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SUBSURFACE PENETRATION TOOLS FOR IN-SITU MEASUREMENTS ON PLANETARY BODIES

Abstract

Growing interest in planetary subsurface exploration has prompted an examination of new sampling tech-nologies and subsurface in-situ measurements. In this talk, an instrumented hammering mole for subsur-face measurements (HP3) will be presented. The instrument consists of an electro-mechanical mole, a payload compartment, and a tether equipped with temperature sensors. The latter can be actively heated for thermal conductivity measurements. A tiltmeter and accelerometer will help to track the path of the mole. The payload compartment has room for sensors such as a permittivity probe, a bore-hole camera, and/or a mass-spectrometer. Following deployment of the instrument, instrument operations will be split into two phases: During the penetration phase soil intrusion is achieved by means of the electro-mechanical hammering mechanism. The net hammering time is expected to be 12 h to reach the final depth, but hammering will be interrupted at intervals of 0.5 m to conduct thermal conductivity and elec-trical measurements. After the final penetration depth has been reached, the instrument will switch to the monitoring mode. This mission phase basically consists of column temperature readings and lasts to the end of the mission.

The instrument has been pre-developed in two ESA funded precursor studies and has been further devel-oped in the framework of ESA's ExoMars mission. The current readiness level of the instrument is TRL 5.6 (ESA PDR Apr. 2009) which has been achieved with several Breadboards developed and tested be-tween 2004 and 2009. As no drilling is required to achieve soil penetration, HP3 is a relatively lightweight heat flow probe, weighting less than 1800 g. HP3 has been further studied as parts of the discovery pro-posals Lunette and GEMS and for the proposed Japanese lunar mission SELENE 2.

Another further application of the Mole is the so called "Cryo-Mole", which will be a combined hammer-ing and melting probe for icy planetary subsurfaces as can be found on the Moon, Mars, Titan, and Eu-ropa. This device is right now under development at the Institute for Sapce Systems in Bremen.

Based on a parameter study, a first baseline-design will be presented, which will include for instance the design of a pressure vessel for the mole housing to prevent the mechanisms and electronics from intruding water, the implementation of a tip-heating to facilitate movement in the ice-soil mixture and the general heating concept of the system.