Environment and Processes of Subglacial Lake Whillans, West Antarctica

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Subglacial Lake Whillans (SLW) lies 800m below the low gradient, Whillans Ice Plain West Antarctica, upstream from where Whillans Ice Stream goes afloat into the Ross Ice Shelf. During 2013-14 season the WISSARD project made measurements in, and collected water and sediment samples from SLW. Sediment is typical subglacial till; a homogenized, structureless diamicton. Debris from local basal ice is likely not contributed to SLW by rainout because ice is theoretically below pressure melting. So lake floor diamicton likely was transported to SLW by deformation while the ice stream was grounded at the drill site both prior to lake formation and during lake “lowstands”. Satellite altimetry has shown SLW experiences short (~7 month) discharge events, lowering the ice surface and lake water level by between 1-4m. Lake lowstands are separated by longer periods of gradual recharge, but over the period of many lowstands the ice stream is suspected to touch down and couple with the lake floor, potentially shearing new till into SLW. Subglacial hydrological diversions also may play a role in SLW history; if water is captured by another drainage basin, then the bed at SLW will also act as a till. The lack of sorted sediment (apart from a lamina of mud at the sediment-water interface) and erosional lags within sediment cores indicate water flow during discharge/recharge events has had a low current velocity with quiescent conditions in the lake. Although important volumes of water are moved during such events, water velocities are not those of classic “floods” due to low hydropotential gradients on the ice plain and wide channels. Sediment source indicators (particle composition, form and surface texture, geochemistry (XRF, XRD, ^{10}Be), fossils, biomarkers) show sediment is recycled from older Cenozoic sediments and bedrock. Biologists show δ^{18}O values of lake water likely from up-stream ice sheet melt; however, Cl and Br ion concentrations indicate a seawater source likely recycled from older marine sediments. Chemolithoautotrophs dominate an active microbial community, indicating they play a role in breakdown of subglacial particulates. The most notable variability in cores is a weak, critical porosity horizon down to ~50cm depth above more consolidated till. We interpret the weak upper horizon as a product of shear deformation and decreasing effective pressure experienced during final stages of grounding prior to a lake recharge event. The presence of this weak layer illustrates the importance of hydrology in modulating till rheology and is an example of how subglacial sediments can preserve archives of hydrologic conditions at the ice-bed interface. All results show till is being subglacially deformed and sheared from up-ice-stream into SLW and beyond. That appears to be the main sediment transport

mechanism rather than fluvial transport. We cannot yet constrain basal/englacial debris transport.