted along with the moving ocean crust that is too thick or too light to be subducted, and instead is scaped off the oceanic plate and smeared on to the edge of the continent in a process called accretion. These accreted chunks are called exotic terranes, because they formed far from their current location in Oregon and have been transported hundreds of miles to come to rest here, plastered onto the edge of the continent. Nearly twenty of these exotic fragments make up the deeper layers of rock beneath all of Oregon, and the Wallowa Mountains are largely made up of rocks of the Wallowa Terrane. We don't know how far the Wallowa Terrane traveled to reach NE Oregon, but it contains the fossils of corals that lived in the tropics nearly 300 million years ago, so it must have travelled a very long way.

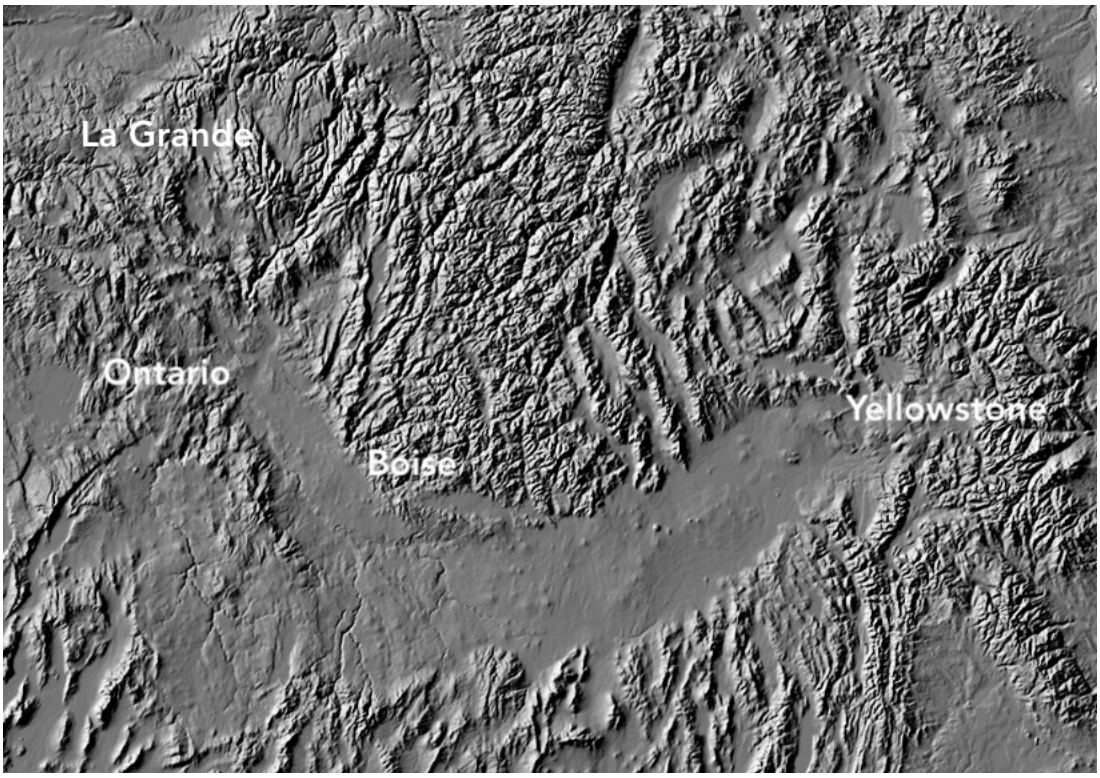
The Rally route won't take you across any of the Wallowa Terrane, but you will see it in the western skyline for much of the ride. The rocks you will be riding over are Columbia River Basalt, the result of

a very different part of the global plate tectonic machine. Driven by the extreme heat near the core of the earth, narrow plumes of hot rock rise rapidly through the mantle to reach the base of the crust, triggering intense volcanic activity over relatively small areas. These are called hot spots, and because they are fixed in the earth's mantle, they appear to move over time as the crust moves past them, leaving a trail of volcanos. One famous example is the Hawaiian islands, which are the youngest in a chain of successively older submarine volcanos that extends for 6,000 miles across the Pacific Ocean floor, marking out the path of the plate as it slides over the hotspot.



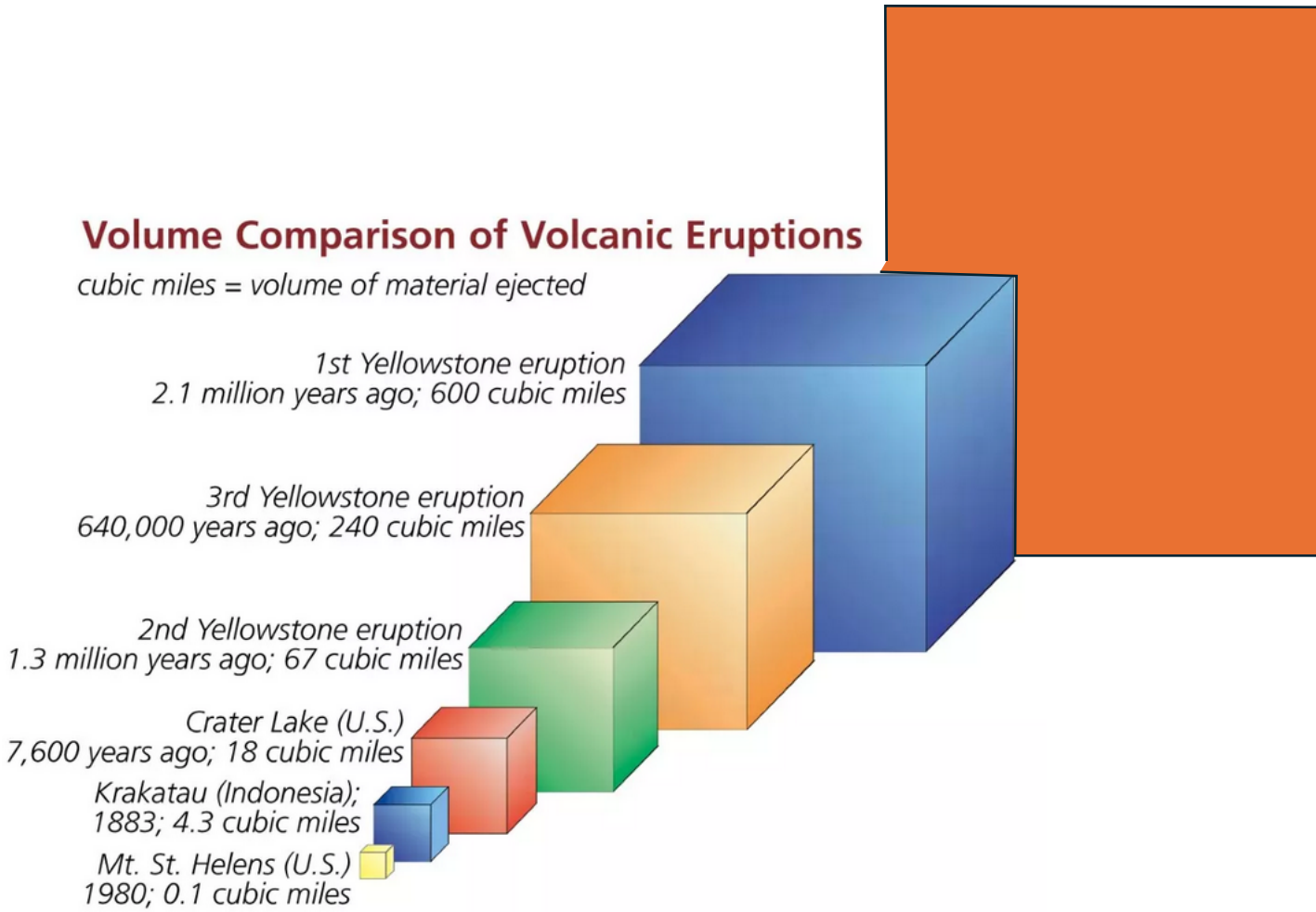
The Hawaiian hotspot track is a chain of undersea volcanoes that extends from Hawaii to Alaska, formed as the Pacific plate drifted over a hotspot. The abrupt changes in direction marks a shift in plate motion millions of years ago. The dark line marking the northern edge of the Pacific is a continuation of the subduction zone in Oregon.

Today Yellowstone National Park and the giant volcanic crater at its center sit on top of the Yellowstone hotspot. If you look a topographic map of the western US, you can see the track the hotspot has created across southern Idaho as the North American plate moves towards the west above the hotspot.



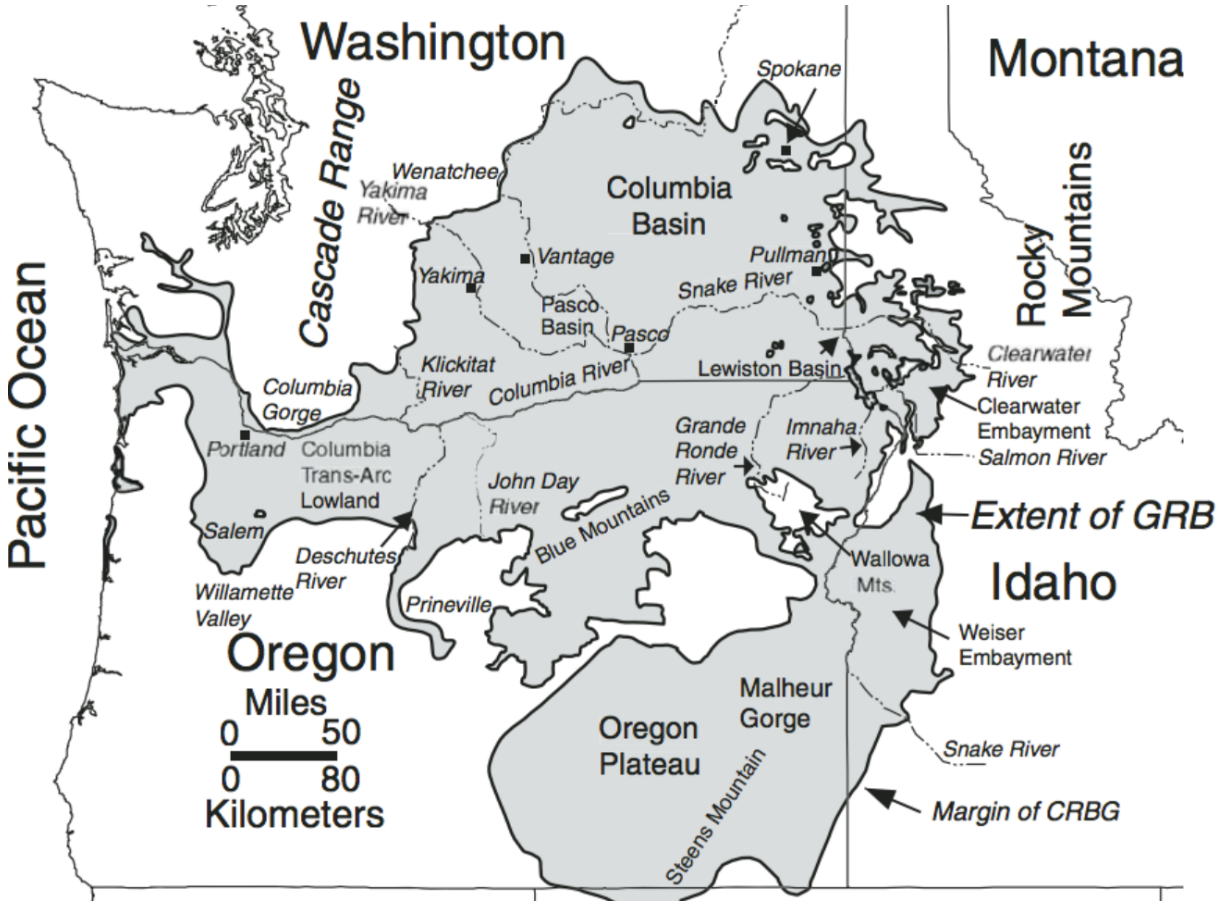
Topographic image of the western US from eastern Oregon to Montana. The broad flat path that cuts in an arc through the mountainous terrain is the track of the Yellowstone hotspot.

This track is marked by a series of successively older volcanic eruptions that lead back to the SE corner of Oregon, which is where the hotspot first reached the surface of the earth 16 million years ago. The arrival of the hotspot was marked by an extraordinary volcanic event, the eruption of the Columbia River Flood basalt. Yellowstone itself is a supervolcano, a caldera 50 miles long and 30 miles wide, that has had huge eruptions, the largest of which was 600 cubic miles of lava and ash. In contrast, the Columbia River basalt erupted nearly 300 lava flows that add up to 50,000 cubic miles covering nearly half of both eastern Oregon and Eastern Washington. The flows erupted from an area near the Oregon-Idaho border, and 20 of them traveled 300-350 miles to reach the pacific. Some individual flows covered as much as 25,000 square miles with a layer of lava 100 feet thick, a quarter of the area of Oregon. It is hard to imagine what the vents for these enormous flows looked like, but we know that they did not come out of typical volcanoes, or craters, but instead erupted from fissures in the earth. The recent basalt eruptions in Iceland give us a little glimpse of what it might have been like. Much of that lava erupted from a fissure 2.5 miles long sending lava fountaining in the air as high as 200 feet for a few days. The Columbia River Basalt erupted from multiple fissures 50 miles long, sending lava thousands of feet into the air for weeks.



Volume comparison of global volcanic eruptions.

The large orange square represents a fraction of the volume of the Columbia River Flood Basalts, which totaled 50,000 cubic miles.



The shaded area shows the extent of the Columbia River Flood Basalts

2024 Basalt fissure eruption in Iceland. Columbia River Basalt eruptions looked like this except hundreds of times larger.

Most of the basalt was erupted in the span of a million years, an incredibly short time for such a huge amount of lava. For much of this time, most of eastern Oregon and Washington would have been a flat featureless plain of black lava, devoid of vegetation, soil or water. In the millions of years since the eruptions, tectonic forces, rivers and glaciers have broken and shaped the thick lava layers into the dramatic scenery along the Rally route.