SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development (3)

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# DEVELOPMENT OF A MANEUVERABLE SUBSURFACE PROBE FOR SOLAR SYSTEM ICES AND TESTING IN ANTARCTICA

**Abstract**

A subsurface ice exploration probe is an important building block for future solar system exploration missions. Extensive water ice bodies exist on Mars and the icy moons of the outer solar system. Although their subsurface environments are scientifically extremely interesting, they are also extremely difficult to access. Europa is probably most interesting from the astrobiological perspective, but access to subsurface material might be easier on Enceladus, where - according to Cassini measurements - ice grains with organic compounds escape via cryovolcanism from "warm" fractures in the ice, known as "Tiger Stripes". Because landing in close vicinity to such a fracture is very risky, it might be preferable to land at a safe distance and to use a maneuverable subsurface ice probe to navigate to such a water-bearing fracture at a depth of 200m below the surface. Once there, the subsurface ice probe can sample and analyze the materials in the fracture. The required technology is currently developed and tested at FH Aachen University of Applied Sciences' Astronautical Laboratory. "IceMole" is a maneuverable subsurface ice melting probe for clean sampling of subsurface ice and subglacial liquids and for clean in-situ measurements. In the last 4 years, several IceMole prototypes were successfully tested on glaciers in Switzerland, Iceland and Antarctica, where they demonstrated successful horizontal, upward and downward melting capabilities, curve-driving capabilities, and dirt-penetration capabilities. The most recent IceMole prototype is funded by the German Space Administration (DLR) and developed by a university consortium. It includes a sophisticated system for obstacle avoidance, target detection, and navigation in ice. The main technical

objective of this project, which is termed "Enceladus Explorer" (or "EnEx"), is to develop and test the technology that is required for navigation in deep ice, in preparation of the IceMole and the associated navigation technology for Enceladus and other potential extraterrestrial targets. The EnEx-probe also features a clean mechanism for the sampling of subglacial brine from a crevasse. To validate the technology, the EnEx-probe will be used in 2014 for clean access into a unique subglacial aquatic environment and an extraterrestrial analog at Taylor glacier (Taylor Valley, Antarctica), known as Blood Falls, with subsequent sample return from this subglacial brine for chemical and microbiological analysis. In this contribution, we describe the IceMole probe design and the Enceladus Explorer mission concept, and report the results of our 2013 field tests at Canada glacier and Lake Hoare (also Taylor Valley, Antarctica).