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Scientific Exploration of Subglacial Lake Whillans, West Antarctica

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Subglacial Lake Whillans (SLW) is one of numerous lakes that comprise an extensive drainage basin beneath the lower portion of the Whillans Ice Stream on the Siple Coast of West Antarctica. The surface area of SLW is 59 km^2 ± 12 km^2 and radar observations suggested the lake was ~800 mbs with a maximum water column thickness of 5-6 m. Water enters the lake from the upstream direction and drains downstream at rates of ~10 m^3 s^{-1}. Based on morphometry and fill-drain cycles, SLW has a volume of <0.5 km^3 and the residence time of the lake is estimated to be < 10 y. During January 2013, a hot water drilling system was used to create an access borehole for direct sampling and to conduct measurements for constraining the physical, chemical, and biological characteristics of SLW. A microbiologically clean access strategy was achieved through the use four complementary technologies [(*i*) filtration, (*ii*) ultraviolet (UV) irradiation, (*iii*) pasteurization, and (*iv*) chemical disinfection] that reduced microbial contamination and viability in the drilling fluid and on equipment deployed in the borehole. At 0802 on 27 January, the drill was at 801 mbs and there were indications of unloading on the load cell. Two minutes later, the head above the downhole pump (stationed at ~110m depth) rapidly rose and remained at 80 mbs, indicating hydrostatic equilibration between the borehole and lake water. The water recovered from Niskin casts in the lake contained microbial cell concentrations of 0.9-1 x 10^5 cells mL^{-1}, which were appreciably higher than values observed in water from the drilling system and borehole (2-7 x 10^2 cells mL^{-1}). Significant rates of macromolecular synthesis, respiration, and CO_2 fixation were measured in samples obtained from the water column and sediments, indicating the presence of viable microorganisms and providing evidence for a microbial food web in SLW. Molecular diversity analysis of the water and sediments has provided key data to assess the composition and physiological potential of microorganisms inhabiting the SLW ecosystem.

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