

# Puzzling features deep in Earth's interior illuminated by high resolution imaging

May 19 2022

---



Credit: CC0 Public Domain

New research led by the University of Cambridge is the first to take a detailed image of an unusual pocket of rock at the boundary layer with Earth's core, some three thousand kilometers beneath the surface.

The enigmatic area of rock, which is located almost directly beneath the Hawaiian Islands, is one of several ultra-low velocity zones—so-called because [earthquake waves](#) slow to a crawl as they pass through them.

The research, published today in *Nature Communications*, is the first to reveal the complex internal variability of one of these pockets in detail, shedding light on the landscape of Earth's deep interior and the processes operating within it.

"Of all Earth's deep interior features, these are the most fascinating and complex. We've now got the first solid evidence to show their internal structure—it's a real milestone in deep earth seismology," said lead author Zhi Li, Ph.D. student at Cambridge's Department of Earth Sciences.

Earth's interior is layered like an onion: at the center sits the iron-nickel core, surrounded by a thick layer known as the mantle, and on top of that a thin outer shell—the crust we live on. Although the mantle is [solid rock](#), it is hot enough to flow extremely slowly. These internal convection currents feed heat to the [surface](#), driving the movement of tectonic plates and fuelling volcanic eruptions.

Scientists use seismic waves from earthquakes to see beneath Earth's surface—the echoes and shadows of these waves revealing radar-like images of deep interior topography. But until recently, images of the structures at the core-mantle boundary, an area of key interest for studying our planet's internal heat flow, have been grainy and difficult to interpret.

The researchers used the latest numerical modeling methods to reveal kilometer-scale structures at the core-mantle boundary. According to co-author Dr. Kuangdai Leng, who developed the methods while at the University of Oxford, "We are really pushing the limits of modern high-

performance computing for elastodynamic simulations, taking advantage of wave symmetries unnoticed or unused before." Leng, who is currently based at the Science and Technology Facilities Council, said that this means they can improve the resolution of the images by an order of magnitude compared to previous work.

They observed a 40% reduction in the speed of seismic waves traveling at the base of the ultra-low velocity zone beneath Hawaii. According to the authors, this supports existing proposals that the zone contains much more iron than the surrounding rocks—meaning it is denser and more sluggish. "It's possible that this iron-rich material is a remnant of ancient rocks from Earth's early history or even that iron might be leaking from the core by an unknown means," said project lead, Dr. Sanne Cottaar from Cambridge Earth Sciences.

The new research could also help scientists understand what sits beneath and gives rise to volcanic chains like the Hawaiian Islands. Scientists have started to notice a correlation between the location of the descriptively-named hotspot volcanoes, which include Hawaii and Iceland, and the ultra-low velocity zones at the base of the mantle. The origin of hotspot volcanoes has been widely debated, but the most popular theory suggests that plume-like structures bring hot mantle material all the way from the core-mantle boundary to the surface.

With images of the ultra-low velocity zone beneath Hawaii now in hand, the team can also gather rare physical evidence from what is likely the root of the plume feeding Hawaii. Their observation of dense, iron-rich rock beneath Hawaii would support surface observations, "Basalts erupting from Hawaii have anomalous isotope signatures which could either point to either an early-Earth origin or core leaking, it means some of this dense material piled up at the base must be dragged to the surface," said Cottaar.

More of the core-mantle boundary now needs to be imaged to understand if all surface hotspots have a pocket of dense material at the base. Where and how the core-mantle boundary can be targeted does depend on where earthquakes occur, and where seismometers are installed to record the waves.

The team's observations add to a growing body of evidence that Earth's deep interior is just as variable as its surface. "These low velocity zones are one of the most intricate features we see at extreme depths—if we expand our search we are likely to see ever-increasing levels of complexity, both structural and chemical, at the core-mantle boundary," said Li.

They now plan to apply their techniques to enhance the resolution of imaging of other pockets at the core-[mantle](#) boundary, as well as mapping new zones. Eventually they hope to map the geological landscape across the [core-mantle boundary](#) and understand its relationship with the dynamics and evolutionary history of our planet.

**More information:** Kilometer-scale structure on the core–mantle boundary near Hawaii, *Nature Communications* (2022). [DOI: 10.1038/s41467-022-30502-5](#)

Provided by University of Cambridge

Citation: Puzzling features deep in Earth's interior illuminated by high resolution imaging (2022, May 19) retrieved 25 April 2024 from <https://phys.org/news/2022-05-puzzling-features-deep-earth-interior.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.