EGU24-20066, updated on 14 Mar 2024
https://doi.org/10.5194/egusphere-egu24-20066
EGU General Assembly 2024

Interdisciplinary insights into an exceptional giant tsunamigenic rockslide on September 16th 2023 in Northeast Greenland

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On September 16th, 2023 at 12:35 UTC, a 25.5 M m3 rockslide occurred on the slope of Dickson Fjord in Northeast Greenland. The rockslide impacted a gully glacier, leading to a rock and ice avalanche that entered the fjord causing an up to 200 m high tsunami with observable runup up to 100 km away. The event produced an unprecedented very long period (VLP) seismic event observable on seismic stations worldwide for up to nine days. Here we focus on reconstructing the dynamics of the landslide, while detailed analysis of the VLP seismic signal is presented by Widmer-Schnidrig et al. in Session GM2.1.

Detailed analysis of the landslide reveals that a large body of metamorphic rock, with dimensions up to 150 m thick, 480 m wide, and 600 m long, dropped westwards along a foliation-parallel failure plane. The impact shattered a 200 m-wide outlet glacier, entraining 2.3 M m3 of glacier ice. The event was dynamically preconditioned by the progressive thinning of the glacier that supported the toe of the unstable slope. Subsequent investigations of satellite images and seismic records indicate that up to five minor landslides occurred in the years prior to the largest event in Sept. 2023, and one subsequent landslide has also been recorded.

Seismic signals generated by the landslide-tsunami were observed at nearby seismic stations, providing insights into its dynamics. The seismic signatures, including emergent high-frequency

arrivals and low-frequency signals, match with characteristics of landslides involving glacial ice. Infrasound signals were also detected up to 3310 km away.

To reconstruct the landslide run-out, seismic waveforms from the closest stations were analyzed, resulting in a maximum force of 192×109 N, corresponding to a mass estimate of 78-103×109 kg, equating to a volume of ca. 29-38 M m3, consistent with results from photogrammetric reconstruction. The inverted run-out path indicates the initial rockslide impact with the gully wall, followed by entry into the water. The whole slide lasted c. 90 seconds. An independent numerical model to simulate the landslide force-history is in overall agreement with the seismic inversion results. Simulations of the landslide induced tsunami compare well with observations of the tsunami run-up, and also show evidence of longer lasting seiche action.

The landslide is the first glacial debuttressing landslide known from Greenland, and the first tsunamigenic landslide of this magnitude recorded in Northeast Greenland.

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