

# GENERAL CONCEPT AND LABORATORY TESTING OF A DEEP HOT-WATER DRILLING SYSTEM FOR ACCESSING SUBGLACIAL LAKE QILIN IN EAST ANTARCTICA

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The project aims to explore Subglacial Lake Qilin, located within long subglacial canyons in Princess Elizabeth Land, East Antarctica. This lake is ~42 km in length and has an area of 370 km<sup>2</sup>, making it one of the largest subglacial reservoirs in Antarctica (Yan et al. 2022). The lake is overlain with an average ice thickness of about 3600 m. The estimated maximal water thickness in the central part of the lake is ~240 m. The average temperature of the ice at the surface is -41 °C.

Subglacial Lake Qilin has been chosen as a candidate for exploration because it is (a) logistically accessible through Chinese scientific field operations (it is located ~520 km from the Chinese Zhongshan Station); (b) thought to have been isolated for potentially hundreds of thousands of years and may provide unique information about microbial evolution, past climate, and the formation of the ice sheet; (c) representative of many other deep subglacial Antarctic lakes in terms of pressure and temperature. During the 2024-2025 season, field radar and seismic surveys were conducted above Subglacial Lake Qilin, and the optimal location for the drilling site was identified in the central part of the lake.

The proposed exploration concept is based on a deep clean hot water drilling system, which is considered to be the most environmentally friendly access technology at the moment. We also plan to test an alternative option for subglacial exploration – combination of hot-water drilling with thermal drilling by RECOVERABLE Autonomous Sonde (RECAS). RECAS allows us to drill ice both downward and upward, and to sample subglacial water, while keeping the subglacial lake isolated from the surface.

The proposed drilling system includes eight subsystems: (1) primary heating system, (2) secondary heating system with high-pressure pumps, (3) cleaning system, (4) hoisting system of the main hole, (5) downhole drill-nozzle, (6) return water system, (7) electrical generators, and (8) control system (Talalay et al. 2024). The total estimated weight of the system, excluding generators and fuel, is 85.8 t. The working power of all the equipment is in range of 200-275 kW, and the estimated diesel fuel consumption for drilling and maintaining of the access hole with depth of 3600 m is approximately 110 t.

All the drilling components passed through intensive subassembly tests, and the whole system was tested in Qiaowei Lab, Jilin University, Changchun, China. According to the proposed schedule, the hot-water drilling system will be delivered to Antarctica in November-December 2025, and then transported to the selected site. Access drilling to the lake is planned for January-February 2026. In an ideal scenario without any accidents, it would take approximately 170 h to penetrate through the ice with hot water drill, sample the water, and collect sediment samples.

## References

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