

Collaborative Research: Whillans Ice Stream Subglacial Access Research Drilling (WISSARD) - Integrative Study of Marine Ice Sheet Stability and Subglacial Life Habitats in West Antarctica

Intellectual Merit: WISSARD is an unprecedented, multidisciplinary research project that will study the relationships between biogeochemical, genomic, and physical processes of a complex subglacial environment, which includes a subglacial lake and the grounding zone of Whillans Ice Stream. The WISSARD project will focus on two questions that are of broad scientific interest and are relevant to present-day societal concerns: (1) how stable are marine ice sheets and what are their potential to make a significant contribution to near-future global sea-level rise? and (2) how does life survive and thrive in dark subglacial environments that have been isolated from the atmosphere for tens of thousands to millions of years? Subglacial water and sediments help control the movement of ice sheets and are themselves moved by ice; water and sediments are needed for life, and microorganisms can modify them, inspiring us to integrate glaciology, geology, and biology in the study of the Whillans subglacial system.

Subglacial lakes and grounding zones of ice streams represent important unexplored frontiers. Their control over future sea level rise and their unique biota make them high-priority targets for US and international researchers. WISSARD will be the first large-scale drilling project to examine a subglacial system holistically by integrating geological, glaciological, geochemical, and biological research questions with contamination-conscious sample recovery. A dynamic team of 7 PIs and 4 co-PIs from 7 institutions with diverse expertise ranging from geophysics to microbial ecology has been assembled with the common goal to investigate these unique subglacial environments. Geophysical imaging, in-situ borehole measurements, remotely operated vehicle (ROV) surveys, and borehole sample acquisition will provide unmatched datasets, which will be used to test the **overarching hypothesis: Dynamic glaciological, sedimentological, and biochemical processes act synergistically to stabilize the ice sheet and control the structure and function of microorganisms inhabiting the Whillans subglacial environment.**

The proposed study involves 3 field seasons and 1 year for data analysis and dissemination. In year 1, the spatial extent and internal structure of the grounding zone wedge will be mapped; site selection for drilling will be finalized and test drills will be conducted to define a “clean” sampling protocol. Year 2 drilling will target the GZW and neighboring sub-ice-shelf cavity. The ROV will be deployed to explore the cavity and the seaward part of the GZW. Simultaneously, geophysical surveys will determine the geometry of the SLE basin, map its relationship to neighboring geologic units, search for outlet conduits, and determine the impact of the lake on internal ice deformation. Year 3 drilling will focus on safely and cleanly penetrating SLE and its neighboring features. Geochemical and microbiological measurements will be made on the subglacial samples retrieved in year 2 and 3. Genome-enabled diversity characterization, isotope geochemistry, nutrient analyses and physiology experiments will be used in concert to investigate subglacial microbial phylogeny, metabolism and weathering processes.

Broader Impacts: One goal of WISSARD is to increase student and early career scientist involvement, in polar research including fieldwork and data analysis. Each PI is committed to outreach projects: K-12 curriculum design, public science exhibits and web-based resources. Significant popular media attention is anticipated for WISSARD that will publicize project discoveries. A key innovation of WISSARD is the integration of biologists and physical scientists in a systems-level approach. These communities are still separate in Antarctic research, but WISSARD provides a forum to promote communication between these scientists and will foster new discoveries that would not occur if each were working in isolation. WISSARD will follow through on National Research Council recommendations to establish a clean sampling protocol as well as pioneering technologies for future USAP subglacial lake drilling and exploration.