Evidence found of ultralow-velocity zone possibly feeding Icelandic plume

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Iceland. Credit: Jeff Schmaltz, MODIS Rapid Response Team, NASA/GSFC

(Phys.org)—A pair of researchers with the Berkeley Seismological

Laboratory in California has found possible evidence of an ultralow-velocity zone (ULVZ) feeding the Icelandic plume. In their paper published in the journal *Science*, Kaiqing Yuan and Barbara Romanowicz describe using earthquake data to gain a better perspective on the ULVZ and its possible role in the development of Iceland and parts of Norway and Scotland.

ULVZs were first discovered in 1996, and ever since, then they have been a subject of study by seismologists around the world. While it is still not clear exactly what they are made of, prior research showed that they are "blobs" of material that sit at the top of the border between the core and the mantle. Currently, it is believed that there are somewhere between 10 and 20 of them, and each is composed of different materials—researchers found this out by noting that seismic waves travel through them approximately 30 percent more slowly than other parts of the mantle. Because the ULVZs are approximately 2,800 km beneath the surface, learning more about them is difficult. In this new effort, the researchers focused their attention on one particular ULVZ—the one that sits directly below Iceland.

To learn more about the object of their interest, the team used seismic tomography, an imaging technique—it involves measuring the earthquake-generated waves that move through the Earth. By looking at waves moving through the ULVZ at different angles, they determined its size and form—they report it to be roughly cylindrical, approximately 15 km in height, and 880 km in diameter. They also report that the ULVZ is situated directly below the Icelandic plume, which they note offers strong evidence that the plume is fed by the ULVZ.

The researchers also suggest their imaging efforts offer a hint that the material that makes up the ULVZ is likely molten (because of its shape) rather than rock, which, they note, would likely be more irregular. They add that they believe pictures of all of the ULVZs will improve over

time as more powerful computers are used, which should give more evidence of their actual makeup.

More information: Kaiqing Yuan et al. Seismic evidence for partial melting at the root of major hot spot plumes, *Science* (2017). DOI: 10.1126/science.aan0760

Abstract

Ultralow-velocity zones are localized regions of extreme material properties detected seismologically at the base of Earth's mantle. Their nature and role in mantle dynamics are poorly understood. We used shear waves diffracted at the core-mantle boundary to illuminate the root of the Iceland plume from different directions. Through waveform modeling, we detected a large ultralow-velocity zone and constrained its shape to be axisymmetric to a very good first order. We thus attribute it to partial melting of a locally thickened, denser- and hotter-than-average layer, reflecting dynamics and elevated temperatures within the plume root. Such structures are few and far apart, and they may be characteristic of the roots of some of the broad mantle plumes tomographically imaged within the large low-shear-velocity provinces in the lower mantle.