

# Seismic evidence of variable bed conditions beneath Thwaites Glacier, West Antarctica

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Seismic measurements on Thwaites Glacier show a spatially variable bed, with implications for ice-sheet stability. The West Antarctic Ice Sheet is losing mass rapidly through outlet glaciers and ice streams in the Amundsen Sea Embayment, including Thwaites Glacier. Observations and modeling show that the ice flow depends on bed properties. Here we characterize bed properties of Thwaites Glacier based on analysis of seismic reflection data from a ~40-km-long profile collected approximately in the direction of flow and two ~10-km-long profiles transverse to flow. The upstream portion of the seismic profile reveals a ~12-km long sedimentary basin, which is capped by a continuous till layer that is likely soft and deforming, with several locations where water likely has pooled at the bed. Downstream of this sedimentary basin, the bed rises by ~400 m over ~25 km into subglacial highlands. Our seismic survey reveals strong spatial variations in bed character across rugged topography (~200 m amplitude at several-km wavelength) in these subglacial highlands. The bed on the stoss sides of bedrock highs is more consolidated, whereas the lee sides and flat regions are similar to the till of the upstream sedimentary basin. We suggest that the bed strength varies along flow at the several- to tens-of-kilometer scale depending on the underlying topography and geology. Modeling suggests that the grounding-line-retreat rate in response to oceanic warming is strongly influenced by such variations in bed character as well as by the topography, highlighting the need for more geophysical surveys to reveal the bed conditions for Thwaites Glacier and other important outlets.