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Raman characterization of minerals in two lunar achondrites: NWA 2700 and Dhofar 1085

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Abstract

We characterize here the main minerals forming two lunar achondrites (NWA 2700 and Dhofar 1085) whose properties are being extensively studied as a final degree project of first author. Both are different lunar achondrites, the first being a complex breccia and the second one is an anorthositic rock mainly formed by fayalite (Fe_2SiO_4) and ferrosilite ($FeSiO_3$). Our goal is obtaining information on the physico-chemical processes that participated in the formation of both stones.

1. Introduction

To reach our planet meteorites of lunar origin require an impact process excavating the surface and releasing both rocks with enough kinetic energy to escape the Moon's gravity field. Such processes are typically involving impacts capable to eject surface rocks with velocities larger than 2.4 km/s. In a previous work we studied the reflectance properties of NWA 2700 [1]. In the present work we have selected different areas in both studied meteorites in order to characterize their main forming minerals, also with the idea to search for possible evidence of shock.

2. Procedure and experimental setup

To study the sections of both achondrites we first created high-resolution reflectance mosaics by using a Carl Zeiss petrographic microscope. We selected in the imaged sections 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 [2]. 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. Both meteorite sections were brought to a Raman spectrometer in order to identify the main forming minerals, also searching for evidence of shock. The Raman spectrometer allowed us to get high-resolution spectra in a typical working window of 200 to 1,400 cm^{-1}. When needed to identify other minerals the window was expanded until 1,900 cm^{-1}.

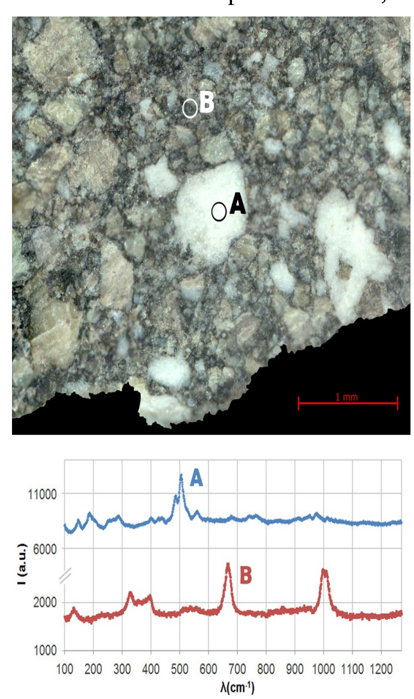

Figure 1: Two main minerals in NWA 2700. A spectrum corresponds to plagioclase and B to augite.

3. Discussion

We suspect that the two achondrites studied here have distinctive origins in the Moon as they are formed by different minerals. NWA 2700 a fascinating 31.7 g lunar meteorite found in Morocco on 2004. This lunar meteorite consists of two distinctive lithologies: olivine gabbro and regolith breccia [1, 3, 4]. Dhofar 1085 is a more homogeneous rock of anorthositic nature, and mostly composed by fayalite (in mol%): 34±10 and Ferrosilite: 31±8 [5]. Anorthosite is an important rock type forming the lunar highlands and it is usually considered since its first characterization [6] as representative of the primordial lunar crust [7].

3. Summary and Conclusions

We have successfully characterized the main rock-forming minerals of lunar achondrites NWA 2700 and Dhofar 1085 by using a Raman spectrometer. Particularly NWA 2700 exemplifies a complex impact history. The breccia is formed by fragmented grains that are typically ~50 μm in diameter as consequence of continuous collisions with meteoroids that produced brecciation and chemical implantation. Lunar achondrites are contaminated with meteoritic siderophile elements that are characteristic of CM chondrite-forming materials [see e.g. 8]. As future work we plan to keep the study of both achondrites by using SEM and EDX to find evidence of those processes, and shock features.

Acknowledgements

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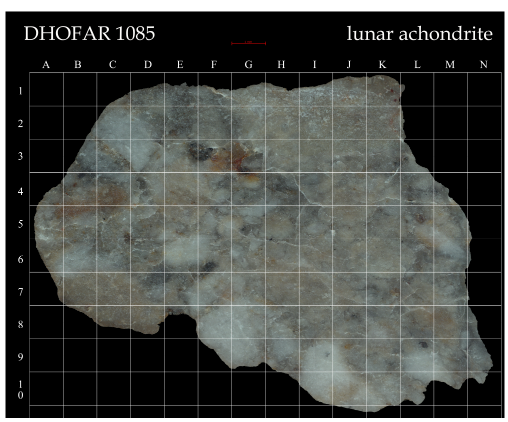

Figure 2. A high resolution mosaic of the section of Dhofar 1085 obtained from reflected light images taken with a Zeiss Scope petrographic microscope.