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Raman characterization of minerals in Martian achondrites: Zagami, Nakhla, and DaG 735

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Abstract

We characterize here the main minerals forming three SNC achondrites (Zagami, Nakhla and DaG 735) whose properties are being extensively studied as a master degree project of first author. Zagami and Dar al Gani 735 are shergottites, while Nakhla gives name to the nakhlites. Our goal is obtaining information on the physico-chemical processes that participated in their formation and delivery to Earth. We are also studying the ability of some minerals forming the different groups to retain Mars atmospheric gases during the post-shock stages [1, 2] in order to sample Mars' atmospheric evolution [3].

1. Introduction

Despite their unique and distinctive chemical and oxygen isotopic values, the SNC suite was not completely accepted as Martian in origin until D.D. Bogard and P. Johnson noticed that some of them contain mineral phases with trapped gases that are consistent with Viking measurements [2]. In the present work we have selected three SNC meteorites in which we expect to find olivine and pyroxene to be consistent with previous observations of Martian mineralogy [4]. We are also interested in the secondary minerals that can provide information about the timing and nature of hydrous activity and atmospheric processes on Mars [5].

2. Procedure and experimental setup

We first created high-resolution reflectance mosaics of the Martian meteorites by using a Carl Zeiss petrographic microscope, that allowed us to select several areas to be precisely characterized (see top of Fig. 1). Micro-Raman spectra were recorded in backscattering geometry at room temperature using the 5145 Å line of an Argon-ion laser with a Jobin-Yvon T-64000 Raman spectrometer attached to an Olympus microscope and equipped with a liquid-nitrogen-cooled CCD detector. The lateral spatial resolution was ~ 1µm and the laser power onto the sample was kept below 1mW to avoid degradation due to overheating of the proved volume. Nakhla and DaG 735 sections were brought to a Raman spectrometer to identify the main forming minerals and search for evidence of shock. The Raman spectrometer allowed us to get high-resolution spectra in working windows between 100 and 1,400 cm^{-1}.

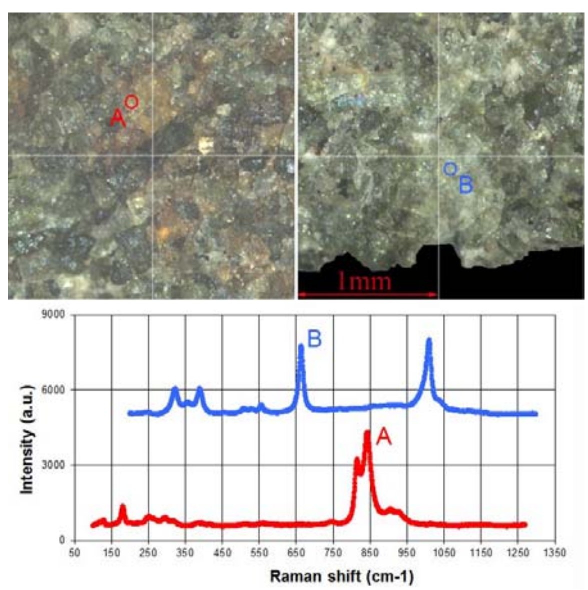

Figure 1: Two minerals characterized in Nakhla section. A spectrum corresponds to olivine, while B corresponds to augite. Both spectra are shifted to avoid superposition.

3. Discussion

We suspect that the SNC achondrites studied here have distinctive origins in Mars. Nakhla is an olivine-clinopyroxenite cumulate formed in flows or shallow intrusions of basaltic magma on Mars, while Zagami and DaG735, as usual in shergottites, are igneous rocks. Taking into account that different regions in Mars have different mineralogical compositions, this could imply distinctive origins, as mentioned before. These meteorites also show signs of shock alteration. When an impact released them from Mars, they experienced a significant shock that allowed them to retain tiny amounts of Mars' atmosphere in the melted shock-altered glasses and the maskelynite that were formed in the shock veins [6].

4. Summary and Conclusions

We have successfully characterized the main rock-forming minerals of three Martian achondrites. DaG 735 showed millimeter sized olivine grains in a finer grained matrix of pigeonite and feldspathic glass, while Nakhla is mainly composed of clinopyroxene with olivine inclusions. We also plan to keep the study of these three SNC meteorites by using SEM and EDX to find more evidence of shock features.

Acknowledgements

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References

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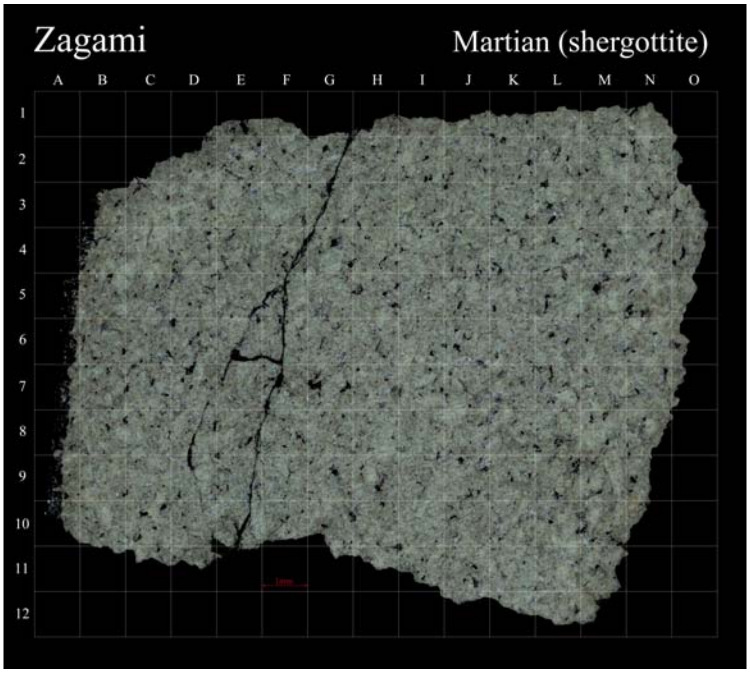

Figure 2. A mosaic of the section of Zagami obtained from reflected light images taken with a Zeiss Scope microscope. The grid is 1mm wide.