

Inference of grounding-zone properties from radar basal reflectivity, dielectric modeling, and basal-echo phase analysis

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Properly mapping bed topography and basal conditions in ice-sheet grounding zones is crucial to understanding ice-sheet evolution. Detailed maps of bed topography are needed to properly assess the impact of bed pinning points in grounding-line retreat scenarios. Other processes, including sediment deposition, till compaction, and infiltration of seawater upstream of grounding via tidal flexure, may also have important effects on grounding-line stability. Ice-penetrating radar is the most commonly used technique to examine ice-sheet grounding zones because it supplies large amounts of useful data comparatively easily. Although mapping the bed topography is relatively straightforward, more-complete interpretations of radar data incorporating information from basal reflectivity and basal-echo phase remain challenging, especially in complex environments, where thin films of various materials (e.g., freshwater, seawater, debris-bearing ice, sediment of varying compaction state), widespread crevasses, and off-nadir reflections may affect the radar returned signal. Here we use information from basal reflectivity and bed-echo phase analysis to infer basal conditions and water column properties at the grounding zone of Whillans Ice Stream, West Antarctica. This analysis is further informed by active-source seismic data, which image grounding-zone bathymetry. Our results indicate substantial mixing in the shallow water column in a subglacial embayment where several subglacial lakes drain whereas the transition from ice overlying till to ice overlying seawater is more abrupt in nearby areas with no subglacial drainage. Thus, properly considered, radar data can yield valuable information on grounding-zone conditions, including water properties as the ice begins to float. We conclude by discussing ramifications of this study for interpretation of airborne radar data collected over other grounding zones, including those of Pine Island and Thwaites Glaciers.

Theme: Surfin' USA (both West Coast Blue and Promised Land)