National Aeronautics and Space Administration

Postdoc Research

Analogue mission to Europa's ocean with an Alaskan field campaign

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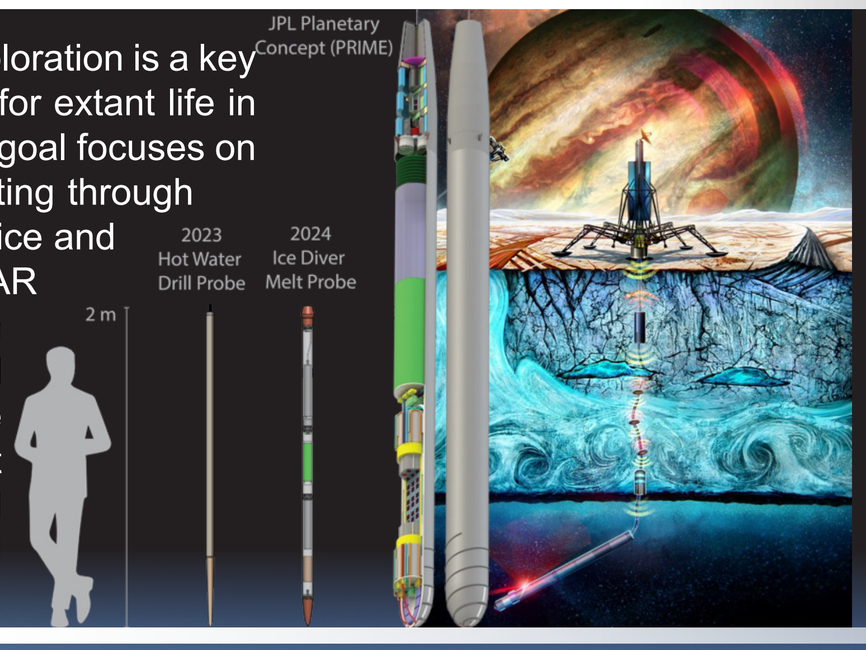
Context

Planetary ocean access and exploration is a key goal in the exploration of Ocean Worlds and search for extant life in our solar system. Ongoing development towards this goal focuses on autonomous robots, called *Cryobots,* capable of melting through icy shells and conduct science measurements in the ice and ocean. ORCAA, funded through the NASA PSTAR program, is an analogue mission to Europa's ocean including two field campaigns in summers 2023 and 2024 to the Juneau Icefield, AK. The 2024 objective will be to access a subglacial lake using a cryobot prototype. In 2023, we tested the project's integrated logistics, scientific operations, glacier environmental constraints definition, and science sampling.

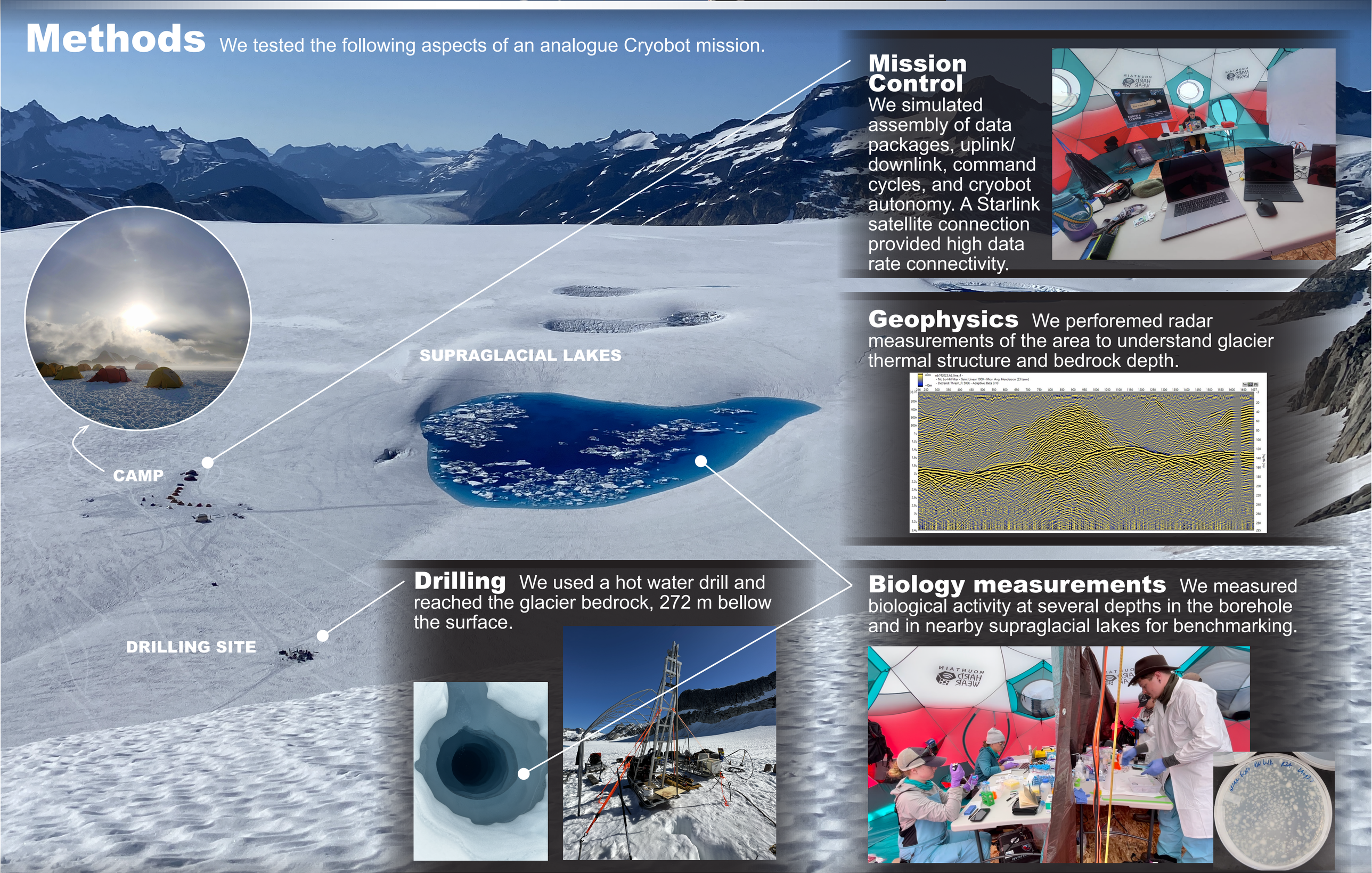


Implications for future missions

Integrated field testing and operations of the Cryobot concept in the context of an analogue Europa mission aims at providing JPL–and other institutions developing these technologies–with constraints on detection limits and life in glacial reservoirs. It also represents the critical first step towards understanding how future operations will be conducted, including autonomy and the role of humans-in-the-loop.

Methods

We tested the following aspects of an analogue Cryobot mission.



Mission Control

We simulated assembly of data packages, uplink/ downlink, command cycles, and cryobot autonomy. A Starlink satellite connection provided high data rate connectivity.

Geophysics

We perforemed radar measurements of the area to understand glacier thermal structure and bedrock depth.

Drilling

We used a hot water drill and reached the glacier bedrock, 272 m bellow the surface.

Biology measurements

We measured biological activity at several depths in the borehole and in nearby supraglacial lakes for benchmarking.

Results and conclusions

Analyses with both terrestrial microbiology and planetary astrobiology instruments found very low ATP (and other biomarker) concentrations in both supraglacial lake and melted borehole water, demonstrating the necessity for very clean instrumentation for the 2024 campaign to ensure accurate biology measurements. Hydrology of the glacier was surprisingly active. We observed the borehole draining and getting refilled in less than 24 hours and encountered several stable glacial water reservoirs. Geophysical measurements were conducted at the 2024 analogue mission site, observing very active hydrology in the glacier with a subglacial lake that we will access using a Cryobot. Efforts now focus on integreating pumping, sampling, and analysis systems to automate sample collection and scientific study. Continued development of automation and assessement of command cycles, as well as the role of humans-in-the-loop, will enable this simulation of the first Europa analogue Cryobot mission next summer.

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