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New Synthetic Martian Basalts from Spirit data, Gusev crater.

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Abstract

There are no suitable terrestrial analogues for martian basalts, which are richer in Fe and Mg. We present the results of a preliminary experiment to synthesise martian basalts based on the Spirit data from Gusev Crater.

1. Introduction

According to the recent observations by the Mars Exploration Rover (MER) *Spirit*, Martian basalts are chemically very different from terrestrial basalts, being characterized in particular by high Mg and Fe contents [1]. In order to provide suitable analogue basalts for the European Space Analogue Rock store (ESAR) which provides analogue rocks and minerals for *in situ* space missions and, especially, the upcoming Mars missions MSL-2011 and the future ESA-NASA ExoMars-C-2018 mission, it is necessary to synthesise martian basalts because appropriate analogues do not exist on Earth [2, 3, 4]. The aim of this study is therefore to make a preliminary experiment to synthesise martian basalts based on the geochemical data from the MER rover Spirit. We present the results in this contribution.

2. Materials and Methods

In this experiment, we used the data from basalts analysed in Gusev Crater by Spirit for this experiment [5]. In order to obtain the best average chemical composition, we used only data from the least altered basaltic rocks in Gusev Crater, obtained from analyses made on surfaces previously cleaned by Spirit's RAT (Round Abrasive Tool). The chemical composition of the samples obtained by APX-S is shown in Figure 1.

Previous studies of artificial martian materials were based on the previous Pathfinder analyses which did not benefit from an abrasion tool to remove the altered surface [6, 7], plotted in Figure 1. Our results are therefore significantly different.

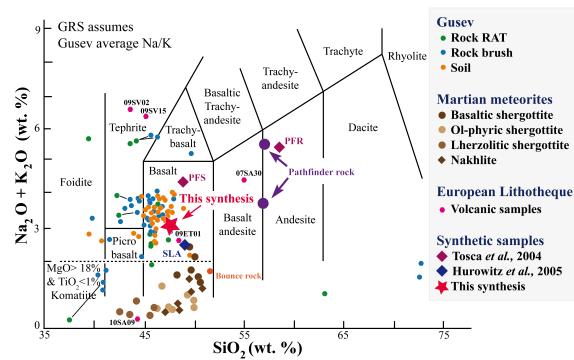


Figure 1: TAS diagram for martian basalts: *in situ* analyses, meteorite data, terrestrial analogues from the ESAR (after [1, 2, 4, 8]), and synthetic martian basalts based on Pathfinder analyses (PFR,PFS), Los Angeles (SLA) [6, 7] and on Spirit analyses.

For the synthesis, we used oxide powders which were molten in an alumina crucible. The samples were heated in a vertical oven to 1350°C over a period of 5 hours under reducing conditions (CO-CO₂ gas mixture). One sample was rapidly cooled (named "Bernard") and the other slowly cooled (named "Jack"). 2 grams of material were obtained from which polished sections were prepared for structural, textural and mineralogical analyses by Raman spectroscopy, SEM, and electronic microprobe.

3. Results

3.1 Bernard (slow cooling)

This sample was cooling slowly (during a day) and is characterised by a spinifex-like texture (Figure 2). It consists of large pyroxene crystals and small crystals of forsterite exhibiting an arborescent texture. Associated with these major phases are minor, well crystallized oxides, such as spinels (in light-colored on the SEM picture, Figure 2). Despite the relatively slow

cooling, the sample contains small areas of augitic glasses associated with two types of elongated crystals. The textures in this sample are more suggestive of rapid magmatic cooling than slow cooling.

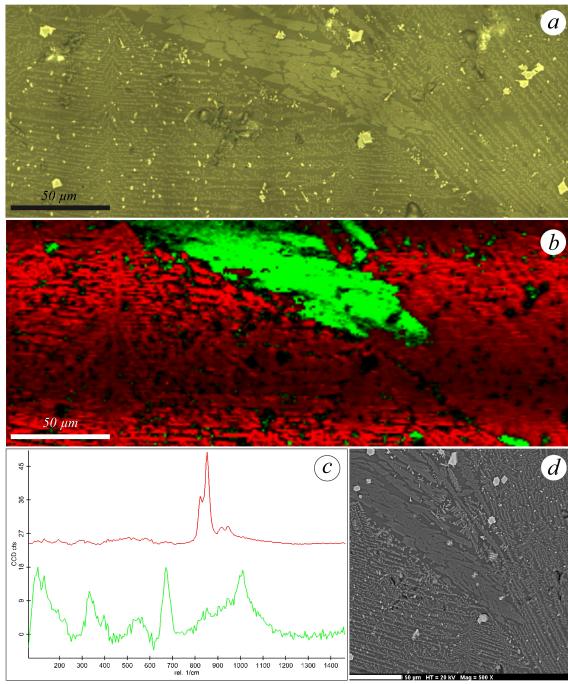


Figure 2: a- Reflected light optical view of the slowly cooled sample "Bernard" showing large elongated crystals of augite with the forsterite dendritic crystals and the small spinels. b- Raman mapping of (a), augite in green and forsterite in red; the spinels do not give any spectrum. c- Raman spectra used for mapping (b). d- Backscattered SEM image.

3.2 Jack (fast cooling)

This sample was cooling faster (~ 70 minutes). It contains large areas of augitic glass and has the same mineralogical composition as Bernard. The mineralogical phases are more anhedral (globular) due to the faster cooling.

4. Summary and Conclusions

With this study, we have created new Martian basaltic samples with compositions very close to those analyses from Gusev Crater. However, the basalts in Gusev will not be representative of all Martian basalts. Having a higher Fe- and Mg-rich content, komatiite-like lavas, potentially with spinifex-textures, could be

more common on Mars than on the Earth [9]. Our preliminary study has provided new useful analogues for martian basalts for the ESAR collection that can be used to test *in situ* instrumentation under development and, through the online database, during a missions.

Our investigation also has an astrobiological application. Clays formed on basalts may have been implicated in the prebiotic stage of organic molecule formation [10].

Acknowledgements

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