Earth's heat adds to climate change to melt Greenland ice

December 12 2007

Scientists have discovered what they think may be another reason why Greenland 's ice is melting: a thin spot in Earth's crust is enabling underground magma to heat the ice.

They have found at least one “hotspot” in the northeast corner of Greenland -- just below a site where an ice stream was recently discovered.

The researchers don't yet know how warm the hotspot is. But if it is warm enough to melt the ice above it even a little, it could be lubricating the base of the ice sheet and enabling the ice to slide more rapidly out to sea.

“The behavior of the great ice sheets is an important barometer of global

climate change," said Ralph von Frese, leader of the project and a professor of earth sciences at Ohio State University. "However, to effectively separate and quantify human impacts on climate change, we must understand the natural impacts, too.

"Crustal heat flow is still one of the unknowns -- and it's a fairly significant one, according to our preliminary results."

Timothy Leftwich, von Frese's former student and now a postdoctoral engineer at the Center for Remote Sensing of Ice Sheets at the University of Kansas, presented the study's early results on Thursday, December 13, 2007, at the American Geophysical Union meeting in San Francisco.

von Frese's team combined gravity measurements of the area taken by a Naval Research Laboratory aircraft with airborne radar measurements taken by research partners at the University of Kansas. The combined map revealed changes in mass beneath the Earth's crust, and the topography of the crust where it meets the ice sheet.

Below the crust is the mantle, the partially molten rocky layer that surrounds the Earth's core. The crust varies in thickness, but is usually tens of miles thick. Even so, the mantle is so hot that temperatures just a few miles deep in the crust reach hundreds of degrees Fahrenheit, von Frese explained.

"Where the crust is thicker, things are cooler, and where it's thinner, things are warmer. And under a big place like Greenland or Antarctica , natural variations in the crust will make some parts of the ice sheet warmer than others," he said.

The ice thickness, the temperature at the base of the ice, and ground topography all contribute to the forming of an ice stream -- a river of ice

that flows within a larger ice sheet. In recent years, Greenland ice streams have been carrying ice out to sea faster, and ice cover on the island has been diminishing.

Once the ice reaches the sea, it melts, and global sea levels rise.

“The complete melting of these continental ice sheets would put much of Florida, as well as New Orleans, New York City and other important coastal population centers, under water,” von Frese said.

The ice sheet in northeast Greenland is especially worrisome to scientists. It had no known ice streams until 1991, when satellites spied one for the first time. Dubbed the Northeastern Greenland Ice Stream, it carries ice nearly 400 miles, from the deepest interior of the island out to the Greenland Sea.

“Ice streams have to have some reason for being there. And it's pretty surprising to suddenly see one in the middle of an ice sheet,” von Frese said.

The newly discovered hotspot is just below the ice stream, and could have caused it to form, the researchers concluded. But what caused the hotspot to form"

“It could be that there's a volcano down there,” he said. “But we think it's probably just the way the heat is being distributed by the rock topography at the base of the ice.”

Collaborator Kees van der Veen began working on the project when he was a visiting associate professor of geological sciences and research scientist at Byrd Polar Research Center at Ohio State. He is now at the University of Kansas.

“Recent observations indicate that the Greenland Ice Sheet is much more active than we ever believed,” van der Veen said. “There have been rapid changes in outlet glaciers, for example. Such behavior is critically linked to conditions at the ice bed. Geothermal heat is an important factor, but until now, our models have not included spatial variations in heat, such as this hotspot.

“Our map is the first attempt at quantifying spatial variations in geo-heat under Greenland -- and it explains why the Northeast Greenland Ice Stream is where it is,” van der Veen added.

To measure actual temperatures beneath the ice, scientists must drill boreholes down to the base of the ice sheet-- a mile or more below the ice surface. The effort and expense make such measurements few and far between, especially in remote areas of northeast Greenland.

For now, the researchers are combining theories of how heat flows through the mantle and crust with the gravity and radar data, to understand how the hotspot is influencing the ice.

Once they finish searching the rest of Greenland for other hotspots, they hope to turn their attention to Antarctica.

Source: Ohio State University