Uncovered anatomy of a subglacial hydrological system coupled to past ice sheet grounding lines

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Abstract

Subglacial hydrology is critical to understand the behavior of ice sheets, yet active meltwater drainage networks beneath contemporary ice sheets are rarely accessible to direct observation. Here we present the discovery of a paleo-subglacial hydrological system spanning, from its source to grounding line positions, active beneath the East Antarctic Ice Sheet in formerly glaciated western Ross Sea. A long channel, sourced from upstream subglacial lakes, repeatedly delivered meltwater to an ice stream grounding line and was a persistent pathway for episodic meltwater drainage events. Embayments within grounding zone wedges coincide with the locations of meltwater channels, marking reduced sedimentation and restricted landform growth. Consequently, channelized drainage at the grounding line influenced the degree to which these landforms provided stability feedbacks to the ice stream. The subglacial lakes are in an area of geologically recent rifting and active volcanism, and therefore elevated heat fluxes would have produced sufficient basal melting to fill the lakes over decades to several centuries, consistent with geomorphological constraints on the drainage frequency at the grounding line. Based on the trajectory of grounding line retreat across the study area, we hypothesize the retreating ice stream was sensitive to the presence of the antecedent subglacial hydrological system.

Keywords: meltwater drainage, grounding line