Earth's core seems to be surrounded by enigmatic layer, geologists say

Jagged region sits at boundary between liquid and solid rock and might be remnants of ancient seafloor

By Carolyn Y. Johnson at The Washington Post, April 10, 2023

Earth, in a NASA and NOAA Suomi NPP satellite image. (Robert Simmon/Robert Simmon / NASA Earth Observatory)

For decades, scientists have debated the nature and origin of what some experts consider the most anomalous and enigmatic layer of Earth's deep interior: the boundary between its scorching-hot liquid outer core and the solid mantle that surrounds it.

New measurements from 15 seismic stations buried in the snow across Antarctica have revealed that this weird boundary layer, nearly 2,000 miles deep, may have once been part of the surface. The evidence suggests that at subduction zones, where one tectonic plate dives beneath another, ancient ocean floor gets thrust down and drops to the bottom of the mantle over hundreds of millions of years.

The findings, published in the journal Science Advances, provide a glimpse into the geologic cycling fueled by tectonic plates. They also offer new clues to the way heat moves through Earth's many layers.

Understanding this planetary churn is an existential pursuit: Heat radiating from the planet's solid metal core drives the motion of fluid in the outer core, which is thought to generate the protective magnetic field that makes life possible on the surface.

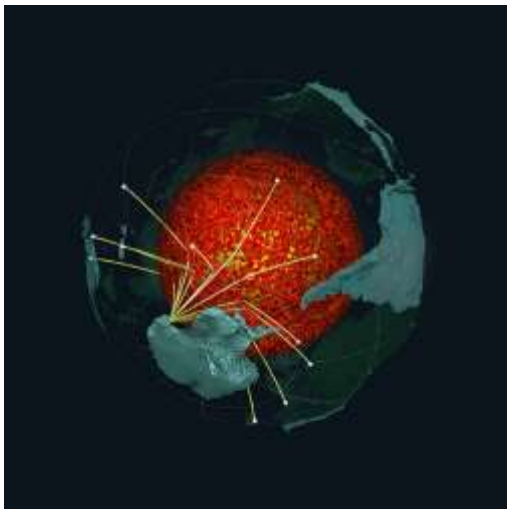
Scientists have discovered a new core at the center of the Earth
https://www.washingtonpost.com/climate-environment/2023/02/24/new-earth-inner-core-layer-metallic-ball/

But the results also showcase the difficulty of providing any firm descriptions of Earth's inaccessible innards. The scientists are quick to hedge their conclusions as a likely possibility, not a final conclusion. And basic questions remain: The boundary could be patchy, with bits of oceanic floor, or it could be a continuous layer of variable thickness enveloping the core.

"For a long time there was debate in the scientific community about whether subducting slabs could make it all the way down to the core-mantle boundary," said Elizabeth Day, a seismologist at Imperial College London who was not involved in the study, though she noted most experts now think at least some slabs can drop down that far.

"Given how complicated the surface of our planet is," she added, "it feels very reasonable for there to be a lot of complexity at the core-mantle boundary."

Hot, rocky Jell-O?



An illustration shows how the jagged layer along Earth's core-mantle boundary interacted with seismic waves from earthquakes that struck in various spots around the Southern Hemisphere. Those waves were then recorded by sensors in Antarctica. (Drs. Edward Garnero and Mingming Li/Arizona State University)

Most people give little thought to Earth's deep interior, thinking of our home planet as simple nested layers, like a jawbreaker hard candy. But Samantha Hansen, a seismologist at the University of Alabama who led the work, described the abrupt transition between the liquid outer core and the mantle as more pronounced than the difference between solid rock and air.

She suggested thinking about this subterranean boundary zone as a geological aspic.
"It's kind of a hard thing to visualize," Hansen said. "You have this very dense, very anomalous structure with this other stuff filling in the gaps around it, if you will. Think of it like things stuck in Jell-O, maybe."
Because the depths of the planet are off-limits for direct exploration, scientists measure how seismic waves generated by earthquakes propagate through the interior. When those waves meet this boundary layer — formally known as ultra low velocity zones — they bounce around and get deflected in ways that allow geoscientists to model the structure.

Hansen and colleagues made multiple trips to Antarctica between 2012 and 2015 to dig holes in the snow and plant seismic monitoring stations, then returned to gather data. Their primary goal was to study a poorly understood mountain range that crosses the continent, the Transantarctic Mountains. But they realized that their instruments also gave them a way to scan portions of the deep interior under the Southern Hemisphere.
What they found was a thin but dense layer between the core and the mantle that ranged in thickness from three to 25 miles.
"That's five times the size of Mount Everest," Hansen said. Earth's tallest peak was most recently measured at 29,031 feet, or almost 5.5 miles. "You have this dramatic topography, some being lower and some very high." That jagged structure, coupled with geologic models, suggests that the layer is made up of subducted seafloor, the paper's authors conclude.

John Vidale, a seismologist at the University of Southern California who was not involved in the work, said he wasn't fully persuaded by the findings, pointing out that there remain many possible explanations for what is going on at the boundary between the mantle and the core.
"The core-mantle boundary is one of the more dynamic parts of the planet. … We just don't know what's happening," Vidale said.

Scientists place seismic equipment at one of the Antarctic research stations in 2012. (Lindsey Kenyon)

The hope is that understanding the structure of this boundary zone will help shed light on other mysteries: How does the core radiate heat outward to the mantle? Do the ancient ocean floors get recycled once again, swept up in mantle plumes like the one underneath Hawaii and turned back into surface material through volcanic eruptions?

Even though Earth has been around 4.5 billion years, and geology is not a new field, our understanding of the planet's innards is still immature, Hansen said. Fundamental questions are still out there, and scientists are eager to find answers.

"I think there's still a whole lot more we don't know, and a lot to be learned," Hansen said. "It's neat that we don't know a lot about the planet we live on."

By Carolyn Y. Johnson

Carolyn Johnson is a science reporter. She previously covered the business of health and the affordability of health care to consumers.

Ook heel interessant te lezen is:

The U.S. is about to open a new window into Earth's mysterious insides - The Washington Post
https://www.washingtonpost.com/science/2023/07/18/earth-layers-high-pressure-laboratory/