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Colorimetric analysis of rocks powders helping for the calibration of Close-up Imager (CLUPI) of the ExoMars mission.

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Abstract

The ExoMars rover will be equipped with a drill allowing study of the near sub-surface of Mars. During this phase, the heap of rock powder produced at the surface will be observed by the CLUPI camera. The aim of this work is thus to determine if the images of the powders could be used to obtain any petrological information. In particular, we attempt to link the type of the rock to its colour using various volcanic rock powders.

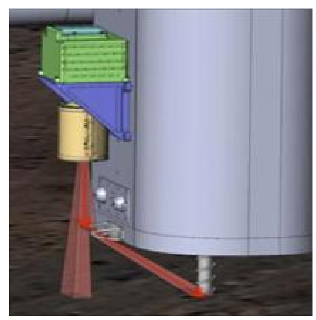

Figure 1: CLUPI on the drill observing the powder.

1. Introduction

The objective of the 2018-ExoMars mission (ESA-Roscosmos) will be to search for past or extant traces of life on the red planet. The payload of the rover will be composed of several instruments dedicated to imaging (PanCam and CLUPI) and analysis (IR spectrometer, Wisdom, Adron, Ma-MISS, MicrOmega, MOMA and the Raman Laser Spectrometer). The originality of the mission is its drill which will permit production of centimetric drill-cores down to 2 meters in depth. During these drilling phases, the CLUPI camera fixed on the arm of the drill will observe the pile of rock powder forming at the surface (see Fig. 1). The aim of this work is thus to determine if any geological information can be deduced from these observations.

Studies related to the color of rocks are relatively limited. They mainly have focused on fragments of particular rocks such as marbles or carbonates for instance [1, 2]. Indeed, on Earth there is no need to observe rocks in powder form and thus, to date, no investigation has been done to link the color of a powder with the type of volcanic rock. However, due to the particularity of the in situ automated space missions, color information could become essential to improve the identification of rocks on Mars.

2. Materials and methods

The majority of rocks on the surface of Mars are volcanic [3, 4]. Thus, relevant samples were selected from the Massif Central, in France, in order to cover a large range of volcanic rock types in the TAS diagram, as shown in Fig.2.

The samples were then crushed and sieved in order to obtain different grain size powder distributions. The snapshots were made using a commercial camera equipped with a similar detector as will be utilized by the CLUPI, i.e. a numerical Foveon captor. The images were then calibrated using a colour chart (ColorChecker) and the R, G, B values of several pixels were measured for each powder.

3. Results and discussion

Preliminary observations showed a variation in color with decreasing grain size of the same sample. Mea-

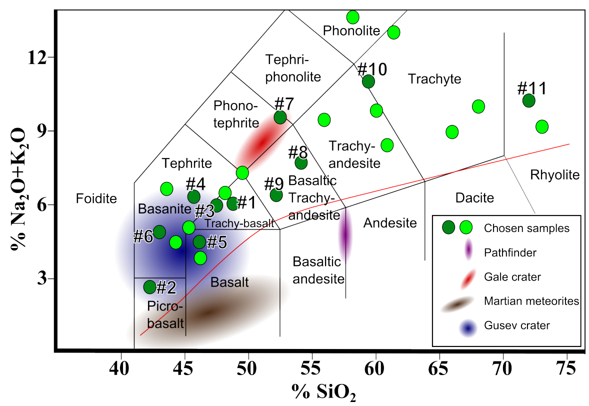

Figure 2: Total Alkali Silica (TAS) diagram for volcanic rocks. The samples used for this study are shown in green and the measurements made on Martian samples have been reported.

surement of the R, G, B values showed an increase in brightness without any change in the normalized values of chromaticity, defined by three components: R/(R+G+B), G/(R+G+B) and B/(R+G+B) (these parameters are used to plot Maxwell's chromaticity diagram [5]). We conclude that decreasing grain size induces an increase in brightness without changing the chromaticity of the rock. Therefore, in order to avoid any grain size effect while comparing the color of the different powders, a comparison was made using the same grain size (<63 μm), which is comparable to the expected grain sizes during drilling on Mars.
Since chromaticity variations within the same powder are very slight, the average R, G, B values for each sample were used. It is shown that the respective proportion of each R, G and B value is globally the same, regardless of the sample (about 1/3, 1/3, 1/3) in accordance with the optical observations, ranging from dark to light brownish-gray, as shown in Fig. 3. Thus, the R+G+B pseudo-brightness parameter appears to be a more pertinent parameter than chromaticity in order to distinguish the different samples.

4. Conclusion

These preliminary results must be confirmed but it appears that the different volcanic sample powders do not have the same color, in particular when compared in terms of brightness. The color ranges are from dark gray for basalts to nearly white for rhyolite. However, some limitations exist, e.g. obsidian is as dark as basalt even though it has a rhyolitic chemical composition. More analysis and tests are planned in order to

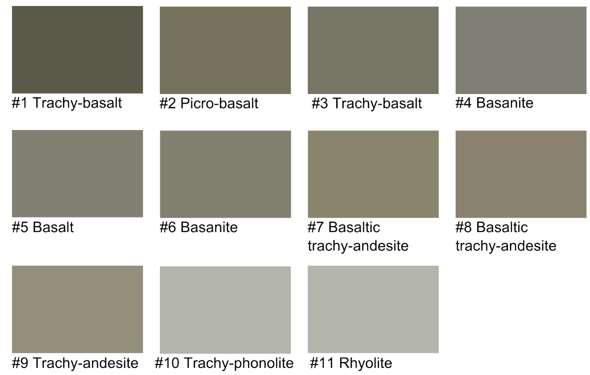

Figure 3: Average color for a first set of volcanic rock powders reported in dark green in Fig. 2.

improve our results and to determine the pertinent parameters to use in order to link the powder color with the type of rock. Nevertheless, in association with the other measurements made during the ExoMars mission (such as Raman and infrared spectroscopy), the color of the powder obtained with CLUPI could play a key role in petrological identifications.

Acknowledgements

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