

ExoMars CLUPI Instrument Testing at MINAR II

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Abstract

The CLUPI (Close-UP Imager) instrument developed for the ESA ExoMars 2018 mission participated to the MINAR II campaign inside the Boulby Mine, Cleveland Potash in April 2014. Operation and science validation tests have been carried out and the protocols and results are described.

1. Introduction

The design of landed planetary missions on Mars and the Moon needs in-depth testing on Earth in analogue sites. These are natural terrestrial sites that offer one or more analogies with the to-be-explored locations on the Moon or Mars, in terms of geological formations, mineralogy, environment, as well as biosignatures (especially for Mars exploration). Terrestrial analogue sites serve several purposes: (1) instruments science validation and tests for scientific performance; (2) instruments testing in specific and relevant environment; (3) instruments operations rehearsal; (4) mission operation on-site and remote teams coordination. The MINAR II campaign during which the CLUPI (Close-UP Imager) instrument for the ESA ExoMars 2018 mission has been tested addresses the first three points above.

2. MINAR II Campaign

2.1 MINAR II and Cleveland Potash

The MINAR II (MINe Analogue Research, second out of 6 scheduled analogue campaigns) programme was held at Boulby Mine, Cleveland Potash, UK, on 1-3 April 2014. Boulby Mine is a working potash and halite mine that hosts an underground astrobiology lab at 1.1 km depth [1] [2]. It allows testing instruments for planetary exploration in extreme subsurface environment, with low radiation levels, and the presence of salts minerals whose analogue could have formed in the Martian geological history

[2]. Several instruments were tested inside the mine, in particular the ExoMars payload CLUPI.

2.2 CLUPI Description

CLUPI is a powerful, miniaturized, low-power, efficient and highly adaptive system composed of three main parts: a flexible structure focus mechanism that allows the acquisition of sharp images of any target from 10 cm to infinity, a colour Active Pixel Sensor with 2652 x 1768 x 3 pixels that provides RGB colours keeping the spatial resolution, and a high-performance integrated electronics system. It replaces the geologist hand lens. The CLUPI analogue instrument tested during the MINAR II campaign had the same image sensor as the CLUPI that will be on the ExoMars rover (but optics with a slightly larger field of view). The CLUPI Calibration Target, 2.5 x 2.5 cm² in size, was also used. Images were acquired using either a small light system or larger spotlight, while always monitoring the light flux on the targets.

3. Analogue Site Investigation

3.1 Approach

Since CLUPI will be operated on Mars to look at the surface, rocks, and outcrops from 10 cm to infinity, typically after long-range images by the PanCam (Panoramic Camera) instrument have been acquired, a similar approach has been followed during the MINAR II campaign.

3.2 CLUPI Imaging

Images were acquired in various situations representative of the ExoMars mission: from less than 40 cm, from about 4 m, as well as from 20 m. Each time a calibration target was used, along with a resolution bar target for the farthest targeted rocks.

Also complementary imaging sequences were carried out with PanCam. The target was first imaged by PanCam, then by CLUPI from afar and then at close-up range. This was repeated for a wall originally covered by dust, then scrubbed, and then washed.

Preliminary analyses of the CLUPI images only show that the close-up ones allow the distinction of minerals of salt, with typical glassy surfaces, various amounts of impurities and inclusions. However detailed geochemical analyses would be needed to distinguish their mineralogy. Clear textural change was also observed for clay and/or silt. For the tested geometrical configurations, resolution was down to 40 $\mu\text{m}/\text{pixel}$ at close-up range, and 2.4 mm/pixel at 21 m distance. Taking into account the larger field of view of the CLUPI analogue, these resolutions are expected to be even better with the real CLUPI.

4. Summary and Conclusions

The CLUPI testing during the MINAR II campaign proved very successful, and lessons were learned with regards to instrument operation, and science validation. Participation of CLUPI in the future MINAR campaigns, using more developed models (e.g., Science Validation Model, Qualification Model), would be very valuable to refine these preliminary tests with more representative models.

Acknowledgements

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References

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