Subglacial hydrology inferred from analyzes of subglacial water and basal ice from the UpC Sticky Spot

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Basal water plays an important role in the dynamic of the West-Antarctic Ice Sheet. Melting of ice at the base of the ice sheet lubricates the ice sheet bed allowing fast ice streaming. Basal melt is mainly produced under the thick insulating ice in the WAIS interior and under the fast moving ice stream. In the ice stream tributaries basal melting might be negligible and refreezing of basal water might be possible, leading to the accretion of multiple meter-thick clear sediment-containing basal ice layers.

Lacking direct observations from the base of the ice stream tributaries it is currently unclear whether basal melting or freezing occurs underneath ice stream tributaries. Model results assuming low basal shear stresses (1 to 10 kPa) indicate that a 12 to 25 m thick basal ice layer found at the UpC Sticky Spot could have formed in the ice stream tributaries (Vogel and others, in press). Higher basal shear stresses (~ 70 kPa) as suggested from force balance calculations (Joughin and others, in press) would lead to significant amount of basal melting (> 150 m).

Little is known about the hydrological system underneath the WAIS capable to either connect areas of basal melting with areas of basal freezing or draining the basal melt water towards the ocean. Borehole observations found water at the base of Byrd Station (Gow and others, 1968) and suggest that underneath the Siple Coast ice streams a mm to cm thick linked cavity system exists (Engelhardt and Kamb, 1997; Kamb, 2001). However it is unclear whether a 1.5 m thick water filled cavity, found at the UpC Sticky Spot ice stream margin, is just a single large cavity or it belongs to an extensive drainage system.

Chemical and isotopical analyzes of basal water from the 1.5 m thick UpC Sticky Spot cavity and from a location 4 km south of the cavity in the southern Ice Stream C branch indicate two distinct basal water bodies. The water in the ice stream location contains dissolved weathering products indicating that the water has interacted with the sediment bed, while the cavity water has lower solute concentrations and is closer to fresh basal melt water. In case the source and source area of both water bodies was originally the same, isotope analyzes suggest that the cavity water would have traveled faster.

As the water samples were a byproduct of sediment sampling using a piston corer and haven't been specifically sampled for the purpose of chemical analyzes we consider these results preliminary and have to be confirmed by future investigations.

References:

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