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Microimaging VIS-IR spectroscopy comparison between two shergottites

P. Manzari, S. De Angelis, M.C. De Sanctis, Istituto di Astrofisica e Planetologia Spaziali, INAF-IAPS, via Fosso del Cavaliere, 100 – 00133, Roma, (paola.manzari@iaps.inaf.it)

Abstract

Micro-imaging spectroscopy is the new frontier of non destructive investigation methods on planetary materials and analogues. With the aim of supporting the measurements by Ma_MISS spectrometer onboard future Exomars 2020 mission, spectral investigations are ongoing on meteorites and Mars analogues by means of the Spectral Imager (SPIM). In this abstract, we compare the measurements obtained with SPIM on two shergottite slabs: North West Africa 8657 and Dar Al Gani 489 trying to highlight the spectral differences between these two meteorites.

1. Introduction

Several studies in these last years showed that micro-imaging spectroscopy is the new frontier of non destructive investigation methods both for the spectral characterization of planetary materials and analogues [1, 2] and for validating remote sensed data on planetary and terrestrial surfaces. In this respect, the effectiveness of the SPIM (Spectral Imager) high resolution spectrometer for spectral characterization of meteorites was previously discussed [4,5]. As a short term goal, the interpretations of VIS-IR spectra related to Mars meteorites and analogues will support the Ma_MISS (Mars Multispectral Imager for Subsurface Studies) measurements during the next ExoMars 2020 mission. Ma_MISS is a miniaturized visible/near-infrared imaging spectrometer in the range 0.4-2.2 µm with 20nm spectral sampling devoted to observe the lateral wall of the borehole generated by a drilling system [6]. In the present abstract we show results about the spectral characterization of two shergottite slabs NWA 8657 and DAG 489 by means of SPIM spectral imager.

2. Experiment set up and samples

The imaging spectrometer installed in SPIM is a spare of the spectrometer on Dawn spacecraft. It works in the 0.22-5.05 µm spectral range, with a spatial resolution of 38x38 µm on the target [7]. Both analyzed meteorites are basaltic shergottites. Their petrographical composition slightly differ: Dar al Gani 489 (DaG) is composed of olivine megacrysts up to 5 mm set in a fine-grained groundmass of pyroxene, maskelynitized plagioclase and mesostasis [8]. Minor phases reported include chromite, ilmenite, whitlockite, Cl-apatite, pyrrhotite. North West Africa 8657 mainly consists of 64.3 vol% pyroxene and 32.8 vol% maskelynite with minor opaque minerals, 1.6 vol%, and phosphates, 1.3 vol%. The accessory ilmenite, ulvospinel, pyrrhotite, merrillite, apatite and quartz [9].

3. Results

In fig.1, SPIM images collected on the two meteorite slabs are showed. The average spectra related to the slabs are in Fig.2. The comparison between the two samples shows clearly the different composition of pyroxenes. The spectrum of DAG489 is marked by a signature typical of low-Ca pyroxenes with two major features centered at 0.98-0.99 and 1.98-2 µm. In the spectrum of NWA8657 the 1 and 2 µm band are centered at longer wavelengths. This means a prevalence of Ca-rich pyroxenes [10] in NWA 8657 with respect to DAG 489.

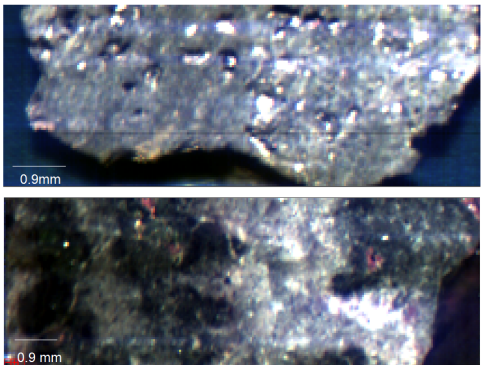

Fig.1 RGB (0.680µm;0.560µm;0.468µm) images of NWA8657 (top) and DAG 489 (bottom) collected by means of the SPIM, SPectral IMager.

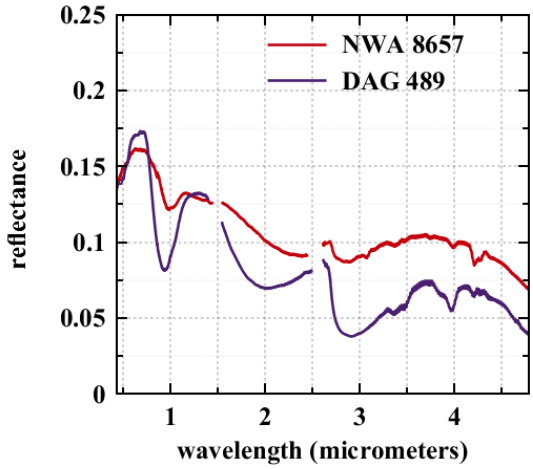

Fig.2 Average spectra related to NWA 8657 and DAG 489 investigated slabs.

On the basis of the results on NWA8657 by SEM, a preliminary spectral investigation pixel by pixel on DAG489 slab was performed. Aside the pyroxenes, the slab shows clearly spectra of maskelynite/glass, carbonates and opaques (Fig.3).

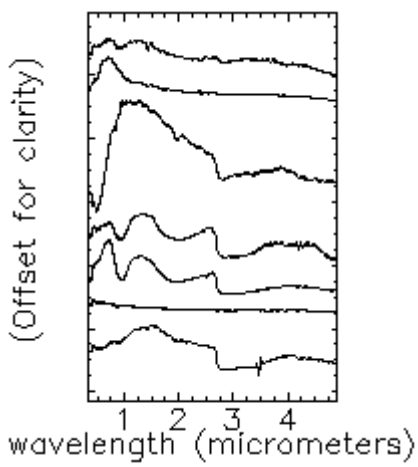

Fig.3 Spectral classes found in DAG489 slab

During this first look the occurrence of hydrated mineral phases was revealed in DAG489. These spectra are characterized by the 1.91, 2.78µm absorptions due to H_2O stretch. A deeper look at the features of these spectra showed some absorptions like 3.87, 3.97, 4.20, 4.7µm that are typical of SO_4 combinations and overtones [11] (fig.4).

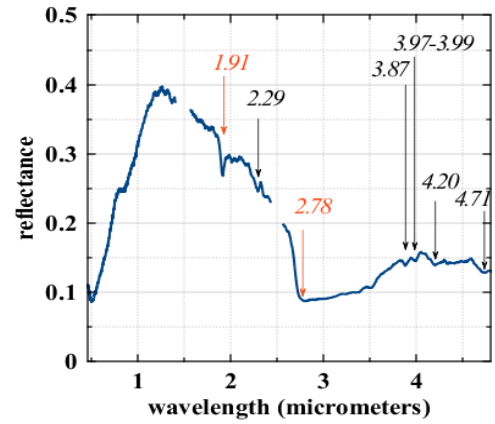

Fig.4 Spectrum of hydrated phase characterized by H_2O (red arrows) and SO_4 absorptions combination and overtones (black arrows)

4. Summary and Conclusions

This preliminary investigation on two basaltic shergottites show that they are different in the pyroxene composition, being DAG489 composed of low Ca pyroxenes respect to NWA8657. Moreover, respect to NWA8657, DAG489 show the occurrences of some pixel spectra characterized by absorptions at 1.9 and 2.8 µm that are due to water contents and that in some grains are found together with features related to SO_4 groups. Further investigations are ongoing for a more reliable spectral characterization and in order to support MaMiss spectrometer during the Exomars2020 mission.

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