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Not My Fault: The earth's inner core may be changing its rotation – Does it matter?

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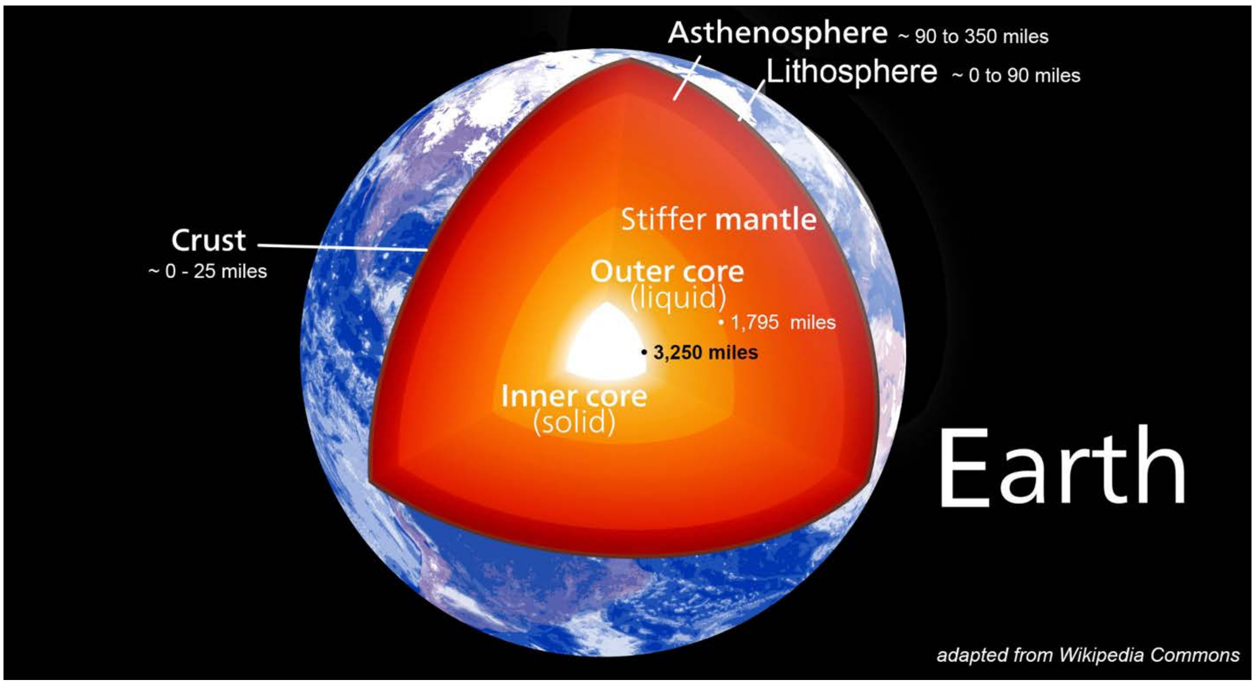

Earth structure – the crust is the top of the lithosphere, the relatively rigid outermost part of the earth overlaying the more ductile aesthenosphere, stiffer mantle, liquid outer core, and solid inner core.

Time to take a seismic pause. A recent paper in Nature Geoscience focused on the rotation of the earth's inner core. Authors Yang and Song from Peking University in Beijing argued that rotation of the innermost part of the earth, the inner core, has slowed.

I am fascinated when there is a new reveal about this mysterious part of the planet. We know more about interplanetary space than we do about the inner core. Probes have ventured throughout the solar system but the deepest we've penetrated into our own planet is less than eight miles. Everything we know about 99.9 % of the planet has to be learned indirectly.

The earth has four distinct regions, based on chemistry and physical properties. The crust is the smallest by volume, but it's what we live on and most affects human activities. About four miles thick in the ocean and up to 25 miles beneath continents, it's a marvelously diverse layer - just look at your children's rock collections.

The base of the crust is the Moho, named for Croatian seismologist Andrija Mohorovičić who used seismic waves to detect an abrupt compositional change. His paper was published nearly 123 years ago, and while we've learned far more about the crust since then, no drill hole has ever reached the Moho.

The mantle lies beneath the Moho, making up 67% of the earth's mass and 84% of its volume. We have some direct evidence of its makeup based on mantle rocks brought to the earth's surface by tectonic processes, but most of our knowledge comes from geophysical techniques.

Four years before Mohorovičić found the base of the crust, Richard Oldham published evidence that the mantle stopped abruptly about 1,800 miles beneath the surface. It was the early days of seismology but by 1906 there were seismic stations in many parts of the world and the San Francisco earthquake provided a treasure trove of data.

Oldham and others noted that seismic wave arrivals abruptly changed at a distance of about 7000 miles from the epicenter. Seismologists could track the seismic signals as they examined seismograms taken further and further from the epicenter. For large earthquakes like 1906, they were still loud and clear at stations 6000 miles distant and then abruptly vanished.

Occam's razor, attributed to the 14th-century English theologian William of Ockham, states the simplest solution to a problem is the best. In the case of the missing seismic waves, the simplest solution was a discontinuity. Oldham proposed the earth had a core and the core was fluid. P-waves and S-waves both travel through solid rock. You may have experienced these separate pulses in our recent quakes, the initial P-wave followed a few seconds later by the much stronger S-waves. S-waves only travel in solid materials. Oldham was able to find the P-waves further away from the epicenter, but the S-waves had vanished entirely.

For the next thirty years, earth scientists believed the liquid core extended to the earth's center. From gravity data they determined it was more than twice as dense as the mantle and likely composed mainly of iron. Liquid iron made sense from a magnetic perspective as well. Variations in the magnetic field were well documented and the easiest way to explain them was by movements of a fluid conductor.

In 1936 Danish seismologist Inge Lehman found the final interface. Her 1936 paper showed very weak seismic arrivals at epicentral distances beyond 7,000 miles. Lehman was a meticulous reader of seismograms, and for eight years she documented these odd arrivals. Her explanation was an interface 3,250 miles beneath the surface.

Much has been learned about the inner core since Lehman first unveiled its existence. We think it is made up of solid crystalline iron and is the result of the very slow cooling of the once entirely fluid core region. The boundary between the completely solid inner core and the fluid outer core is complex. There is no consensus on when it began to form, but published studies concur it is a relative newcomer in the planet's history, somewhere between .5 and 2 billion years old.

The new study looks at the rotation of the inner core. Our lives are controlled by the rotation of the mantle. The crust is firmly stuck to the mantle and how the mantle moves, so do we.

Contrary to our perception, the length of the day is not a constant. It varies in predictable and unpredictable ways that can be directly measured by astronomical observations.

Seasonal movement of the atmosphere causes minute annual perturbations. There are decadal and century fluctuations believed linked to coupling between the liquid outer core and the mantle. Great earthquakes can produce a small wobble. There's even a long-term gradual slowing believed to be caused by tidal friction. We've gained about two hours a day since Devonian times roughly 400 million years ago.

It's much hard to measure the rotation of the inner core. The recent study examined seismic waves that traveled directly through the center of the earth – the source is on one side of the planet and the seismic stations are on the opposite side. By tracking the travel times of seismic waves over decades, small changes can be measured.

In 1996, Song first used this method to compare the inner core rotation to that of the mantle and suggested that it was rotating more quickly than the planet as a whole. The new analysis suggests the speed has slowed, and relative to the mantle, it now lags behind us. Contrary to some media headlines, it hasn't reversed.

Yang and Song aren't the first to document variable rotation of the inner core. Last year a paper in Science Advances (Wang and Vidale) examined the seismic records from nuclear testing and found changes in the inner core rotation speeds.

The inner core is not going to affect you. Slowing doesn't mean that the planet is suddenly applying the breaks and we will all be spun off into space. The changes are part of a natural cycle of relative slowing and speeding up that reveals a little more about the delicate interconnectivity of different parts of planet earth.

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