Landslide triggers megatsunami in narrow fjord

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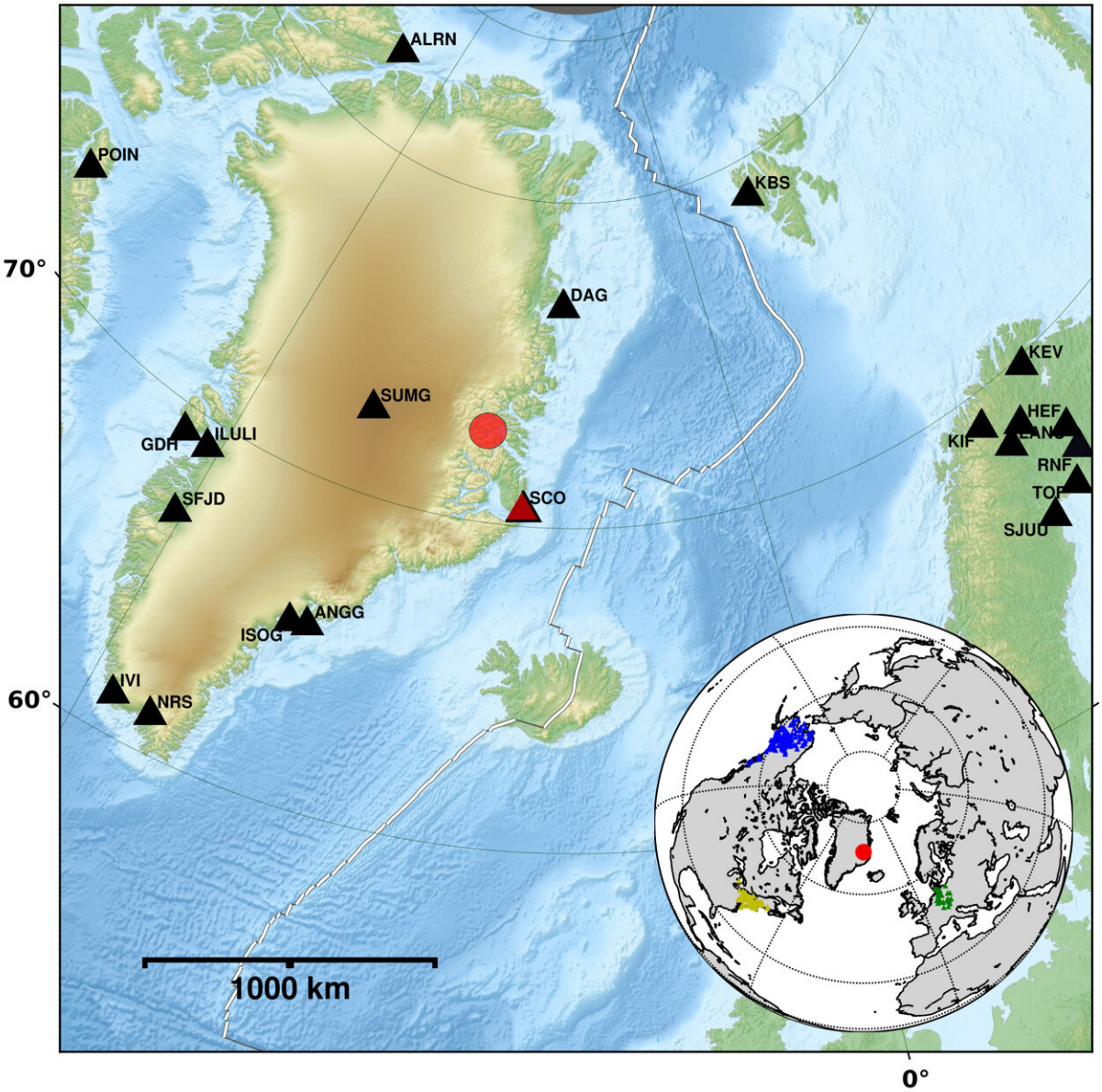


Overview of seismic stations on Greenland (black triangles), the location of the tsunami (red circle) and the nearest seismic station (red triangle), whose filtered signals are shown. Credit: adapted from *The Seismic Record* (2024). DOI: 10.1785/0320240013

It was a monster wave that hit a fjord on Greenland's east coast on 16 September 2023. In certain places, the traces of the flooding reached 200 meters high. Researchers led by Angela Carrillo Ponce from the German Research Centre for Geosciences (GFZ) have now evaluated the seismic signals from earthquake measuring stations worldwide and discovered another unusual event: Triggered by the megatsunami, a standing wave sloshed back and forth in the narrow bay of the uninhabited Dickson Fjord for more than a week.

The international team has published their work in *The Seismic Record*.

Rockslide as triggering event

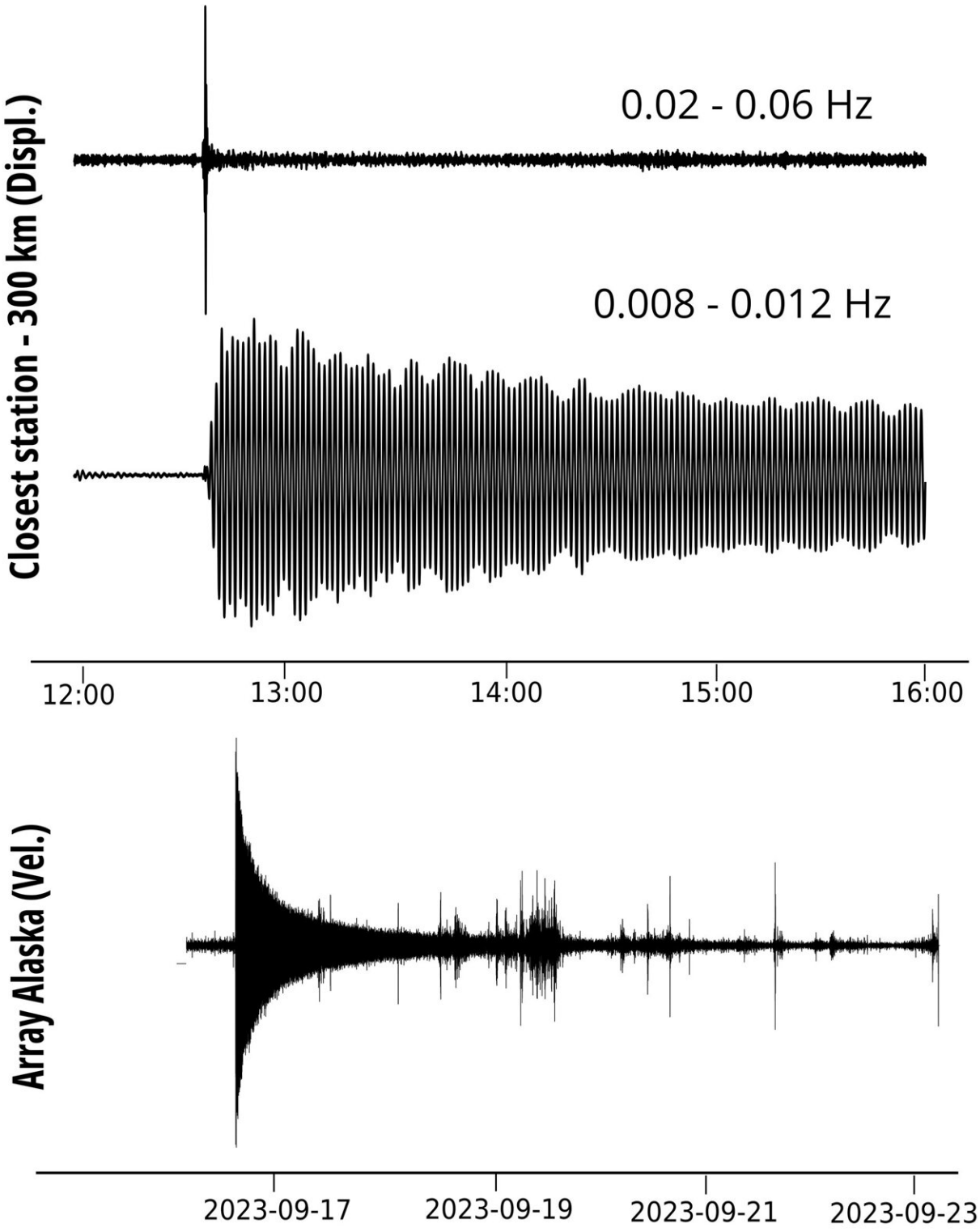
The tsunami was triggered by a large landslide. Earthquake measuring stations up to 5,000 kilometers away registered the shaking caused by the landslide as a short signal. However, there was also a very long-period (VLP) signal that was recorded by the seismometers for more than a week.

Angela Carrillo Ponce, who works as a doctoral student in the "Physics of Earthquakes and Volcanoes" section of the GFZ, says, "The mere fact that the VLP signal of a wave sloshing back and forth triggered by a landslide in a remote area of Greenland can be observed worldwide and for over a week is exciting. That's why we in seismology have been most concerned with this signal."

Fortunately, the researcher adds, no people were harmed. Only a military base, which was without personnel at the time of the tsunami, was devastated.

Analysis of the seismic signals—shock waves that travel thousands of kilometers in the earth's crust—showed that a so-called standing wave formed in the fjord after the landslide. Initially, the parts of the flank that fell into the water triggered a giant wave that spread through the entire fjord to the offshore island of Ella, more than 50 kilometers away. Near the point where the rockslide entered the fjord, the maximum height was more than 200 meters, along the coast an average of 60 meters.

Parts of the wave apparently spilled back from the steep banks in the narrow fjord and a standing wave began to form, which undulated back and forth for more than a week. However, this wave measured only around 1 meter in height.



Depending on the frequency range filtered out, the rockfall triggering the tsunami can be seen as a single peak (top), the standing wave sloshing back and

forth as an undulating pattern in the recordings (middle, with several hours depicted) or the overall signal of the rockfall and the tsunami over the course of a week with strongly decreasing intensity of the oscillations (bottom). Credit: adapted from *The Seismic Record* (2024). DOI: 10.1785/0320240013

Standing wave persisted for an unusually long period

Such standing waves and the resulting long-period signals are already known in research. Such VLP signals are normally associated with large break-offs from glacier edges.

"In our case, we also registered a VLP signal," says Carrillo Ponce, adding that "the unusual thing about it was the long duration."

What was particularly impressive was that the data from seismic stations in Germany, Alaska and other parts of North America were of very good quality for the analysis. A comparison with satellite images confirmed that the cause of the first seismic signals corresponded well with the strength and direction of the rockfall that triggered the megatsunami. In addition, the authors were able to model the slow decay and the dominant oscillation period of the VLP signals.

This gives the researchers hope that they will be able to detect and analyze other similar events from the past. It is obvious that the retreat of glaciers, which previously filled entire valleys, and the thawing of permafrost are leading to increased landslides. Climate change is accelerating the melting of glaciers and could therefore increase the risk of megatsunamis.

More information: Angela Carrillo-Ponce et al, The 16 September 2023 Greenland Megatsunami: Analysis and Modeling of the Source and

a Week-Long, Monochromatic Seismic Signal, *The Seismic Record* (2024). DOI: 10.1785/0320240013