Subglacial lakes, seafloor geomorphology, and deglaciation history in Pine Island Bay, West Antarctica during the last glacial termination

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Abstract

Subglacial meltwater largely facilitates rapid but nonlinear ice flow beneath concurrent ice streams, and there is widespread evidence for a dynamic subglacial water system beneath the Antarctic Ice Sheet. It steers and affects the pattern of ice flow and is a direct result of boundary processes acting at the ice sheet bed, i.e. pressure-induced basal melting. Consequently, the occurrence of subglacial meltwater plays an important role in bedrock erosion, subsequent re-deposition, and in shaping the topography of ice-sheet beds.
Here we present new geological, geophysical, and geochemical data from sediment cores recovered from the continental shelf in Pine Island Bay. We interpret the data as reliably indicating palaeo-subglacial lake deposition beneath the formerly expanded West Antarctic Ice Sheet, presumably during and/or subsequent to the Last Glacial Maximum (LGM) (Kuhn et al. 2017). Characteristic changes of sedimentary facies and geochemical profiles within these cores that were recovered on RV Polarstern expeditions ANT-XXIII/4 (2006) and ANT-XXVI/3 (2010), support the presence of an active and expanded subglacial lake system in at least five basins. The basins, which also have been targeted by sediment coring during the recent RV Polarstern cruise PS104 (2017), had been carved into bedrock over previous glacial cycles and were then filled with several meters of sediments. These findings have important implications for palaeo ice-sheet dynamics, suggesting the presence of considerable amounts of water lubricating the ice-bed interface, eventually leading to the subglacial deposition of lake sediments and water-saturated soft tills.
Based on our recent findings, we conclude that the transition from the subglacial lake to an ocean-influenced environment took place during deglaciation at the transition from the LGM to the Holocene. We suggest that the ice sheet thinned and the subglacial lake basins successively transformed to sub-ice cavities, flushed by tidal currents at this time. We will present estimates of ice thickness for buoyancy at the grounding line for the time when the grounding line retreated landward across the rim of the subglacial lake. These estimates are based on the bathymetric setting, a glacial isostatic adjustment model, a global sea level curve, and the available chronological information. Our findings have implications for ice sheet models, which need to consider the predominantly non-linear effects related to subglacial hydrology.

Keywords: West Antarctic Ice Sheet (WAIS), Sub-Ice processes, Deglaciation processes

References

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