Linkage between Grounding Line Dynamics and Geological Observations in the Weddell Sea Sector of Antarctica

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Surface-exposure dating is a potentially a powerful technique to constrain Antarctic ice-sheet thinning from the Last Glacial Maximum to its present state. In the austral summers of 2010-2011 and 2011-2012, our research team (led by Greg Balco and Claire Todd) collected erratics near the grounding line of the Foundation Ice Stream in Antarctica's Weddell Sea sector. Using surface-exposure dating techniques, these erratics detail thickness maxima and exposure rates along nunatak elevation transects. These points in space and time constrain the local ice elevation and rate of thinning -- but what can they tell us about the history of the interior ice stream's elevation profile?

The elevation profile of the interior ice is strongly controlled by the position of the grounding line, which, in turn, depends on sea level, accumulation, and the ice stream/shelf's physical characteristics. We use an idealized flowline model to assess the relative importance of different aspects on modeling ice stream thickness profiles. We divide these aspects into two general categories: model physics, and environmental factors. Model physics include the sliding law, and the calculated flux at the grounding line, where the ice transitions from grounded stream to floating shelf. Environmental factors include climate, basal topography, sliding efficiency, sea level, ice softness, and lateral shelf stresses. Presently, we do not account for the potentially important effects of isostatic rebound and the gravitational pull of the ice-sheet on ocean water (e.g. Gomez et al., 2010).

Preliminary findings show that the position of the grounding line controls the elevation at the exposure sites; and that sub-glacial and sub-marine basal topography, together with the assumed form of the grounding-line flux, dominates the grounding-line sensitivity to change. We also show that the ice-flux necessary to hold the grounding line at a fixed point is very sensitive to the lateral stresses along the sides of the ice shelf. Consequentially, the ice surface elevation predominantly reflects regional-scale ice sheet behavior rather than the climate local to the ice-stream catchment.