When Hotspots Coincide With Spreading Centers – Tutorial Script

When oceanic plates move over hotspots, magma supply is high enough for lavas to pile up faster than plate movement and volcanoes rise up above sea level to create islands. Eventually the plate moves the volcanic island away from the hotspot. The volcano goes extinct; the island erodes and ends up below sea level as a seamount. A new volcano and island forms at the section of plate now over the hotspot.

When divergent plate boundaries produce volcanic activity at seafloor spreading centers, magma supply is much lower than for hotspots. Spreading is usually much faster than the eruption of lavas, so before lavas can pile up to create volcanoes, they are split and spread apart. Volcanoes rarely form here.

What happens when hotspots coincide with seafloor spreading centers? Because of the much larger magma supply associated with hotspot eruptions compared to normal divergent plate boundary volcanism, lavas can accumulate faster than spreading occurs and pile up above sea level to create islands. Instead of a single chain of volcanoes, we get two chains or ridges that spread away from each other. We see this today on the island of Iceland, which is getting continually wider and connects two ridges that are gradually older and older the further away they have traveled from their formation at the hotspot. The oldest rocks produced by this coincident hotspot and spreading center are about 60 million years old and mark the opening of the North Atlantic Ocean.

If you look more closely at the northern mid-Atlanic ridge system and the current spot of active volcanism in Iceland, you can see that the main spreading center has shifted west relative to the hotspot, which itself is mostly fixed relative to plate motion. The two are still close enough together, however, for the hotspot to pull the spreading center eastwards at the Iceland latitude. However, if the spreading center keeps moving westward, eventually these two systems will separate, and the ridge will return to a more western location, while the eastern plate – the European plate – will continue moving over the Iceland hotspot and create a single chain of islands much like the Hawaiian Islands in the middle of the Pacific Plate.

The Galapágos Islands in the Pacific Ocean are a set of hotspot-produced islands where we see this transition has already happened. Note how close these islands are to the Galapágos Spreading Center. At one point in the past, the Galapágos spreading center was above the hotspot. These two symmetrical ridges are the remnants of that old coincidence. Geologists think the Galapágos hotspot itself could be as old as 90 million years and remnants of that volcanism have long since been subducted or accreted to the edges of the continents. About 5 million years ago, the spreading center migrated northwards of the hotspot, and the two separated. The current Galapágos Islands are now the nonsymmetrical chain of volcanism that results from the movement of one plate across the Galapágos Hotspot with the oldest volcanoes furthest away and the islands there extinct and eroding, and the active volcanism most directly over the current hotspot location.

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*Iceland and Greenland Bathymetry and Topogaphy: IDOP

*Iceland Earthquake Map: Páll Einarsson Institute of Earth Sciences, University of Iceland JÖKULL No. 58, 2008 (Data from USGS)
*Galapagos Spreading Center and Ridges:
http://www.geo.cornell.edu/geology/GalapagosWWW/GalapagosGeology.html
*Galapagos Islands Map with Ages: Galapagos Geomorphology: A Walk Through the Islands, Bill White and Bree Burdick