

A NEWLY DEVELOPED MUTI-PROCESS DRILLING SYSTEM (MPDS) FOR SUBGLACIAL BEDROCK SAMPLING BENEATH POLAR ICE SHEET: DESIGN AND PRELIMINARY TEST

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Subglacial bedrock, buried beneath polar ice sheet, is important for the study of the historical evolution of ice sheets, revealing geological tectonics and paleoclimate. However, the sampling of subglacial bedrock is extremely difficult in technology and logistics. At present, only several subglacial bedrocks have been sampled from polar regions.

China is developing a muti-process drilling system (MPDS) for sampling at least 10 m bedrock beneath 1000 m ice sheet in polar regions. The MPDS is designed to remove drill cuttings using compressed air or drilling fluid in reverse circulation. The MPDS generally has five subsystems: drill rig, down-hole drill tool, generator, air system and drilling fluid circulation system. All the subsystems were modularly designed and can be integrated in standard 20 ft container, and could be easily moved on the ice surface by sledges. During drilling, compressed air with reverse circulation was used to penetrate firn and ice. The process continued until the ice pressure at the depth posed a risk of downhole drill sticking, necessitating operational adjustments. Then, drilling liquid was used to drill the ice that was leftover and the subglacial bedrock.

In 2024/2025 season, the MPDS was preliminarily tested at a site of 25 km away from the Zhongshan station in Princess Elizabeth Land, East Antarctica. In the test, air drilling in firn performed very poor, because the air reverse circulation can't form well and a lot of compressed air lost into highly permeable firn. Then, a casing made by unplasticized polyvinyl chloride has to be lowered down to 42 m to isolate the firn and was then cemented by freezing melting water. Subsequently, kerosen-based drilling fluid was used to drilling ice in reverse circulation. Finally, a 110 m borehole was drilled without coring. In the test, many problems were found in drilling rig, down-hole drill tool, air system and drilling fluid circulation system. Base on the experiences and lessons learned from field test, the MPDS is being improved and another test in Antarctica is expected in the coming season.

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