The 2018 ExoMars WISDOM GPR on Mt. Etna: First Field Test Results in a Mars Analogue Volcanic Environment

Valerie Ciarletti (1), Stephen Clifford (2), Andre-Jean Vieau (1), Benjamin Lustrement (1), Rafik Hassen-Kodja (1), Philippe Cais (3), and Dirk Plettemeier (4)

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

The WISDOM (Water Ice Subsurface Deposit Observation on Mars) Ground Penetrating Radar (GPR) is one of the instruments that have been selected as part of the Pasteur payload of ESA's 2018 ExoMars Rover mission. The panoramic camera and the WISDOM radar will be used to perform large-scale scientific investigations of the land-ing site, while the Analyical Laboratory Instruments will analyze the core samples obtained by the subsurface drill. WISDOM will help identify the location of sedimentary layers, where organic molecules are the most likely to be found and well-preserved. WISDOM has been designed to investigate the near-subsurface environment down to a depth of $\sim$2-3 m with a vertical resolution of a few centimeters [1]. WISDOM is a step frequency radar operating over a wide frequency band and particular attention was paid to the design of the antenna system, which needs to be able to conduct polarimetric measurements over the whole bandwidth[2].

A WISDOM prototype instrument, representative of the mass, volume and power consumption of the final flight model is now being tested in both artificial and natural environments. A series of calibrations and verifications on artificial targets have been initiated as well as field tests in Martian analogue environments.

Validation and calibration of the instrument in simple environments: Simple targets like metal spheres and plates have been buried in the sand at Fontainebleau and Cernay (France) and used to validate the instrument's performance, data processing and interpretation codes. The results are in good agreement with expectations in terms of penetration depth and resolution. These initial tests have also shown that the shape and amplitude of the returned surface echo can provide quantitative information regarding surface roughness and top layer permittivity.

Field test in volcanic environment: The prototype was field tested on Mount Etna in October 2010. Despite the rather high moisture content, due to recent rainfall, the WISDOM prototype achieved a maximum penetration depth in excess of 3 meters in a thick pyroclastic deposit, where subsurface interfaces were clearly detected. A number of 2D profiles were obtained by conducting a series of successive soundings at 10 cm intervals. A 3D map of the subsurface downward-dipping geometry of the best-resolved interface was then constructed by obtaining several constant-interval parallel and orthogonal 2D profiles in the form of a grid. Additional profiles were obtained in other Etna pyroclastic environments which included embedded lava bombs and thinly-mantled lave flows. Full-polarimetric measurements were also acquired for the first time, demonstrating their ability to: (1) provide a better understanding of sub-surface structure and (2) significantly reduce the ambiguity associated with identifying the location of off-nadir reflectors, relative to the rover path.

These initial field tests, using both artificial and natural targets, have met WISDOM performance expectations. Further optimization of the instrument, through additional field and laboratory tests - conducted in a wide variety of simulated and natural Mars analoque environments, will allow improvement of the signal-to-noise ratio that will make possible the detection of more subtle reflections. Our current plans are to conduct $\sim$1-2 major Mars analogue field tests, to further these instrument development objectives, each year.

[1] Ciarletti V et al. (2010) WISDOM a GPR designed for shallow and high resolution sounding of the Mar-tian subsurface, 0023-SIP-2010-PIEEE
[2] Plettemeier D et al, Full Polarimetric GPR Antenna System Aboard the ExoMars Rover, 2009 IEEE Radar Conference - 2009