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Mesosiderites and HEDs characterized combining by µ-IR and SEM/EDS analyses in relation to infrared spectra of Vesta-like asteroids

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Abstract

We present the results of a µ-IR and SEM/EDS combined study of three Howardite-Eucrite-Diogenite meteorites (HEDs) [1] and two mesosiderites [2] compared to the spectroscopic data collected by VIR onboard Dawn spacecraft [3]. The origin of HED group is thought to be linked to the asteroid 4 Vesta [4]. This hypothesis is reinforced by the data provided by the Dawn mission [5]. However, understanding the origin of mesosiderites is still challenging, since it is not clear whether a connection between these two groups of meteorites actually exists [6].

1. Introduction

In order to acquire a fuller grasp of remotely sensed compositional data, it is fundamental to compare them to analogue samples analyzed by means of spectroscopy techniques. Here, we report a SEM/EDS and µ-IR spectroscopy combined study of five meteorite samples: 1) NWA 7159, a monomictic brecciated eucrite consisting of exolved orthopyroxene and anorthite with accessory silica polymorph and ilmenite; 2) NWA 7490 a diogenite with a cumulate texture dominated by orthopyroxene, with Ca-plagioclase, minor olivine and chromite and troilite as accessory minerals; 3) NWA 2698, an howardite with eucritic pyroxene; 4) Vaca Muerta and 5) NWA 6266 (Fig. 1) two mesosiderites with subequal silicate and metallic components.

2. Experimental set up

For the µ-IR analyses on meteorites fragments we used a microscope (mod. Bruker Hyperion 3000) connected to the Vertex 80 interferometer. This set-up is able to acquire spectra in reflection mode on a single feature with minimum dimensions of 50 µm. For the SEM/EDS analyses we used a Field-Emission Gun Scanning Electron Microscope (FEG-SEM) equipped with an energy dispersive spectrometer (EDS) operating at 20 kV with an ultimate resolution of 1.5 nm, and a magnification up to 400.000x.

Figure 1: The NWA 6266 meteorite

3. Discussion

The µ-IR analysis performed on meteorite slabs provided punctual information on the mineralogy of the samples. The mid-IR reflectance spectra on pyroxenes present in the three analysed HEDs are shown in figure 2.

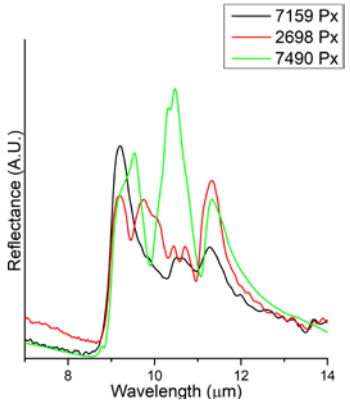

Figure 2: Spectra of pyroxenes in NWA 7159, NWA 2698 and NWA 7490.

The spectrum of NWA 2698 meteorite (red in fig. 2) shows the bands at 9.1, 10.4, 10.7 and 11.3 µm that can be attributed to pigeonite, whereas the bands at 9.7 can be ascribed to an "impurity" of calcium plagioclase. The bands at 9.2, 10.4, 10.7 and 11.3 µm in the spectrum of NWA 7159 meteorite (black in fig.2) can be attributed to pigeonite. The reflectance spectrum of NWA 7490 (green in fig.2) shows the bands at 9.5, 10.3, 10.4 and 11.3 µm attributable to hypersthene. Figure 3 shows two spectra collected on the NWA 6266 mesosiderite, the black one on the metal fraction whereas the red one the silicates portion, pyroxene dominated.

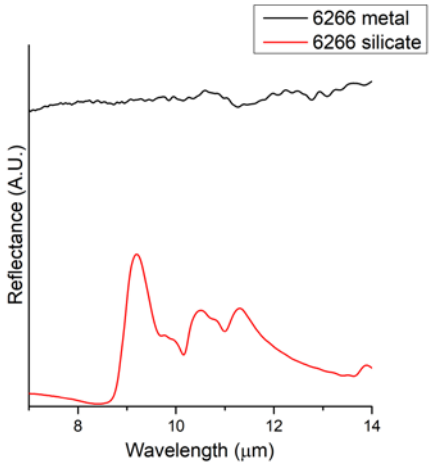

Figure 3: Spectra collected on the NWA 6266 meteorite.

While the µ-IR analysis provided reflectance spectra of single phases, the SEM/EDS analysis corroborated the results adding chemical and textural information on the samples. By means of combined analyses, we obtained a comprehensive mineralogical framework for the HEDs and mesosiderites. It has been verified that the mineralogical heterogeneity of the HED meteorites is consistent with the spectroscopic diversity seen on Vesta, and proven that the silicate fraction of the mesosiderites and HEDs are isotopically identical [7]. Therefore, this work helps to better constrain and characterize the reflectance spectra performed on Vesta-like bodies through the spectroscopic study of these two meteorite families.

4. Conclusions

The laboratory data acquired on three HEDs and on two mesosiderites indicate that:

- the pyroxene of NWA 2698 is a pigeonite in accordance with the composition of the eucritic pyroxene, as reported in the Meteoritical Bulletin N°90;
- the NWA 7159 sample shows a predominant presence of anorthite, as confirmed by the value of Christiansen feature. The presence of pigeonite is in accordance with the pyroxene composition reported in the Meteoritical Bulletin N°104;
- the meteorite NWA 7490 shows the presence of Ca-plagioclase and Mg-olivine, in addition to the predominant occurrence of hypersthene, as reported in the Meteoritical Bulletin N°101;
- the composition of the two mesosiderites is consistent with mixtures of metallic iron and pyroxene;
- based on the obtained results the near-IR spectra of these HEDs are directly comparable to those of asteroid (4)Vesta;
- the next step will be the comparison of the mid-IR data with spectra obtained by means of earth observation on the Vesta-like asteroids.

Acknowledgements

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