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Bed conditions of Subglacial Lake Whillans, West Antarctica

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Subglacial Lake Whillans (SLW) sediment is a typical subglacial till; a homogenized, structureless diamicton. Debris from local basal ice is likely not contributed to the lake by rainout, because based on theoretical estimates, ice is below the pressure melting point. Therefore, the lake floor diamicton likely was transported to the lake by deformation while the ice stream was grounded at the drill site both prior to lake formation and during lake "lowstands". Satellite altimetry has been used to infer that SLW experiences short (∼7 month) discharge events, lowering the ice surface and lake water level by between 1-4m. The 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 the lake. Subglacial hydrological diversions also likely play a role in the history of the lake, and 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 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. Del18O values of lake water indicate that it is from ice sheet melt (it must be from up-stream); however, Cl and Br ion concentrations indicate a seawater source likely recycled from deeper sediments deposited when WAIS grounding line was retreated back up-stream from this site, perhaps during past interglacials. Biologists show that chemolithoautotrophs dominate an active microbial community at SLW indicating they play a significant role in breakdown of subglacial particulates. The most notable variability in the cores is a uniformly weak, critical porosity horizon extending to ∼50cm depth above more consolidated till. We interpret the weak upper horizon to be a product of shear deformation and decreasing effective pressure experienced during the 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 hydrological conditions at the ice-bed interface.