World's biggest ice sheets likely more stable than previously believed

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A new study suggests that the previous connections scientists made between ancient shoreline height and ice volumes are erroneous and that perhaps our ice sheets were more stable in the past than we originally thought. The study found that the Earth's hot mantle pushed up segments of ancient shorelines over millions of years, making them appear higher now than they originally were millions of years ago.

For decades, scientists have used ancient shorelines to predict the stability of today's largest ice sheets in Greenland and Antarctica. Markings of a high shoreline from three million years ago, for example – when Earth was going through a warm period – were thought to be evidence of a high sea level due to ice sheet collapse at that time. This assumption has led many scientists to think that if the world's largest ice sheets collapsed in the past, then they may do just the same in our modern, progressively warming world.

However, a new groundbreaking study now challenges this thinking.

Using the east coast of the United States as their laboratory, a research team led by David Rowley, CIFAR Senior Fellow and professor at the University of Chicago, has found that the Earth's hot mantle pushed up segments of ancient shorelines over millions of years, making them appear higher now than they originally were millions of years ago.

"Our findings suggest that the previous connections scientists made between ancient shoreline height and ice volumes are erroneous and that

perhaps our ice sheets were more stable in the past than we originally thought," says Rowley. "Our study is telling scientists that they can no longer ignore the effect of Earth's interior dynamics when predicting historic sea levels and ice volumes."

The study, published online in *Science* on May 16, was a collaboration that included CIFAR Senior Fellows Alessandro Forte (Université du Québec à Montréal) and Jerry Mitrovica (Harvard), and a former CIFAR-supported post-doctoral fellow Rob Moucha (Syracuse).

"This study was the culmination of years of work and deep collaboration by researchers in CIFAR's program in Earth System Evolution," explains Rowley. "For this study, each of us brought our individual expertise to the table: Rob and Alex worked on simulations of Earth's mantle dynamics, Jerry provided calculations on how glaciers warp Earth's surface, and I shaped our understanding of the geology of the landscape we were looking at. This study would not have been possible without CIFAR."

The team studied the coast from Virginia to Florida, which has an ancient scarp tens of metres above present-day sea level. Until now, many research groups have studied this shoreline and concluded that during a warm period three million years ago, the Greenland, West Antarctic and a fraction of East Antarctic ice sheets collapsed, raising the sea level at least 35 metres. But the new findings by Rowley and his team suggest that these ice sheets, particularly the East Antarctic Ice Sheet (the world's largest), were probably more stable.

To do their study, the team used computer simulations to follow the movement of mantle and tectonic plates that occurred over time. Their prediction of how the ancient shoreline would have developed over millions of years matched what geologists mapping this ancient coast have observed. The next steps for the team are to try to make accurate

predictions in other locations around the world.

"The paper is important because it shows that no prediction of ancient ice volumes can ever again ignore the Earth's interior dynamics," explains Rowley. "It also provides a novel bridge between two disciplines in Earth science that rarely intersect: mantle dynamics and long-term climate. It is the kind of study that changes how people think about our past climate and what our future holds."

More information: "Dynamic Topography Change of the Eastern United States Since 3 Million Years Ago," by D.B. Rowley et al. *Science Express*, 2013.

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