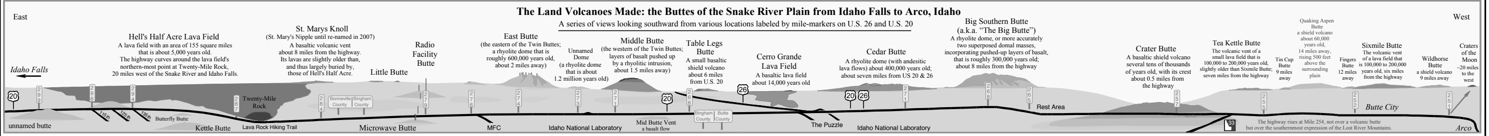
The Land Volcanoes Made: the Buttes of the Snake River Plain from Idaho Falls to Arco, Idaho

A series of views looking southward from various locations labeled by mile-markers on U.S. 26 and U.S. 20



The sketch above is not a panorama but a series of views from different points along US Highways 20 and 26 between Idaho Falls and Arco in eastern Idaho. The views are keyed to mile markers so that landscape features are each seen on lines perpendicular to the highway. Mile markers have the peculiarity that the highway east of The Puzzle is numbered in US 20 miles but the highway west of The Puzzle is numbered in US 26 miles, resulting in an overlap of numbers near The Puzzle. Curves in the highway dictate that mile markers are not spaced evenly in this document.

The landscape south of US Highways 20 and 26 from Idaho Falls to Arco is a sampler of **volcanic features**, from flat lava flows to gently peaked shield volcanoes to sharply upright volcanic domes. It is the result of volcanic eruptions over the last million years, and as recently as 5,000 years ago, a blink of an eye in geologic time.

A butte ("byoot") is an isolated hill, typically with steep sides and commonly with a relatively flat top. A butte can thus consist of any geological material, but all of the buttes shown on this document are volcanic features. They rise from a vast plain of basalt, a common volcanic rock, that has been erupted here over the last 4 to 5 million years. The unnamed butte at Mile 299 provides travelers with a close look at the vent at the top of a volcanic butte, as does Microwave Butte at Miles 279-280.

Igneous rocks are the rocks that form from magma (molten mineral material), and **volcanic rocks** are the igneous rocks that form when magma rises from Earth's interior all the way to the surface. Magmas have a spectrum of chemical compositions that range from rich in magnesium and iron ("mafic" is the made-up word for them) to rich in silicon and aluminum ("sialic" is the made-up word for them). This chemical distinction leads to two things that one can see from miles away. First, abundant silicon makes a magma viscous, so that it does not flow across the landscape and instead piles up in a dome, whereas a mafic magma (with less silicon) will flow for miles and miles to make a flat lava field or a low-lying shield volcano. Second, the iron of mafic magmas makes the resulting rocks (basalts) black in color, whereas the lack of iron in sialic magmas makes the resulting rocks (rhyolites) white. Thus one looks across the Snake River Plain and sees light-gray domes of sialic rhyolite like the Big Southern Butte and East Butte, and sees broad flat expanses of mafic black basalt like the Hell's Half Acre Lava Field. Less apparent is that the entire plain consists of older basalt that is commonly covered with lighter-colored wind-blown dust and/or with a coating of white caliche, a secondary surficial coating of calcium carbonate common in dry environments.

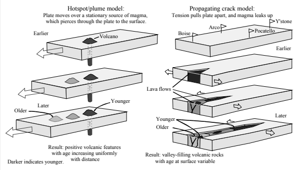
The difference between viscous rhyolitic magma and flowing basaltic magma means that the eye is impressed with **rhyolitic domes** and misses **basaltic lava fields** that have an equally large or even larger area. For example, the Big Southern Butte has a footprint of about 10 square miles. Sixmile Butte, which looks much more modest, produced a lava field with a larger area, of at least 12 square miles. Even larger, Crater Butte (over which most people drive without noticing) has a lava field with an area of at least 50 square miles. Thus the Big Butte might better be called Tall Butte or Steep Butte, in deference to the basaltic buttes from which much more lava has poured much more frequently to cover a much larger area.

The Big Southern Butte is easily the most prominent of the buttes of the Snake River Plain. It rises to 7548 feet (2300 m) above sea level, and thus about 2400 feet (730 m) above the Snake River Plain, with slopes exceeding 30° on its sides. Clouds sometimes cover its upper reaches when the surrounding plain is clear. The Bureau of Land Management says the Big Southern Butte is "one of the largest volcanic domes in the world", and the butte gives Butte County its name.

The Big Southern Butte is locally called just "the Big Butte". However, there is also a "Big Butte" near Grangeville in Idaho County, Idaho, and so distinction between the two is needed. One might ask why the one at Grangeville wasn't called "northern", and the butte here would more logically be called the "Southern Big Butte" – but it is formally named the Big Southern Butte.

Crater Butte is a shield volcano covering more than 50 square miles and reaching an elevation of 5567 feet above sea level. A 100-foot deep crater at the top of Crater Butte gives it its name, but that crater is inaccessible to visitors because it is in the restricted area of the Idaho National Laboratory. Crater Butte is sufficiently high that, from the highest point that Highways 20 and 26 reach on its flank, the Tetons can be seen on the eastern horizon on clear mornings. It is also high enough to be seen in the far west in the view in the panel above this one.

All of the rocks and geologic features in the Snake River Plain are remarkably young by geological standards: hardly anything seen at the surface is more than a million years old. For comparison, the rocks in the Lost River, Lemhi, Beaverhead, and Bitterroot Mountains visible to the north are largely hundreds of millions of years old, and the mountain ranges into which they are arranged today are several million years old. Earth itself is four and a half *billion* years old.

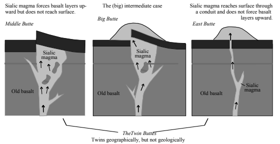


The volcanic rocks of the Snake River Plain and Yellowstone are often attributed to a hotspot, a plume of magma rising from within the Earth over which North America has migrated to the southwest. A simple **hotspot model** explains a series of volcanoes erupted onto the Earth surface in which the volcanoes progress from younger to older with distance from the hotspot. The Snake River Plain volcanics don't fit the model well. First, they are not volcanoes looming over southern Idaho but fill a valley a between the mountains to north and south. Second, they do not have the age progression expected of eruptions from a hotspot plume now under Yellowstone. For example, the very young volcanic rocks at Craters of the Moon, Cerro Grande, and Hell's Half Acre can't have formed from a plume of magma that has been under Yellowstone for a million years.

An alternate model is a **propagating crack:** a crack progressively opens in the crust (imagine a growing crack in your windshield), and magma leaks up in that crack to make new volcanic rock. At any one place, some leakage may continue, giving young volcanic rocks atop the old. In this model, no old volcanic rocks are found at the present site of cracking, but older volcanic rocks with younger atop them are found in the earlier-opened parts of the crack. That describes the age distribution of the volcanic rocks in the Snake River Plain well.

The two models are not mutually exclusive. Opening of a crack, and the resultant release of pressure and heat deep in the Earth, *might* encourage upwelling of a new plume of magma from far below in the Earth, a plume that would then be stationary as the cracking plate moves over it. Alternately, passage of plate over a plume *might* weaken the plate enough that it could be pulled apart to yield a propagating crack.

A continuum of processes in the origin of the three most recognizable buttes:



The Big Southern Butte is clearly exceptional in terms of size, but it is intermediate between the **East Butte** and **Middle Butte** in terms of its mode of formation. The Middle Butte, at one end of the spectrum, appears to have been pushed up by an underlying mass of rhyolitic magma, but that magma never came to the surface – instead, the overlying layers of basalt of the Snake River Plain were popped upward. In the middle of the spectrum, the Big Southern Butte began to form as a mass of rhyolitic magma moved up and similarly forced up the overlying basalt, but later even more magma came up and through to make the big rhyolitic dome. At the other end of the spectrum, the East Butte formed as rhyolitic magma erupted directly to the surface, without popping up the basalt layers at all. The same appears to be true for the Unnamed Dome too.

Out of this emerges the thought that the Twin Buttes are far from being identical twins – in fact, they're opposite twins.

The buttes of the Snake River Plain are not only geological anomalies – they are also **ecological anomalies.** Because the buttes sit higher and because their northern slopes are heated less by the sun, their northern sides provide a slightly more moist environment for plants and thus a more favorable habitat for animal wildlife. The very name of Quaking Aspen Butte is an expression of this phenomenon as it rises from the sagebrush steppe of the plain. Chokecherries and wild berries cccur on the northern sides of the buttes, and trees are found on the northern sides of the larger buttes. The Big Butte has been characterized as an "ecological island" for hosting lodgepole pine, aspen, Douglas fir, and manzanita.

The Big Butte catches enough precipitation that springs on its northern slopes were one of the places that pioneers on the Oregon Trail stopped to water their horses and livestock as they made their way west in the 1800s.

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The names of buttes and domes used above are from the publications listed here and from other US Geological Survey maps.