Clean-Access Hot Water Drilling Systems: a description of U.S. capability, availability, and past successes for collaborative Antarctic science

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Abstract

COMNAP's Antarctic Roadmap Challenges (ARC) Project describes the need for accessibility and further development of critical 'cross-cutting technology' to improve clean-access retrieval of *in situ* data and samples from subglacial environments. Hot water drilling is the identified best method for rapid access to these environments (Siegert et al., 2015) to address SCAR's Horizon Scan questions #26, #27, #34 relevant to PAIS (Kennicut et al., 2015). Two drilling systems available for future projects are described. Clean-Access Hot Water Drilling System (CHWDS), which was developed by UNL (Rack et al., 2014) for the Whillans Ice Stream Subglacial Access Research Drilling (WISSARD) Project, penetrated through 800 m of West Antarctic ice into Subglacial Lake Whillans (2012-13), and penetrated through the Ross Ice Shelf at its grounding zone with WAIS (2014-15). Instruments deployed through the borehole enabled exploration of interlinked glaciological, geological, microbiological, geochemical and hydrological aspects of these subglacial environments. The smaller Roving Hot Water Drill (RHWD) was constructed by UNL utilizing components from the CalTech and IceCube hot water drilling systems. RHWD could be upgraded to 'clean-access' drilling, required to prevent contamination of pristine subglacial environments, following SCAR's Subglacial access Code of Conduct. CHWDS presently supports the Subglacial Antarctic Lakes Scientific Access (SALSA) Project, which is scheduled to penetrate into hydrologically active Subglacial Lake Mercer (2018-19), with support from NSF through IDPO. CHWDS could be available (and customized) to support new projects from 2020 onwards. As presently configured, CHWDS is capable of producing 1,500 meter-deep and 10 to >100 cm-diameter holes (upgradable to 2,000+ m depth), and able to sustain a flow rate of 72 gal./min. at 90ºC. This system is large, comprising 11 containers that can be deployed via traverse for deep-field operations. RHWD is a smaller, more portable, and scalable system capable of producing 1,000 meter-deep and 10 to 60 cm-diameter holes. Depending on its configuration (small or large), RHWD is able to sustain a flow rate of 8 gal./min or 24 gal./min at 90ºC, respectively. In its lightest (small) configuration it can be towed by snow machine and delivered (with modification) to a field location by Twin Otter flights. RHWD (large) was designed for LC-130 aircraft transport, requiring 4 to 5 flights to deliver all supporting equipment. It is hoped that presentation of these systems' capabilities to the SCAR-PAIS community of geoscientists will help develop new projects to address important questions regarding ice sheet dynamics and history, subglacial hydrology, geothermal heat flux, subglacial sediment distribution, oceanography, geomicrobiology, etc., and identify potential subglacial targets to which UNL's hot water drilling systems could provide clean-access.

Keywords: Hot water drilling, clean-access, subglacial, WISSARD, SALSA

References

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