

Interpretation of WISDOM/ExoMars 2020 data acquired on natural dry environments

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The rover of the future ExoMars 2020 mission to Mars has on board a polarimetric ground penetrating radar named WISDOM (Water Ice Subsurface Deposits Observation on Mars) that will sound and characterize the subsurface along the rover path. WISDOM will provide data that are essential to the understanding of the local geological context and to the selection of the most promising locations to collect samples. Thanks to its broad frequency bandwidth of 2.5 GHz, WISDOM is able to probe down to a depth of approximately 3 m in lithic environments with a vertical resolution of a few centimeters that is requested for the drilling operations. The WISDOM team is currently working on the preparation of the scientific return of the WISDOM data that will be collected on Mars.

In this paper, we specifically focus on the tools that are developed to automatically detect and characterize potential rocks buried in the subsurface, and extract all the possible information from their radar signatures. We show that constraints on the composition of the subsurface can be found through the retrieval of its permittivity and that the geological context of the site can be inferred from the shape and the density of rocks in the subsurface (as they can be related to the geological processes that have shaped and placed them there, such as impacts, fluvial processes, volcanism, . . .).

The algorithm we developed is based on neural network that is used to detect areas in the subsurface that show presence of rocks/blocs. It is then followed by a Hough transform that is used to analyze each radar signature to get an estimate of the local permittivity value (which is mandatory to convert the measured delays in accurate distances). The algorithm has been tested and validated on simulated data obtained with a 3D FDTD code. It has been designed to be run on the data that will be collected on Mars in the limited time allocated during the mission's operations.

We present results obtained by this automatic detection of structures of interest on experimental data acquired in a semi-controlled environment and on Martian analogues (South of France and Atacama Desert), that demonstrate the ability of WISDOM to provide clues about the geological context of a site.