

GEOTIMES

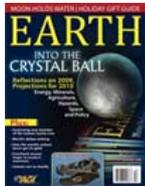
EARTH, ENERGY AND ENVIRONMENT NEWS

JUNE 2008

[SUBSCRIBE
HERE](#)

Ads by Google

- ▶ [Subscribe](#)
- ▶ [Geotimes is now EARTH](#)
- ▶ [Archives](#)
- ▶ [Classifieds](#)
- ▶ [Advertise](#)
- ▶ [Customer Service](#)
- ▶ [Geotimes Search](#)



NEWS NOTES

A slip-sliding Earth?

Plate tectonics — the idea that Earth's surface is divided into large pieces of crust that collide, pull apart or slide past each other — is now a well-accepted theory. We know that Earth moves under our feet. But another, even larger-scale mechanism may also sometimes cause the surface of the planet to move. And instead of doing it piecemeal, this mechanism may periodically prompt the planet to roll over all at once. Now, a new technique pinpoints how — and when — this may have happened in the past.

Like plate motions, the idea of such a whole-Earth shift, called true polar wander, has been around for awhile. "The whole idea of true polar wander really goes back to the beginning of plate tectonics," says John Tarduno, a geophysicist at the University of Rochester in New York.

Earth's continents are currently fairly evenly distributed across the face of the planet. But plate motions have, in the past, pushed many of the continental pieces together, forming supercontinents. When that happens, not only are the continents bunched in one place, but the density of the underlying mantle changes, due to more crust sinking into the mantle, or more volcanism.

As a result, the planet becomes weightier in one spot — and thus imbalanced. True polar wander, the idea goes, may be how Earth regains its balance: As Earth spins on its axis, the entire planet changes its orientation, rolling over like a ball, so that the density is better distributed relative to the spin. This kind of (relatively) abrupt redistribution of mass may have occurred at several times in Earth's history.

"Typically, people only said 'true polar wander' when there was a large shift that couldn't be explained by plate motion," says William Sager, a geophysicist at Texas A&M University in College Station. It was an idea that was difficult to prove, and thus not widely accepted. The idea came into a sort of renaissance in the 1990s, culminating in a 1997 study in *Science* that suggested that, due to the formation of the southern supercontinent Gondwanaland, Earth's entire surface rotated by 90 degrees — so that what had once been the North and South poles rolled around to the equator — about 550 million years ago. That huge shift, the study suggested, prompted the climatic changes that ultimately resulted in the Cambrian evolutionary "explosion" of life.

Other studies over the past decade have suggested smaller true polar wander episodes in Earth's past of 10 to 30 degrees. But distinguishing true polar wander using only paleomagnetic data — data collected from magnetized minerals in very old rocks that once aligned with Earth's magnetic field — can be difficult, because those data can be used to track both individual plate movement and movement of the entire planet. So to isolate whole-Earth motions, studies relied on hotspots such as Hawaii, which were thought to be fixed deeply in the mantle rather than moving around with the plates.

Those "pimples on the mantle" were thought to provide the fixed reference points necessary to distinguish whole-Earth motion from plate motion, says Dennis Kent, a paleomagnetist at Rutgers University in Piscataway, N.J. However, the problem with hotspots turned out to be that they are not necessarily fixed, Kent says. Although they move slower than plates do, hotspots may also move as the mantle convects, which puts a limit on how far back in time they can be used as absolute, fixed reference points. Indeed, a 2003 study in *Science* led by Tarduno found that the Hawaii hotspot moved fairly rapidly, at a clip of more than 40 millimeters per year, in the period from 81 million to 47 million years ago.

Bernhard Steinberger, a geodynamicist at the Geological Survey of Norway in Trondheim, was a co-author on that paper. He found that geodynamic models of flow within the mantle were able to trace the Hawaii hotspot's trail through the Pacific Ocean nearly as well as the paleomagnetic data.

Based on that finding, Steinberger and Trond Torsvik, a geologist also at the Geological Survey of Norway, developed a way to look for true polar wander events in Earth's past. They used hotspots to date any movements up to about 130 million years ago, but prior to that time, hotspot tracks cannot accurately reconstruct plate motions. So for the period extending from 130 million to 320 million years ago, the scientists took an "unplugged" approach, as they reported April 3 in *Nature*. With no fixed reference points, they created a complex model incorporating both paleomagnetic data and models of how plates moved relative to each other. Thus, after reconstructing how individual plates moved and rotated through that time, the researchers were able to identify episodes in which all of the continents appeared to move in unison.

Using this method, Steinberger and Torsvik tracked a steady northward movement of the tectonic plates. But that movement, they found, was also punctuated by several episodes of true polar wander, which rotated the entire planet's surface by 10 to 20 degrees each time. None of those episodes, according to the study, occurred within the last 100 million years; instead, they began at about 110 million, 145 million, 195 million and 250 million years ago.

It's "a new way to look at it," Sager says. "It's interesting and intriguing — something new to think about to stir the pot again, which is a good thing."

Although the study is comprehensive, many uncertainties remain, Kent says. For one thing, he says, some of the paleomagnetic data is problematic because of its age. Indeed, any analysis of data from so far back in time will require a number of assumptions, which suggests caution, Tarduno notes. But Steinberger and Torsvik's study provides a potential new way to pull out a possible true polar wander "signal" from the plate motion "noise," Tarduno says. "These guys have done the best they could, given the limitations of time and data."

And in fact, Kent adds, this study may help to highlight the data issue, and thus herald a new generation of paleomagnetic data collection. What it will also do, he says, is provide points of comparison for researchers to go back

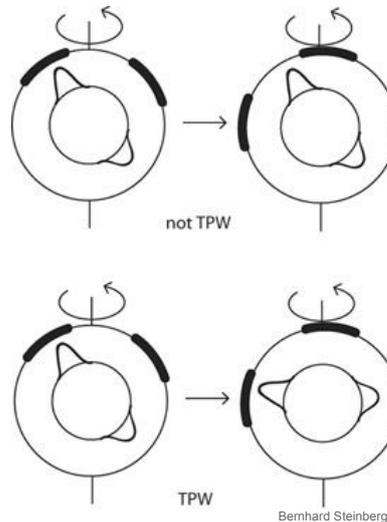


Plate tectonics (top) describes how pieces of Earth's crust slide around each other on the planet's surface. But the concept of true polar wander, or TPW (bottom), goes deeper: Occasionally, if Earth's mass becomes greatly imbalanced, the whole planet may roll over like a ball (relative to its spin axis).

[Geologynet.com](#)
Software and
Information for
Geologists
www.geologynet.com

[Global Mapper](#)
Easily Create
Strike-and-Dip
Maps Download
Your Free Demo
Today!
www.GlobalMapper.com

[Italy Seismic
Potential](#)
S1 INGV-DPC
research project
aimed at seismic
hazard
assessment
sites.google.com/site/ing

[Volcano &
Diamonds](#)
Volcanic eruption
helped bringing up
diamonds out
earth
stores.ebay.com/QualityC



and look at previous reconstructions of plate motions. "I would venture to say that this kind of analysis has taken the existing data to the limit," he says. "It's a very elegant and comprehensive analysis, but it's the end of the line — it's ultimately limited by the quality of the data."

Carolyn Gramling

Links:

[Bending thoughts about Hawaiian chain](#), *Geotimes*, March 2003

[The Hawaiian hotspot debate: an update](#), *Geotimes*, August 2003

[Back to top](#)

[Geotimes Home](#) | [AGI Home](#) | [Information Services](#) | [Geoscience Education](#) | [Public Policy](#) | [Programs](#) | [Publications](#) | [Careers](#)



© 2009 American Geological Institute. All rights reserved. Any copying, redistribution or retransmission of any of the contents of this service without the express written consent of the American Geological Institute is expressly prohibited. For all electronic copyright requests, visit: http://www.copyright.com/cc0/do/showConfigurator?WT.mc_id=PubLink

COPYRIGHT.COM
REUSE THIS CONTENT