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Abstract

The search for evidence of past or present life is the main objective of the ESA-Roscosmos ExoMars rover mission [1]. The rover will be equipped with a suite of instruments dedicated to the investigation and characterization of the surface and shallow subsurface of Mars. In particular, a drill will provide, for the first time, ground samples from a depth of approximately 2 meters and a Ground Penetrating Radar named WISDOM (Water Ice Subsurface Deposit Observations on Mars) will map the shallow subsurface down to a depth of a few meters revealing its stratigraphy and structure, and thus providing invaluable insights into its origin and geological history.

A review of the candidate sites for the ExoMars rover mission has been conducted and four landing sites have been preselected [2] among which the Oxia Planum site (Fig. 1).

In this paper, we use all available information on Oxia Planum to build plausible geological models of the near-surface and translate them into geoelectrical models based on the expected dielectric constant and conductivity values published in the literature. Electromagnetic simulations are then run to assess the performances of the WISDOM radar at Oxia Planum.

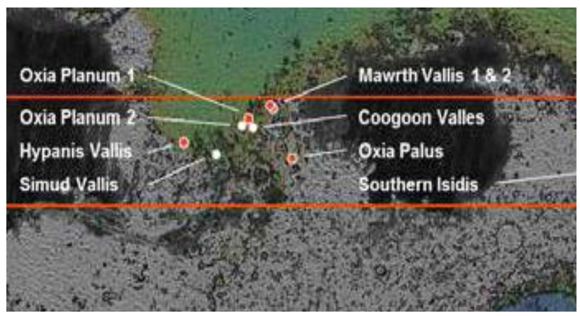

Fig. 1: The landing sites candidate for the ExoMars rover mission

1. The Oxia Planum potential landing site

Oxia Planum, a proposed landing site for ExoMars 2018, is located between 16° and 19° of latitude north and -23° to -28° of eastern longitude. This region exhibits one of the widest Mg/Fe phyllosilicate unit as mapped globally with OMEGA and with CRISM multispectral data [3]. The entire region corresponds to light toned and finely layered units. Thanks to HiRISE image stereo-couples acquired over the landing ellipse, we did a systematic investigation of the layers exposed in the upper part of the ramparts of small impact craters from 300 m to 1 km in diameter. The exposed layers were systematically mapped and their thicknesses were measured under Geographic Information System (GIS) software. The goal was to retrieve the stratigraphy solved by HiRISE data of the ten first meters of Oxia Planum subsurface as 10 m is the maximum depth of penetration of WISDOM. The results show that these ten first meters are composed of 4 to 9 well-identified layers on HiRISE images. The thicknesses of these layers range from 0.4 m to 5 m with an average thickness of 1.2 m.

2. The instrument

The WISDOM GPR [4] will be accommodated the mission Rover and operated from the surface. WISDOM has been designed to meet the scientific requirements of the ExoMars mission, which is to investigate the shallow subsurface down to a depth of ~3 m with a vertical resolution of a few centimeters. The data provided by WISDOM will be critical to understanding the local geologic context and to identifying and prioritizing the most promising targets for investigation by the drill. It will also aid in the identification of potential hazards, such as the presence of buried rocks, which could damage the drill and jeopardize the mission.

The stratigraphic profiles of shallow subsurface provided by WISDOM will allow the analysis of superpositional and cross-cutting relationships of the detected geological units and will give access to their relative timing, erosional history, deformational and structural development

Earlier field tests performed with a mock-up representative of the instrument, allowed us to verify the instrument performances and anticipate the fact that the penetration depth will be larger than 5 m in favorable environments. The purpose of the present study is to simulate the behavior of the instrument on Mars.

3. Simulations tool and results

Electromagnetic simulations that take into account the characteristics of the WISDOM radar (namely its distance to the surface, center frequency, frequency bandwidth, and antenna radiation pattern) have been performed. They were conducted using the OPEN TEMSI-FD software, which is based on the Finite Difference Time Domain method (FDTD). This non-commercial software was developed by C. Guiffaut [5] from the XLIM lab.

Simulation have been run for a variety of subsurfaces including layers with varying thickness, slope and geoelectrical nature, different degrees of roughness at the interfaces, and the presence of embedded blocks and random inhomogeneities within the geological units.

The results of the simulations will be presented for the retrieved stratigraphy of Oxia Planum. The obtained simulated data will be, when possible, compared to actual radar data acquired with WISDOM.

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