Antarctica's Great Sub-Ice Basins: A Natural Wonder or a Global Threat?

Donald D. Blankenship[1]

[1]*University of Texas Institute for Geophysics, University of Texas at Austin, Austin, TX 78758*

Internationally collaborative aerogeophysical exploration over the last two decades has revealed Antarctica as a geologically diverse continent underlying an ice sheet with significant sea level potential, parts of which are currently undergoing rapid change. The sub-continental scale Byrd, Wilkes and Aurora Subglacial Basins, the three largest reservoirs of sea level potential on Earth, are broader, deeper, and more susceptible to marine ice sheet instability than previously known and have been found to collectively represent a potential sea-level contribution of up to twenty meters. In particular, we have discovered that the Wilkes and Aurora Subglacial Basins of East Antarctica share a similar geometry to the Byrd Subglacial Basin underlying the West Antarctic ice sheet, with a large proportion of the ice sheet bed lying one to two kilometers below sea level and sloping towards the interior. The morphology and coastal connections of the ASB indicate a dynamic ice sheet with a significant erosional history and multiple semi-stable ice sheet configurations. Recent results imply routine disintegration of the West Antarctic ice sheet overlying the Byrd Subglacial Basin and significant retreat of the East Antarctic ice sheet into the Wilkes Subglacial Basin during Pliocene warming. Our findings indicate that only small coastal ridges halt irreversible discharge from both the Byrd and Wilkes Subglacial Basins.

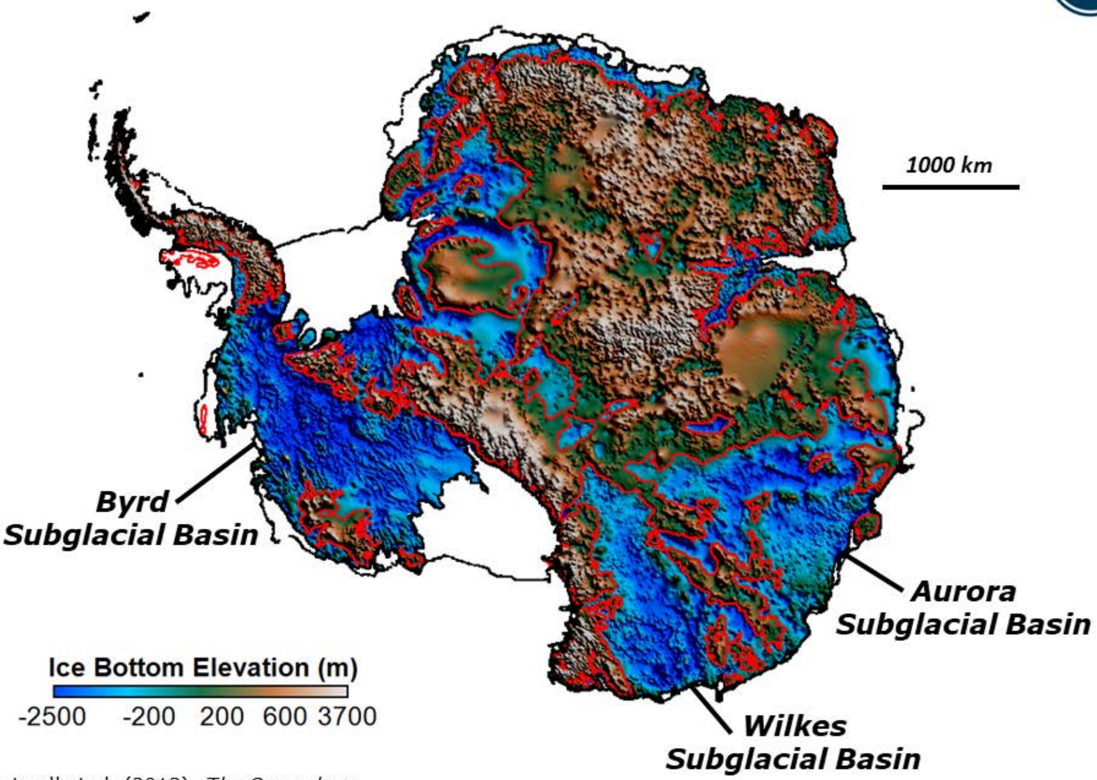
Our aerogeophysical studies have also unveiled complex contemporary subglacial landscapes beneath all three basins suggesting a varied forcing regime on the ice providing new challenges and opportunities to ice sheet modelers attempting to predict both the timing and rates of future sea-level rise. For instance, geothermal heat flow beneath all three basins varies spatially on multiple scales in a continental crust that was long assumed to be homogeneous. For example, a large, active, subglacial hydrological system modulated by rift controlled heterogeneous geothermal flux flows through the Byrd Subglacial Basin of West Antarctica whereas in East Antarctica's Aurora Subglacial Basin, subglacial hydrological pathways likely predate large-scale glaciation.

Geological proxies indicate four to eight meters of global sea level rise during the last interglacial period with ice core results constraining the amount of sea level rise from Greenland to two meters implying a potential two to six meter sea-level contribution form ice overlying the great sub-ice basins of Antarctica. New space- and airborne altimetry data along the Antarctic coast reveal extensive contemporary lowering of the glaciers over both the Byrd and Aurora Subglacial Basins while satellite gravity indicates a variable but persistent record of negative regional mass loss. These discoveries provide a new baseline as the international community increases its focus on glacier change over these basins resulting from both ocean and atmospheric forcing.

Questions driving our current work include:

- What is the character and distribution of subglacial boundary conditions and water systems upstream of the grounding line where these sub-ice basins meet the ocean?
- How much subglacial water discharges into sub-ice shelf cavities downstream of these basins and how does this water modulate ocean forcing, ice surface elevation change and grounded ice mass budget?
- How does ice shelf cavity geometry and atmospheric forcing affect, respectively, sub-ice shelf circulation and ice shelf calving in these areas of significant potential sea level impact?

Natural Wonders or Global Threats? Antarctica's great sub-ice basins



Fretwell et al. (2013), *The Cryosphere*