Ma_MISS on EXOMARS 2020. M.C. De Sanctis (1), F. Altieri (1), E. Ammannito (2), S. De Angelis (1), M. Ferrari (1), A. Frigeri (1), D. Biondi (1), R. Mugnuolo (2), S. Pirrotta (2), T. Di Iorio (3), F. Capaccioni (1), M.T. Capria (1), V. Ciarletti (4), B. Ehlmann (5) , C. Federico (1), G. Magni (1), M. Lavagna (6), M. Formisano (1), S. Fonte (1), M. Giardino (2), G. Piccioni (1), F. Westall (7) and the Ma_MISS team. (1) Institute for Space Astrophysics and Planetology, IAPS-INAF, Rome, Italy (mariacristina.desanctis@inaf.it);(2) Italian Space Agency, ASI, Italy; (3) ENEA, Italy;(4)LATMOS, France; (5) Calthec, USA; (6) POLI-MI, Italy,(7) CNRS Orleans, France

The ExoMars 2020 launch window opens on 26 July 2020, and ExoMars will touchdown at Oxia Planum, a location with a strong potential for past habitability and for preserving physical and chemical biosignatures. The mission will deliver two science elements to the martian surface: (1) a lander instrumented to conduct environmental and geophysical measurements and (2) a rover with scientific payload to conduct a search for signs of life.

Ma_MISS is a visible and near infrared (VNIR, 0.4-2.2 μm) micro spectrometer hosted by the drill system of the ExoMars 2020 rover [1]. The Ma_MISS instrument has been developed to provide hyperspectral images of boreholes excavated by the ExoMars rover drill. Ma_MISS will characterize the mineralogy and stratigraphy of the shallow subsurface down to two meters [2]. The main objectives of Ma_MISS are: (1) determine the composition of the subsurface materials; (2) map the distribution of the subsurface H_2O-bearing and OH-bearing materials and possibly ices; (3) characterize important optical and physical properties of the materials (e.g., grain size); (4) produce a stratigraphic column that will provide information on the subsurface geology.

The drill can reach down to 2 m below the surface, and Ma_MISS will operate periodically during pauses in drilling activity and will produce hyperspectral images of the drill's borehole. The Ma_MISS instrument's main driving requirement was its miniaturization because it is embedded within the drill (Fig. 1). The spectrometer is placed in a box on the side wall of the drill box. The spectral range is 0.4–2.2 μm, with a spectral sampling of 20 nm a SNR~100 and a spatial resolution of 120 μm. The light from a 5W lamp is collected and carried, through an optical fiber bundle, to the miniaturized Optical Head, hosted within the drill tip. A Sapphire Window with high hardness and transparency on the drill tip protects the Ma_MISS optical head allowing to observe the borehole wall.

Different depths can be reached by the use of three extension rods, 50 cm long, each containing optical fibers and a collimator. The first extension rod is connected to the nonrotating part of the Drill, hosted on the rover, through a Fiber Optical Rotating Joint (FORJ), that allows the continuity of the signal link between the rotating part of the drill and the spetrometer.

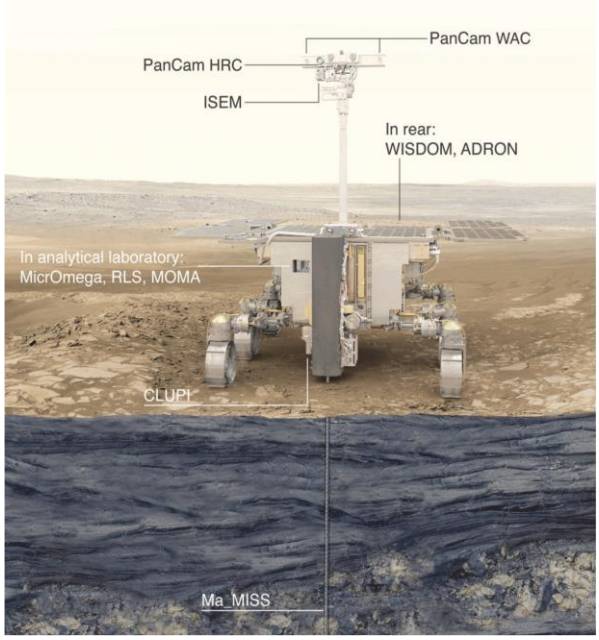

Fig. 1: Artistic view of the ExoMars-Pasteur Rover with instruments allocations. Ma_MISS is integrated within the drill.

The Ma_MISS instrument has been calibrated and delivered and is now integrated into the drill.

Results obtained in the lab on mineral/rock samples confirm that the Ma_MISS spectrometer has a spectral range, resolution and imaging capabilities suitable for the Mars subsurface characterization[2,3]. The spectra acquired with the Ma_MISS fine spatial resolution (120 μm) show minerals that are not recognizable at coarser resolution (~6 mm) (Fig.2). In the case reported in Fig. 2, a lava from *Montiferru/Bonarcado*, Ma_MISS is able to identify the a great diversity, indicating several different mineralogical phases within the observed area. Phyllosilicate, olivine, opaque phase can be identified with Ma_MISS but not at coarser resolution.

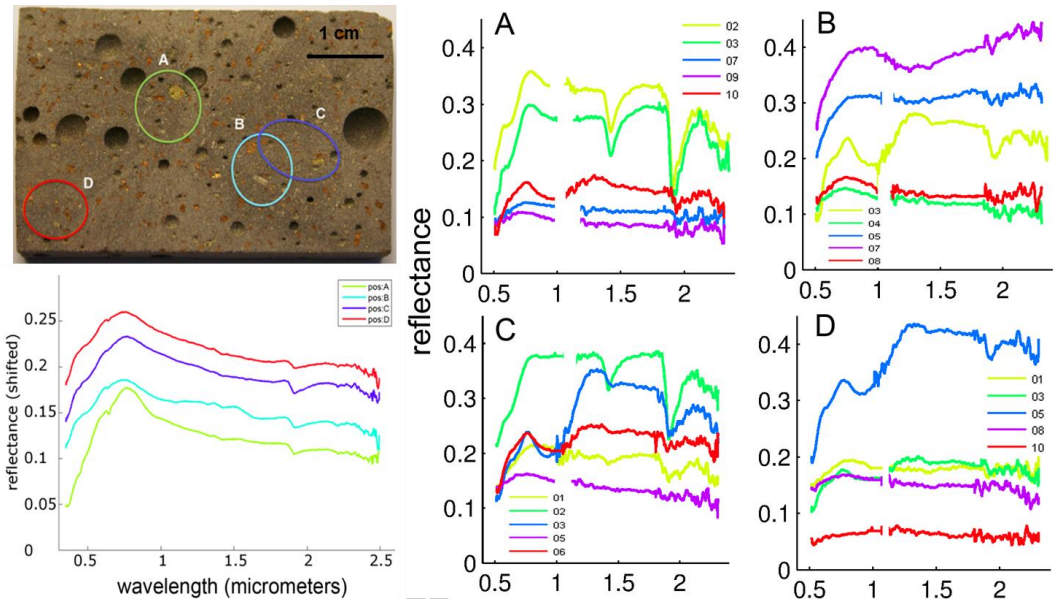

Fig.2 Left Top: slab of Montiferru/Bonarcado Lava. The letters (A,B,C,D) correspond to the areas analyzed with Spectro-goniometer setup. Each area is 6-mm-size; Left bottom: spectra acquired from the regions A,B,C,D, with the spectro-photometer FieldSpec Pro coupled with a mechanical goniometer, having a spatial resolution of about 6 mm. Right: Spectra acquired with Ma_Miss BreadBoard setup. In each single 6-mm-sized area, spectra in different positions have been acquired with Ma_Miss BB setup; Data at 1 μm are not shown in several spectra due to high level of detector noise, as well as data <0.5 μm.

Ma_MISS is the only instrument in the rover's Pasteur payload able to analyze subsurface material in its natural condition (*in situ*), prior to extracting samples for further analysis. In synergy with other Rover instruments, MA_MISS findings will help to refine criteria for deciding form where to collect samples.

References:

[1]Vago J.L. et al. (2017): Astrobiology, 17, 6, 7.
[2]De Sanctis et al. (2017): Astrobiology, 17, 6, 7.
[3]De Angelis et al. (2017): PSS, 144, DOI: 10.1016/j.pss.2017.06.005