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Colorimetric analysis to help identification of drilled rock powders on Mars: the CaliPhoto method.

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Abstract

The aim of the CaliPhoto® project is to work on the development of an optical method permitting to identify rock powders from their colorimetric data obtained by the CLUPI instrument during the next ExoMars 2020 mission. This method also finds applications in many other studies.

1. Introduction

The objective of the ExoMars 2020 mission (ESA-Roscosmos) will be to search for past or extant traces of life on the red planet. The originality of the mission is its drill which will permit production of centimetric drill-cores from up to 2 meters in depth. During these drilling phases, the CLUPI camera will observe the pile of rock powder forming at the surface. The aim of the present study is to determine whether any geological information can be deduced from these observations. On Earth there is no need to observe rocks in powder form and thus, to date, no investigation has been done to link the colour of a powder with a particular type of rock. However, due to the particularity of the mission, colour information could become essential to improve the identification of the drilled rocks on Mars.

2. Analogue sample selection

The majority of rocks on the surface of Mars are volcanic [1, 2] thus, for this study, relevant samples were selected from the Massif Central, in France, in order to cover a large range of volcanic rock types, as designated in the compositional TAS diagram (Total Alkali Silica). The samples were then crushed to less than 60 μm and displayed next to each other showing a large variety of colour (Fig.1).

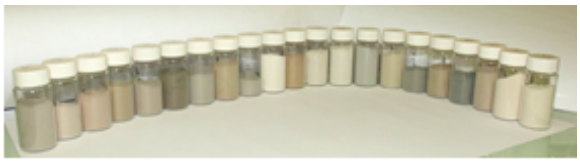

Figure 1: Powders of various volcanic rocks from the Massif Central, France.

3. Main issues

Although the preliminary observation shows differences in colour between the different samples, as shown in Figure 1, two main issues still remained to be tackled.
First, we observed that the main difference between the different powders was the brightness; the different powders being more or less all included in tones of greys exhibiting darkish tones. Unfortunately, it also appears that decreasing grain size induces an increase in brightness. The powders must thus be compared after sieving, i.e. for similar grain size distribution. Nevertheless, this step remains relevant since experiments have shown that drill powders (fines) are characterised by a more or less similar grain size (<60 μm).
Secondly, the most important issue was the fact that the colour of a powder is totally dependent on the ambient luminosity. In order to solve the last issue, a new method called CaliPhoto® was developed that consists of adding a reference target to the field of view of the camera, close to the powder. An image processing algorithm is then used to calibrate the images and permit comparison of the different powders. Well characterized rocks were then crushed, sieved and photographed using a commercial camera equipped with a detector similar to that used by the ExoMars Close Up Imager, CLUPI, i.e. a digital Foveon® sensor, in

order to create a database of the colours of rock powders.

4. The CaliPhoto® method

Several tests were carried out. For rocks included in the database created so far, the method permits identification with good accuracy. More interestingly, for those rocks not included in the database, it was still possible to make a good match based on rocks of similar composition in the database. Moreover, rocks having similar elemental composition but very different bulk colours, such as rhyolite (light) and obsidian (dark), have a similar powder colour, permitting thus a good identification. Finally, the CaliPhoto® method could be very useful on Mars to help identification of rocks during drilling without adding any new instrumentation

5. Summary and Conclusions

The CaliPhoto method permits to link laboratory measurements to optical images taken in the field. More largely, this method should useful in many domains and found application in cosmetics for instance.

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References

[1] McSween H.Y. et al., Science 324, 736, 2009.

[2] Bost N. et al. Planetary and Space Science 82-83, 113-127, 2013.