GROUND PENETRATING RADAR (GPR) DATA FROM "MARS": THE SCANMARS EXPERIMENT IN AMADEE18

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Introduction. The characterization of the subsurface geology, particularly in environmental conditions potentially suitable to host water resources, represents one of the most important objectives of the planetary exploration. The geophysical techniques have all the potential and technology to be used as a tool for gathering such kind of information on other planets. Among those, the Ground Penetrating Radar (GPR) is surely suitable to provide high-resolution data about the structure, geometry and physical properties of the surveyed rocks (Jol *et al*., 2009), also related to the moisture content in the shallow subsurface (Ercoli *et al*., 2017). A proof of that is the incoming mission ExoMars2020, that will bring onboard a rover equipped with a GPR named WISDOM (Ciarletti *et al*., 2017) on the Red Planet. For this reason, analogue planetary missions are mandatory to test new technologies and to refine workflows and operative procedures (Snook and Mendell, 2004; Groemer *et al*., 2014; Rossi *et al*., 2018). During the month of February 2018, the Austrian Space Forum (OeWF) organized a simulated mission, named Amadee18, in the Dhofar desert in Oman. An international group of scientific teams were supervised by a Mission Support Center in Innsbruck (Austria), that also directed a small field

Fig. 1 - Analogue astronauts collecting GPR data during the ScanMars experiment of Amadee18 (Photo credits OeWF).

crew operating in the field. This team, encompassing analogue astronauts left in total isolation for 30 days, have conducted scientific experiments in preparation of future human Mars missions. Several experiments have been done in different fields, like engineering, planetary surface operations, astrobiology, geophysics/ geology and life sciences. Among those, in ScanMars, the astronauts faced with a Ground Penetrating Radar to investigate the subsurface, though the recording of reflected radio-waves pulses.

Data and Method. The ScanMars experiment took place in the Dhofar desert (Oman), where the analogue astronauts used a Radsys Zond 12e Ground Penetrating Radar (GPR). The instrument was equipped with a 500 MHz antenna that guarantee an efficient manoeuvrability and a good compromise between resolution and investigation depth. A key aspect, from a logistical point of view, was that the data were collected by the astronauts, that despite their undoubtful qualities and preparation, didn't have any previous experience in GPR data collection. For this reason, they were trained in December 2017 by the project PIs, that provided them the theoretical, technical and logistical fundamentals. A detailed procedure protocol was also provided, with a step-by-step workflow to set-up hardware and software, in order to correctly collect and check the data during the activity onsite. Once in the field, the analogue astronauts were able to collect more than 110'000 GPR echoes, for a total length of about 2 km and 26 bidimensional profiles. The data quality is generally good, with a max penetration depth of 5 meters. A necessary post-processing phase was successively pursued, aimed to improve the data quality, through a customized processing flow including: trace editing, amplitude recovery, bandpass filters and topography corrections, time migration and depth conversion of the original two-way-travel-time (TWT) GPR profiles.

Results and conclusions. The ScanMars experiment was a success for several reasons: the amount of good quality scientific data collected, the volume of new experience created among the scientific team, the operation rooms and the field crew and also the echo generated by international press and media. This fact is a proof of the increasing interest in the planetary exploration, testified also by an increasing number of simulated experiments. With ScanMars and AMADEE-18 in general, we faced with the different aspects of scientific exploration among different and distant worlds, developing synergic strategies and workflows part of the exploration cascade, that will be the base of future human planetary missions. More in detail on the ScanMars outcomes, the radargrams have shown that different geologic media (e.g. sandy,

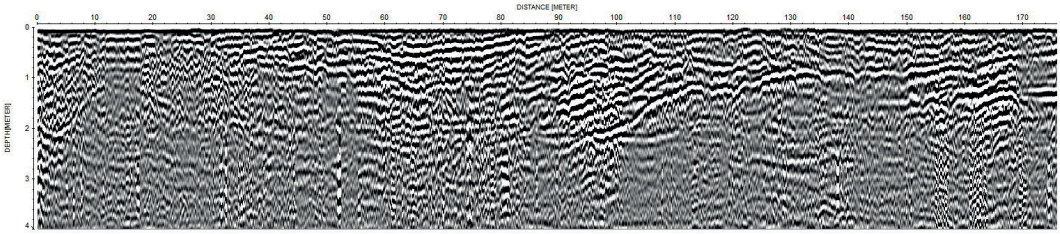

Fig. 2 - Processed GPR radargram from ScanMars experiment. The radargram is the visual representation of the radar echoes recorded in the field, here showing dipping reflectors compatible with geological features typical of the wadi riverbed.

gravelly, clayey and rocky soils) clearly return back different GPR signatures, characterized for example by alternated strong reflections and attenuated signal, or/and diffraction patterns. The processed data show in some cases very clear high-resolution reflectors with variable dip, displaying geologic features typical of the wadi riverbed. Even if we are not yet able to unambiguously distinguish the presence of water, the data clearly display alluvial structures that could guide future astronauts to dig, from a geological point of view, in the most proper sites with higher probability to find water. Considering the recent discovery of liquid water beneath the surface of Mars (Orosei *et al*., 2018), such missions are strategic to look ahead for developing techniques to be used, by the future explorers, on the Martian surface to inspect its buried subsurface.

Acknowledgments. Thanks to the AMADEE-18 field crew, space dreamers whose passion and efforts contributed to the experiment success. Authors also thank the Italian Radio Amateur Association (ARI) and their president Francesco Orfei IZ0ABD, due to their support provided in the GPR equipment optimization in laboratory during the mission preparation.

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