THERMAL INERTIA AND COHESION OF MARTIAN SOIL: THE SPICE EXPERIMENT FOR THE NETLANDER MISSION.

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The NetLander Mission will for the first time offer the opportunity to do long-term Geophysical and Meteorological Network science on Mars. Four identical probes will be brought down at different locations of the surface, thereby yielding a unique opportunity to enhance our knowledge of our neighbour planet.

In response to the AO issued by the NetLander consortium, Spohn et al. proposed the SPICE (Soil properties: thermal Inertia and Cohesion) Experiment to investigate the properties of Martian soil my means of simple techniques.

NetLander description

During the Phase A study, the strawman payload of the NetLander surface modules (SurfM) was considered to consist of a seismometer (SEIS), a meteorological package and a few other experiments (i.e. magnetometer, camera, etc.) The SurfMs will remain operational on the Martian surface for approximately one Martian year. The total mass of one NetLander SurfM is limited to approximately 20kg.

Scientific background

Currently little is known about the microstructure of the Martian regolith, i.e. its porosity, its grain size distribution and the extent of aeolian sedimentation. Another process that is of interest is the volatile exchange between Martian soil and the atmosphere. SPICE tries to address these topics by a set of basic measurements.

The soil properties have important consequences for subsurface volatile ices on Mars as a soil layer serves as a thermal insulation and thus the existence and depth of permafrost layers depends on the insulative properties of the soil. These properties in turn change with sublimation and condensation of CO_2 and H_2O. Key paramaters that play a role in the gas diffusion processes are the pore/grain size and the cohesion of the grains. These also play a role in the rate of aeolian erosion.

Furthermore, the mechanical and thermal properties of the martian regolith should be known to improve future experiments like penetrators or drill devices. Moreover, when samples are taken (i.e. during MSR), it is mandatory to know under which conditions these have been stored.

Description of the SPICE Experiment

SPICE consists of a set of very simple sensors and relys on data processing by the SEIS experiment, thereby reducing its mass to the bare minimum of a few grams. It consists of a miniature force sensor to be integrated into the spikes used for coupling the SEIS seismometer to the ground. Other seismometer spikes will also be equipped with temperature sensors. Some more temperature sensors will be attached to portions of the SurfM structure where they are likely to be in contact with the ground.

All temperature sensors can be operated in two modes: In mode one (low excitation current) the temperature of the sensor will be measured directly, whereas in mode two (high excitation current) the sensors can be heated.

Measured properties

The soil properties measured directly with the SPICE experiment are:

1. The temperature field below the NetLander SurfMs (sensor mode 1)
2. The thermal conductivity and diffusivity (sensor mode 2)
3. The penetration resistance of the martian soil upon release of the seismometer (force sensor)

From these (and other) data it will be possible to deduce a number of results helpful for e.g.:

1. constraining permafrost models
2. deducing layering, grain size distribution
3. modelling gas diffusion
4. modelling cementation

Thus, we will be able to get a relatively high data return from a number of measurements that are rather inexpensive both in terms of mass and data transfer rates.