

# Ground beneath Thwaites Glacier mapped for first time

May 31 2023

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View from the BAS survey twin otter aircraft returning from Thwaites Glacier crossing the Ellsworth Mountains. Credit: Tom Jordan / BAS

The ground beneath Antarctica's most vulnerable glacier has been mapped for the first time, helping scientists to better understand how it is being affected by climate change. Analysis of the geology below the Thwaites Glacier in West Antarctica shows there is less sedimentary rock than expected—a finding that could affect how the ice slides and melts in the coming decades.

"Sediments allow faster flow, like sliding on mud," says Dr. Tom Jordan, a geophysicist with the British Antarctic Survey (BAS), who led the study. "Now we have a map of where the slippery sediments are, we can better predict how the glacier will behave in future as it retreats."

The distribution of sedimentary rocks beneath the Thwaites glacier is included in a new map of the geology of the region produced by the BAS researchers and published in the journal *Science Advances*. The findings are important because the glacier, which is the size of Great Britain or the US state of Florida, is one of the fastest changing ice-ocean systems in Antarctica.

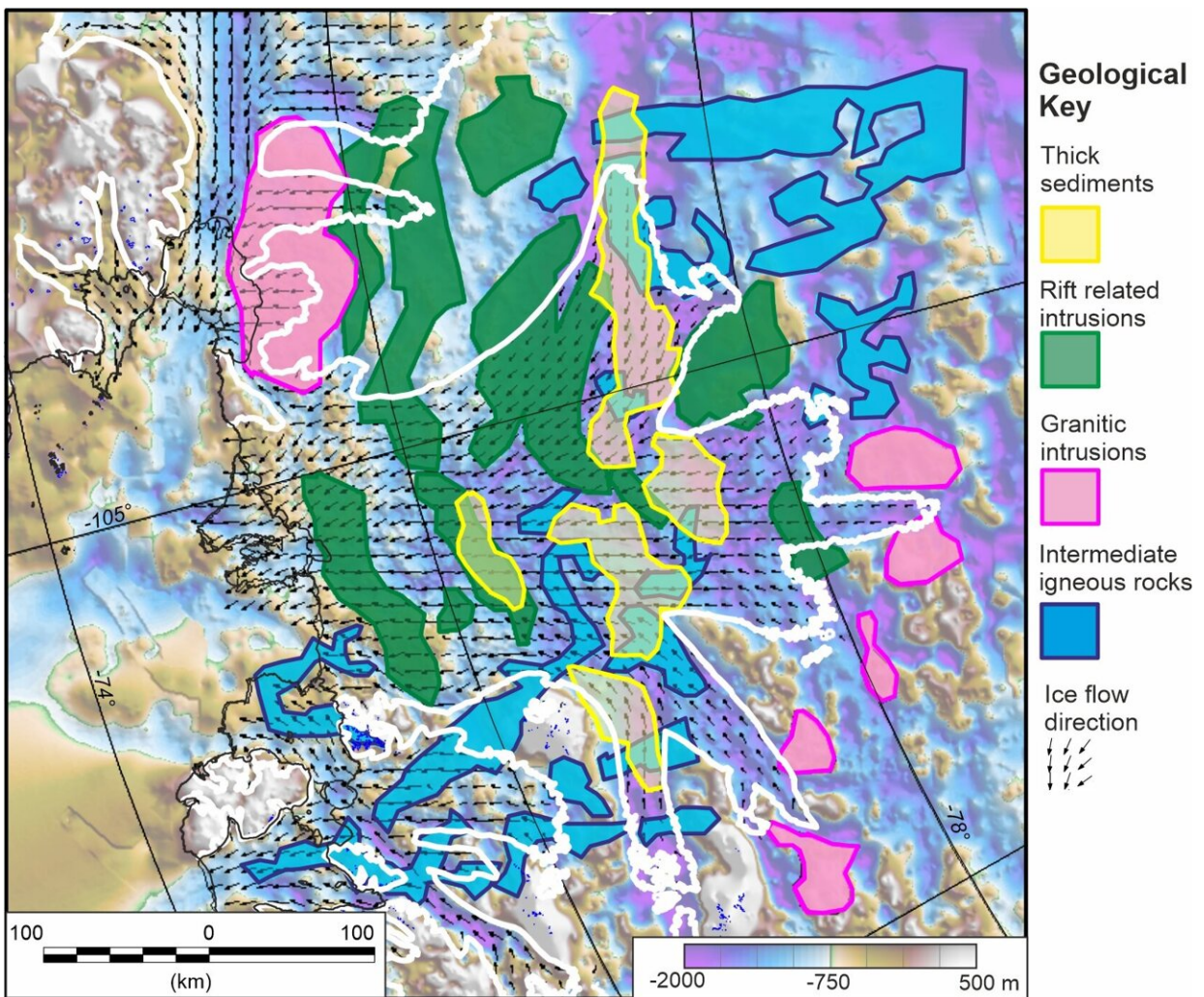
The Thwaites glacier's grounding zone—the point where it meets the seafloor—has retreated 14 km since the late 1990s. Much of the [ice sheet](#) is below sea level and susceptible to rapid, irreversible ice loss that could raise global sea-level by over half a meter within centuries.

The new analysis is based on airborne surveys using aircraft equipped with radar which can see through the ice to the rocks below, as well as sensors which can map minute variations in gravity and magnetism hundreds to thousands of meters below the ground and seabed on which the glacier rests.

The researchers then use these multiple [data sources](#) to compile a 3D picture of features, including the type and extent of different rocks.

Jordan says, "The integrated nature of the airborne surveys was one of the keys to this research. Each sensor on the aircraft provided an important but incomplete part of the picture, but by bringing them all together we could provide the detailed map of the underlying geology."

In doing so, the study effectively turns back the geological clock to examine what happened when New Zealand was ripped away from Antarctica about 100 million years ago—long before the Thwaites glacier was formed.



A map showing the pattern of different rock types beneath Thwaites Glacier as different colors, with the depth of the glacier below sea level in the background. All of Thwaites Glacier is based below sea level, with little to stop future retreat. Credit: Tom Jordan / BAS

Because the base of Thwaites Glacier lies far below [sea level](#), researchers had expected that thick sediments would have been deposited there over the subsequent millions of years. Similar analysis has been done on some other Antarctic glaciers, showing that these other systems were predominantly underlain by thick sediments.

But the aircraft data suggests that only about a fifth of the ground below the glacier is [sedimentary rock](#). These lie in a series of basins between 80 and 200 km long and about 30 km wide.

The rest is made up of other types of geological bodies, including granite peaks and other hard rocks. The scientists think that these sedimentary basins were once much larger, but they have been ground down to the bedrock by movement of the glacier.

It's not yet clear how this new knowledge of the subglacial geology will affect estimates of ice flow and loss from Thwaites and other glaciers. The study does show that the geological landscape has a [direct control](#) on the basal shear stress, which influences how fast ice can flow into the ocean. Members of the research team will now carry out more detailed studies of these processes. Modelers may also be able to use the new data to make more reliable projections of future ice loss.

Jordan says, "We hope that by showing the detailed geology, and how it correlates with the basal friction, future models of glacial retreat will have lower uncertainty, as the controls of the basal processes will be

better understood."

He adds, "No single scientific study could ever match the scale and challenge of climate change. But it is the incremental building of all the individual scientific studies like this that allows us to understand and tackle that challenge."

Glaciologist Dr. Sarah Thompson, co-author on the paper, said, "The integrated approach used in this study has significant potential for successful application elsewhere in Antarctica, enabling us to explore other potentially vulnerable regions where current knowledge is sparse."

The study "Geological sketch map and implications for ice flow of Thwaites Glacier, West Antarctica, from integrated aerogeophysical observations," by Tom A. Jordan, Sarah Thompson, Bernd Kulesa, and Fausto Ferraccioli is published in the journal *Science Advances*.

**More information:** Tom Jordan, Geological sketch map and implications for ice flow of Thwaites Glacier, West Antarctica, from integrated aerogeophysical observations, *Science Advances* (2023). [DOI: 10.1126/sciadv.adf2639](https://doi.org/10.1126/sciadv.adf2639). [www.science.org/doi/10.1126/sciadv.adf2639](https://www.science.org/doi/10.1126/sciadv.adf2639)

Provided by British Antarctic Survey

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