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Radar Sounding Investigations of the Martian Subsurface by the 2018 ExoMars-C Rover

V.Ciarletti (1), D. Plettemeier (2), Philippe Cais (3), S. Clifford (4) and the WISDOM team

(1) LATMOS/IPSL/UVSQ, Guyancourt, France (valerie.ciarletti@latmos.ipsl.fr), (2) Dresden University of Technology, Germany, (3) Laboratoire d'Astrophysique de Bordeaux, Floirac, France, (4) Lunar and Planetary Institute, Houston, USA

Abstract

The WISDOM (Water Ice Subsurface Deposit Observation on Mars) Ground Penetrating Radar will fly on the ESA-NASA 2018 ExoMars-C mission, which combines the science payload of the original ESA ExoMars Rover with the robotic arm and sample cache of NASA's Max-C Rover into a single rover, whose samples will ultimately be retrieved by a future Mars Sample Return mission.

WISDOM was designed to investigate the near-subsurface down to a depth of ~2-3 m, commensurate with the sampling capabilities of the rover's drill. The information provided by WISDOM will assist in understanding the large-scale geology and history of the landing site, as well as selecting the most appropriate locations where to drill and collect sub surface samples for further analysis.

Here we review the real-world performance of the instrument as experimentally observed in various field test environments.

1. Introduction

The main scientific objectives of the 2018 ExoMars mission are to search for signs of past and present life and investigatie the geologic, geochemical, and volatile environment as a function of depth in the shallow subsurface. These objectives called for a combination of surface mobility; the ability to remotely sense, access, and sample the subsurface; and capacity to analyze the collected core samples.

A WISDOM prototype, representative of the final flight model is now being tested. A series of calibrations and verifications on artificial targets have been initiated as well as field tests in a variety of natural environments.

Figure 1 : Experimental set-up for field tests. The electronic unit and the batteries are in the black box. The transmitting and receiving yellow antennas are identical[2]

2. Experimental results

WISDOM is designed to be able to sound the sub-surface to depths that largely exceed the 2-3 meters objective set by the drilling performances. Measurements that have been initiated in various environments (glacier, sand, pyroclastic deposits,…) show that, as expected, the penetration depth is highly dependent on the kind of environment (fractured, conductive,…) but still remains within the mission requirement.

The WISDOM broad frequency bandwidth allows performing sub-surface characterization with a resolution close to 0.5 ns in the time domain. The resulting vertical resolution depends on the sub-surface permittivity. Experimental data have shown that WISDOM is actually able to discriminate thin superimposed layers (see Figure 1)

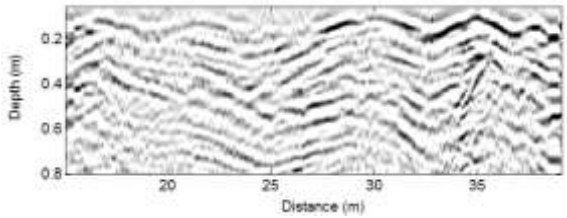

Figure 1: Example of fine layering observed on a glacier (Chamonix, France)

Polarimetric measurements have also been recently acquired. They demonstrated their ability to provide a better understanding of sub-surface structure and significantly reduce the ambiguity associated with identifying the location of off-nadir reflectors, relative to the rover path

6. Summary and Conclusions

Further optimization of the instrument, through additional laboratory and field tests - conducted in a wide variety of natural Mars analogue environments, will allow improvement of the instrument signal-to-noise ratio that will make possible the detection of more subtle reflections.

The new 2018 mission to Mars is still to be defined and some changes in the different units (electronics and antennas) accommodation are expected. Special attention will be paid to the antennas accommodation on the new rover. Partial redesign of these antennas might be necessary to maintain the original performance expectations of the instrument.

Acknowledgements

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References

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