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Adaptations and Proof-of-Concept of the Hammering Drill Device for Investigations of Europa's Ice Crust – The 'Cryo-Mole'

C. Lange, L. Richter

Institute of Space Systems, Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
(Caroline.Lange@dlr.de, Lutz.Richter@dlr.de)

Abstract

With the emerging field of Astrobiology, novel targets for the exploration of our Solar System are being unveiled. One is the Jovian moon Europa, which is not only geologically of particular interest but also from the astrobiological point of view of special importance, since past discoveries have proven the existence of a liquid water ocean under Europa's thick icy crust.

Considering Europa's astrobiological potential, the best way to explore its mysteries is to initially analyse the near-surface composition at a carefully chosen landing site where ocean material may have been exposed in geologically recent times, to be later followed by attempts to gain access to the subsurface ocean. In the past, several concepts of melting probes, so called 'Cryobots' have been proposed for this purpose and it has proven that essentially revolutionary technologies will be needed to cope with the highly demanding constraints imposed on such a system, i.e. considering mass, volume and power budgets, but also environmental and planetary protection requirements.

At the German Aerospace Center DLR, a hammering drill ('mole'), called PLanetary Underground TOol (PLUTO) has been developed for the BEAGLE 2 Mars lander, to represent a new and promising direction for subsurface sampling and in-situ measurements. The method of using an internal electro-mechanical hammering mechanisms for forward movement into the subsurface, reaching depths of several meters, provides a innovative lightweight and low power solution not only for collecting subsurface samples, but also for carrying sensors to perform in-situ investigations of the subsurface.

Though this tool has originally been developed for the application on Mars, it is currently under investigation for utilization in the lunar environment and likewise we propose its utilization at the Jovian moon Europa.

This paper is intended to investigate necessary adaptations of the existing system for such an application, in particular to explore a combination with a melting probe to ensure movement in an ice-dust mixture that is expected to make up the icy crust.

We plan to perform a proof-of-concept and initial lab investigations on this suggested Mole-melting probe combination to define the amount of heating in combination with the hammering force that is required for efficient forward motion depending on the ice-soil mixture properties.

Finally we will investigate boundary conditions and requirements for instrumentation of the 'cryo-mole', to allow maximum scientific return and to advance our understanding of Europa's ice environment and its habitability.