THE CLUPI SCIENCE OPERATION TESTING FACILITY: PREPARATORY ACTIVITIES FOR AQUIRING IDEAL CLOSE UP IMAGES DURING THE EXOMARS 2022 MISSION Tomaso R.R. Bontognali[1,2], Yardena Meister[2], Brigitte Kuhn[2], Jean-Luc Josset[1], Beda Hofmann[3], Nikolaus Kuhn[2] [1]Space Exploration Institute, 68 Faubourg de l'Hopital, 2000 Neuchâtel, Switzerland, [2]University of Basel, Department of Environmental Sciences, Physical Geography and Environmental Change, Klingelbergstrasse 27, 4056 Basel, Switzerland, [3]University of Bern, Geological Institute, Baltzerstrasse 1+3, 3012 Bern, Switzerland, Email: tomaso.bontognali@space-x.ch,

Introduction: The close-up imager CLUPI is one of the instruments that will be onboard of the Rosalind Franklin rover, a robot that will search for signs of life in the framework of the joint ESA-Roscosmos "ExoMars 2022" space mission (Josset et al., 2017, Vago et al., 2017). CLUPI will acquire high-resolution images essential to investigate the geology of Oxia Planum, the selected landing site of the rover. CLUPI has the ideal specifications for deciphering the geological context and for identifying samples with a high potential to contain biomarkers (e.g., samples displaying putative microbially induced sedimentary structures), which will be selected to be analyzed with the instruments inside the rover.

During the ExoMars mission, the science team located at the Rover Operating Control Center will receive a limited number of CLUPI images (on average 1 full resolution CLUPI photograph per day), and it will have only few hours for interpreting the photographs and decide how to program the subsequent activities of the rover. It is, therefore, essential to be able to interpret the transmitted data as quickly and as precisely as possible, obtaining images providing straightforward answers to relevant scientific questions. To adequately prepare for this task, it is important to conduct comprehensive preparatory activities on Earth, prior to the primary mission on Mars.

Here, we describe a recently established testing facility named CLUPI Science Operation Testing Facility (CLUPI-SOTF) (Fig. 1). By presenting the results of some preliminary simulations, we illustrate the type activities we plan to conduct in the CLUPI-SOTF during the forthcoming months in view of the ExoMars prime mission scheduled for 2023.

CLUPI-Science Operation Testing Facility: The CLUPI-SOTF is part of the infrastructures made available by the University of Basel. It is located in Witterswil, Switzerland. Differently from other similar testing facilities, the CLUPI-SOTF has been designed for acquiring images under controlled light conditions from distances up to 8 m, which is not possible in most standard-size laboratories. The CLUPI-SOTF consists of a 80 m^2 room with a high ceiling and includes a 40 m^2 test bed surrounded by a canvas with a printed Martian landscape. The test bed is covered by a layer of basalt fragments and a sedimentary environment is simulated with a sandstone that includes a significant amount of hematite. An artificial outcrop made of painted cardboard has been built and serves as a stand for displaying and photographing actual geological samples. The illumination system includes a point source capable of producing up to 90000 LUX that is used for simulating direct light. For diffused light we use two spot lights combined with attachments that create a widespread light source.

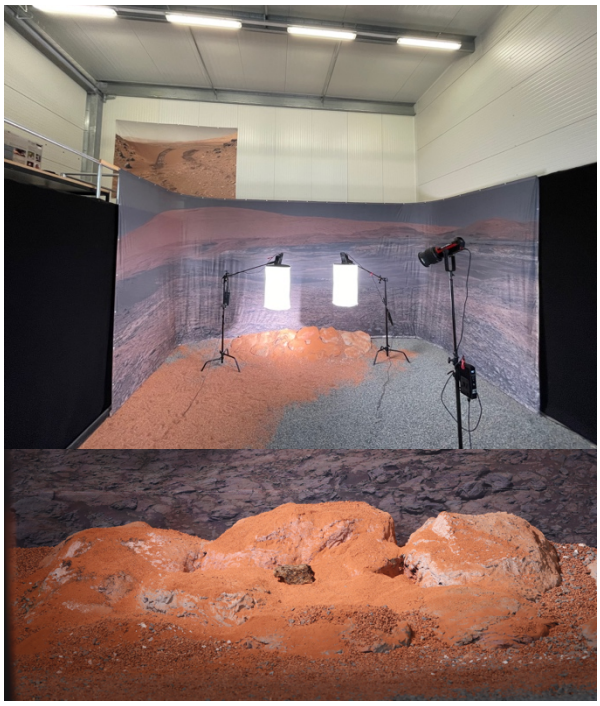

Fig. 1 *– The CLUPI Science Operation Testing Facility of the University of Basel.*

Goal of the preparatory activities: Although the spatial resolution and the technical specifications of CLUPI are well known, without performing tests on actual geological samples it is difficult to predict what is the light conditions and the minimum distance necessary to recognize "textures of interest" with an adequate confidence. Indeed, the ability of recognizing

textures and sedimentary structures from a given distance does not depend exclusively from the size of the defining features (e.g., particle size, thickness of the lamination) but also from attributes like the color (e.g., contrast between single grains or laminae), which in turn depend on the specific rock facies and its weathering status. Figure 2 shows an example of a test performed to identify from what distance a putative morphological biosignatures (i.e., planar cross section of a domical stromatolite) can be identified.

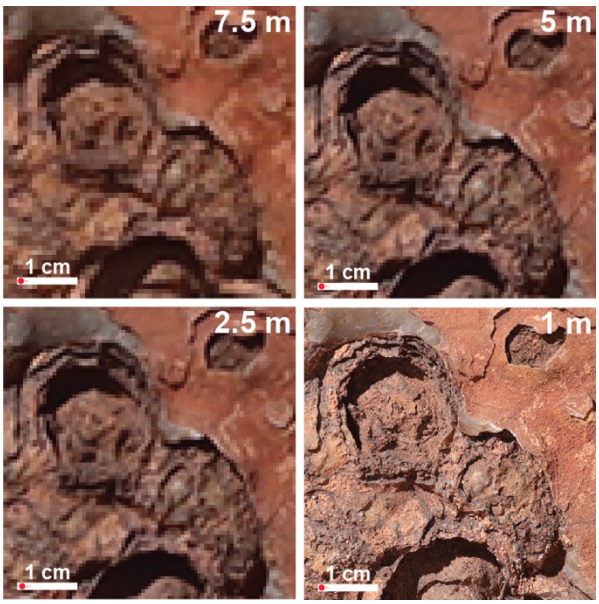

Fig. 2 *- Close ups of simulated CLUPI images acquired from progressively closer distance (white number on the upper right corner) of a domical stromatolite sample.*

The direction of incident light is another importat factor that can have a significant inlfuence for recognizing relevant morphological features. Figure 3 shows the same stromatolite sample photographed from the same position but under two different light conditions. In this example, a lateral illumination allows for a better recognition of textural features due to the topography of the surface of the sample (e.g., lamination emphasized by differential resistance to erosion or secondary alteration features). Instead, a perpendicular illumination appears better for recognizing mineralogical heterogeneities that are emphasized more by differences in color rather than topography.

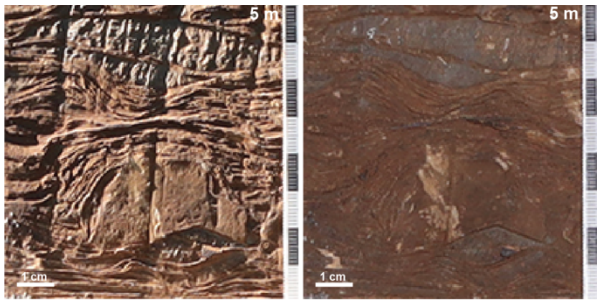

Fig. 3 *- Close ups of simulated CLUPI images of a stromatolite sample acquired with incident light almost parallel (left panel) and almost perpendicular (right panel) to the sample surface.*

The data produced in the CLUPI-SOTF will support the CLUPI/ExoMars science team in the daily tactical planning of the rover during the prime mission on Mars. The simulated CLUPI photographs will allow for approximately predicting what kind of visual information can be expected by acquiring images of geological samples from a given distance. In a mission in which rover movements and data transmission are limited, finding the best balance between "exploring a wider possible area" and "not driving-by interesting outcrops without noticing them" remains a fundamental objective.

References:

Vago, J.L., et al. (2017) Astrobiology 17, 471–510.
Josset, J.-L., et al., (2017) Astrobiology 17, 595–611.