East Antarctica is sliding sideways: Ice loss on West Antarctica affecting mantle flow below

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Image: National Science Foundation

It's official: East Antarctica is pushing West Antarctica around.

Now that West Antarctica is losing weight—that is, billions of tons of ice per year—its softer mantle rock is being nudged westward by the harder mantle beneath East Antarctica.

The discovery comes from researchers led by The Ohio State University, who have recorded GPS measurements that show West Antarctic bedrock is being pushed sideways at rates up to about twelve millimeters—about half an inch—per year. This movement is important for understanding current ice loss on the continent, and predicting future ice loss.

They reported the results on Thursday, Dec. 12 at the American Geophysical Union meeting in San Francisco.

Half an inch doesn't sound like a lot, but it's actually quite dramatic compared to other areas of the planet, explained Terry Wilson, professor of earth sciences at Ohio State. Wilson leads POLENET, an international collaboration that has planted GPS and seismic sensors all over the West Antarctic Ice Sheet.

She and her team weren't surprised to detect the horizontal motion. After all, they've been using GPS to observe vertical motion on the continent since the 1990's.

They were surprised, she said, to find the bedrock moving towards regions of greatest ice loss.

"From computer models, we knew that the bedrock should rebound as the weight of ice on top of it goes away," Wilson said. "But the rock should spread out from the site where the ice used to be. Instead, we see movement toward places where there was the most ice loss."

The seismic sensors explained why. By timing how fast seismic waves pass through the earth under Antarctica, the researchers were able to determine that the mantle regions beneath east and west are very different. West Antarctica contains warmer, softer rock, and East Antarctica has colder, harder rock.

Stephanie Konfal, a research associate with POLENET, pointed out that where the transition is most pronounced, the sideways movement runs perpendicular to the boundary between the two types of mantle.

She likened the mantle interface to a pot of honey.

"If you imagine that you have warm spots and cold spots in the honey, so that some of it is soft and some is hard," Konfal said, "and if you press down on the surface of the honey with a spoon, the honey will move away from the spoon, but the movement won't be uniform. The hard spots will push into the soft spots. And when you take the spoon away, the soft honey won't uniformly flow back up to fill the void, because the hard honey is still pushing on it."

Or, put another way, ice compressed West Antarctica's soft mantle. Some ice has melted away, but the soft mantle isn't filling back in uniformly, because East Antarctica's harder mantle is pushing it sideways. The crust is just along for the ride.

This finding is significant, Konfal said, because we use these crustal motions to understand ice loss.

"We're witnessing expected movements being reversed, so we know we really need computer models that can take lateral changes in mantle properties into account."

Wilson said that such extreme differences in mantle properties are not seen elsewhere on the planet where glacial rebound is occurring.

"We figured Antarctica would be different," she said. "We just didn't know how different."

Ohio State's POLENET academic partners in the United States are Pennsylvania State University, Washington University, New Mexico Tech, Central Washington University, the University of Texas Institute for Geophysics and the University of Memphis. A host of international partners are part of the effort as well. The project is supported by the UNAVCO and IRIS-PASSCAL geodetic and seismic facilities.

Provided by The Ohio State University
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