Ice mechanics, basal water and the stagnation of Kamb Ice Stream, Antarctica

Mason Fried[1], Christina Hulbe[1], and Mark Fahnestock[2]
1: Portland State University
2: University of New Hampshire

Several of the ice streams that move ice from the interior of the West Antarctic Ice Sheet (WAIS) to the Ross Ice Shelf are documented to stagnate and reactivate on multi-century time scales. Once such event may now be underway on the downstream ice plain of the Whillans Ice Stream (WIS), a stream that stopped and started between about 850 and 450 years ago. Kamb Ice Stream (KIS) ceased its rapid flow about 150 years ago in an event that appears to have initiated in the downstream reach of the ice stream. These switches from fast to slow and back again produce major changes in mass balance of the ice sheet and ice shelf system.

Ice stream stagnation must in some way involve changes in the basal water that facilitates fast flow. Here, transients in ice thickness and surface slope, which together steer basal water, are examined in the context of the recent stagnation of KIS. Transients have both regional—changes in WIS flux and in Crary Ice Rise, for example—and local causes. A mechanical analysis of high-resolution surface elevation and ice velocity data sets on the now-active WIS is used as a proxy for past conditions on KIS and an ice flow model is used to place those local conditions in a regional context. We argue that thickness transients associated with stagnation of WIS required the KIS grounding line to retreat far upstream of its present location while reactivation of WIS led to regional thickening, grounding of floating ice, and advance of the KIS grounding line toward its present location. The present work examines the role of lateral margins near the grounding line, in particular the broad, flat, "Duckfoot" on the right lateral side of the KIS outlet and Lake Englehardt, which occupies the same position at the outlet of WIS. Lake Englehardt diverts water away from the main trunk of the ice stream. In the past, the Duckfoot may have played a similar role and that diversion may have been associated with KIS stagnation. Overall, our aim is to understand the interaction among regional and local transients in ice thickness and surface slope and flow events on the downstream ends of ice streams.