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GEOSCIENCE

Earth's inner core may be changing its spin and its shape

Changes to seismic waves travelling through the planet could reveal unusual activity in Earth's core

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"The research shows that, in 2010, Earth's inner core went from rotating faster than the rest of the planet, to slower"

It's not unusual for Earth's core to change its rate of rotation or even its shape over time – though, as far as scientists could tell, never simultaneously. But new research reveals that something unexpected may be happening deep beneath our feet.

Scientists have long debated the cause of strange changes to the seismic waves triggered by earthquakes when they ripple through the planet's core. One side argued the core's rotation rate delays or accelerates the travel time of the waves, while the other claimed that it's deformation of the inner core causing changes in the waves. In the new study, published in journal *Nature Geoscience*, scientists from China and the US reveal that it's likely to be both.

The research shows that, in 2010, Earth's inner core went from rotating faster than the rest of the planet, to slower. This – along with changes near the surface of the inner core – likely interrupted the seismic waves. Like X-rays as they pass through our flesh and bones, these waves allow scientists to 'see' what's happening inside the planet. The researchers think the discovery could help us unlock more information about the core's properties and structure.

"For now, these findings simply provide an observable change that might lead us to get a clearer picture of how the inner core is flexing on a timescale of years. Further surprises may await," John Emilio Vidale, a professor of Earth Sciences at the University of Southern California Dornsife, and the lead author of the study, told *BBC Science Focus*.

At around 5,200°C (close to 9,400°F) Earth's inner core is almost as hot as the surface of the Sun. It also begins roughly 5,100km (3,200 miles) beneath the planet's surface and has a higher pressure than the deepest parts of the ocean. In other words, there's no way to directly access the core and study it.

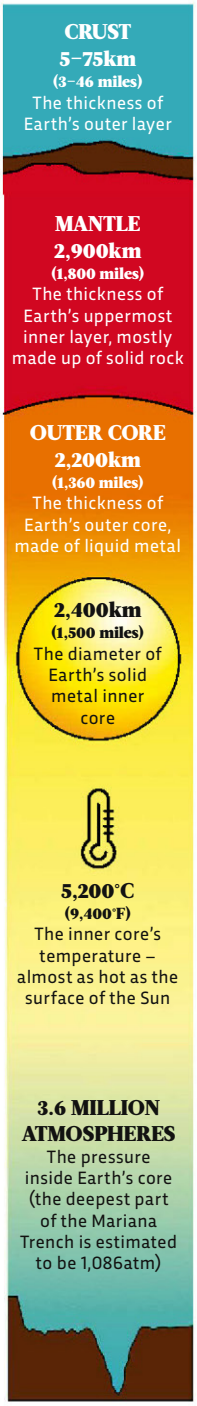
Instead, scientists study seismic waves caused by earthquakes. By examining how these waves travel through different layers of the planet, scientists can better understand the structure, movement and behaviour of the core.

In this latest set of research, the team looked at seismic waves from 121 repeating earthquakes (earthquakes that occur in the same place, but at different times) in the South Sandwich Islands between 1991 and 2023. These earthquakes were recorded at two seismic arrays: one in Eielson in Alaska, in the US, and the other in Yellowknife, in Canada.

By looking at the arrival times and changes of these seismic waves over multiple decades, the team could detect minor shifts in the core's movement. If the inner core was rotating steadily, the arrival times of the seismic waves would shift consistently over time.

The study's findings showed a few noticeable trends in Earth's inner core. It rotated faster than Earth's mantle and crust for several decades, before slowing down around 2010. But some earthquakes showed no significant time shift, suggesting that the rotation paused or reversed at times.

The study had a secondary finding: due to differences in the signals coming from the two seismic arrays, the team was able to detect that something other than rotation was affecting the inner core.



The team behind the study thinks viscous deformation near the inner-core boundary might be the culprit. Though the inner core is made of solid metal, variations in the shape of the outer core or changes in the mantle's density can change the inner core's structure.

While this behaviour is seemingly erratic, there currently isn't enough data to confirm whether this is normal or not – and therefore get a clear picture of how Earth's core is really behaving.

According to Vidale, the simplest explanation is that the outer core's movements initiate the inner core's rotation, effectively realigning the inner core over decades. The exact mechanism by which this happens is uncertain, however.

"If this was the case, the rotation of the cores would be mostly harmonic [predictable]," he said. Alternatively, "the inner core motion could be mostly chaotic, just going in the direction the outer core goes."

For now, this research remains an interesting analysis of the behaviour of Earth's core, but it could lead to more discoveries. Vidale notes that further analysis could show when and where outer core convection is most vigorous, or where the inner core is more or less soft.

He also believes there's a chance it could reveal a link between inner core changes and unpredictable jerks in Earth's magnetic field. While these don't affect our everyday lives directly, they can affect satellites and compasses.