Results from the first field tests of the WISDOM GPR (2018 ExoMars Mission). V. Ciarletti[1], S. Clifford[2], A.J. Vieau[1], B. Lustrement[1], R. Hassen-Kodja[1] and P. Cais[3].
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Introduction: 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[1]. The Pasteur payload actually consists of two different sets of instruments: the Panoramic Instruments, which include a wide angle camera and the WISDOM radar, that will be used to perform large-scale scientific investigations of the landing site and the Analytical Laboratory Instruments that 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 ~2-3 m with a vertical resolution of a few centimeters [2]. WISDOM is a step frequency radar operating over a wide frequency band between 0.5 and 3 GHz. Particular attention was paid to the design of the antenna system, which needs to be able to conduct polarimetric measurements over the whole bandwidth without significant distortion [3].

Tests and experimental validation of the instrument A WISDOM prototype instrument (electronic unit and antennas), representative of the mass, volume and power consumption of the final flight model is now available for tests 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 and the data processing and interpretation codes. The obtained results are in good agreement with the 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 same prototype has been used during a field test on Mount Etna in October 2010 (see Fig.1).

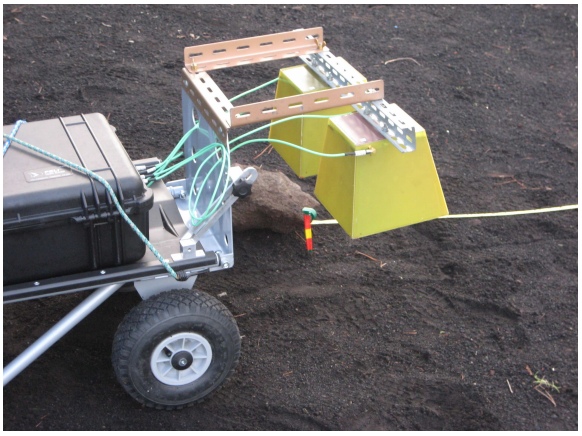

Fig. 1 : WISDOM prototype on Mount Etna

Despite the rather high moisture content in the pyroclatistic deposits due to preceding rain fall, a penetration around 3 meters has been observed and interfaces were clearly detected below the surface level. .Several profiles have been obtained by conducting a series of successive soundings 10 cm apart and a preliminary 3D mapping of the main detected interface has be reconstructed from measurements performed following a grid pattern (see Fig.2).

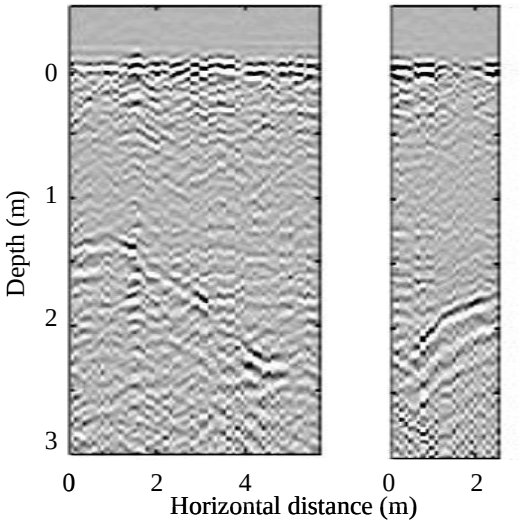

Fig.2 : Example of two perpendicular profiles showing the same buried interface between 1.5 and 2.5 meters below the surface.

Conclusion and perspectives The preliminary results obtained on both specific targets and on the natural environment of Mount Etna meet the instrument requirements.. Further optimization of the instrument will allow improvement of the signal to noise that will make possible the detection of even weaker signals. Future work will be dedicated to quantitative interpretation of polarimetric experimental data sets This will require acurate electromagnetic simulations able to model the antennas system as well as the wave propagation in and interaction with complex subsurface structures (including interface roughness, inhomogeneous layers, inclusions and faults).

Acknowledgements: WISDOM development and this research were supported by funding from the French space agency CNES and from the German space agency DLR.

References:

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