Lithospace: an automated system for in situ petrographic thin section preparation on Mars

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Abstract

The aim of the LithoSpace project, supported by the CNES since 2014, is to work on the development of an automated system permitting preparation of petrographic thin sections on extraterrestrial bodies, in particular, on Mars.

1. Introduction

Optical microscopy in transmitted light is probably one of the most standard techniques in geology. It has been used for more than 150 years. Indeed, atlases of microscopic images of rocks and their characteristic mineralogy and textures are widely used in geological departments [1]. Observation in transmitted light permits identification of rocks having similar chemical and mineralogical compositions but different mineral organizations (basalt vs. gabbro for instance). Using polarized light, it permits identification of most of rock-forming minerals in thin section [2]. Observation in transmitted light is also essential for micropale-ontology since it is the only way to observe individual microfossils, if they are large enough 1, and to document the mineralogical and textural context in which the biosignatures occur. Nevertheless, optical observation in transmission has never been carried out on Mars. Indeed, although optical microscopes can be readily designed for space exploration, thin section preparation is not easy to do *in situ*. In particular, it requires several human manipulations that are difficult to automate.

The aim of the LithoSpace project, supported by the CNES since 2014, is to work on the development of an automated system permitting preparation of petrographic thin sections on extraterrestrial bodies, in particular, on Mars. Several studies and tests were conducted and most of the problems solved. The final protocol follows the process from obtaining a standardized drill core to observation of a thin section in a fully automated way.

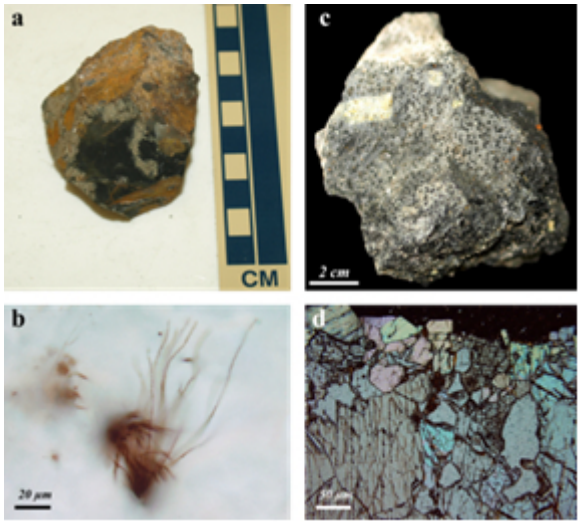

Figure 1: Pieces of rocks from (a) the Gunflint formation (-1,9 Ga) and (c) Svalbard, and (b,d) associated optical microscopy images in transmitted light. (d) Image in polarized-analyzed light.

2. Proof-of-concept

The objective of the project is now to make a "proof-of-concept" model. Thus, a first numerical model of the system has been designed by students in fifth year at the engineering school Polytech', University of Orléans. With the help of students in BTS (two-year technical degree) "industrialization of mechanical products", from the Benjamin Franklin high school of Orléans, the objective is now to make this model real. Finally, this study is a good way to raise student aware-

ness of space exploration by involving them directly at the start of the project.

3. On the use of thin sections for *in situ* space exploration

In situ thin section preparation would be an important improvement for the geological and astrobiological exploration of the solar system, for Mars but also of other planetary bodies. The proposed instrument could incorporate new high resolution techniques, such as Raman mapping or micro-LIBS as well as optical microscopic observation in transmitted light

4. Summary and Conclusions

The LithoSpace project permit us to propose a concept for an automated system permitting preparation of petrographic thin sections on extraterrestrial bodies. This project appeared to be an excellent way to raise student awareness of space science and technology. A group of five students from the Lycée B. Franklin, helped by their teachers, have started the development of a physical demonstration model to be presented during the EPSC 2018 meeting.

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