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Hyper-spectral measurements of Howardites with the SPIM facility

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Introduction

We report visible and infrared measurements on powdered samples (<75μm) of three howardite meteorites. These preliminary measurements are part of a set of spectroscopic measurements performed on 33 HED samples with different laboratory setups in use at INAF-IAPS. Here we describe reflectance spectra measured with the SPIM facility on three meteorites: CRE-01400, EET-87509 and EET-87513.

1. Petrologic description

The three howardites are antarctic meteorites and did not show severe weathering (weathering type A/B).

Mount Crean 01400 (CRE-01400) shows a groundmass of tiny pyroxene and plagioclase crystals (up to 0.5 mm) and clasts of basalts and orthopyroxenite. The pyroxene composition is $Fs_{21}Wo_2$, whereas plagioclase consists of $An_{85\text{-}90}$ $Or_{0.5}$. Furthermore, orthopyroxene ($Fs_{52}Wo_5$) and augite ($Fs_{25}Wo_{40}$) occurring together in exsolved grains were found [1].

Elephant Moraine 87509 (EET-87509) was paired with EET-87503, in which a groundmass of orthopyroxene and pigeonite and plagioclase (grains up to 0.3 mm) and rare polymineralic clasts up to 2.5 mm across were found. Pyroxene composition stands around $Wo_{1\text{-}22}$, $Fs_{20\text{-}56}$, $En_{24\text{-}76}$; orthopyroxene ranges around Wo_2Fs_{23} and pigeonite around $Wo_{12}Fs_{50}$. Plagioclase has anorthitic composition, $An_{88\text{-}95}$ [2].

Elephant Moraine 87513 (EET-87513) shows textural and composition similarities with EET87503. Based on these observations, Buchanan et al. (2000a,b) [3,4] concluded that these meteorites are paired. In these howardites pyroxenes range in composition from magnesian orthopyroxene to Fe-rich pyroxenes containing augite exsolution lamellae (Buchanan and Mittlefehldt, 2003) [5].

2. Experimental setup

Measurements have been performed with the SPIM facility in use at the INAF-IAPS laboratory [6]. The imaging spectrometer installed in SPIM is a spare of the spectrometer on Dawn spacecraft [7]. It works in the 0.22-5.05 μm spectral range, with a spatial resolution of 38x38 μm on the target. Two bi-dimensional focal plane arrays, one for the visible between 0.22 and 1.05 μm (spectral resolution of 2 nm) and one for the IR between 0.95 and 5.05 μm (spectral resolution of 12 nm) allow to obtaining the spectral coverage. Thanks to the alignment of the bi-dimensional focal planes with the spectrometer' slit axis (the slit is 9x0.038 mm in size), it is possible to acquire the target's image of 0.038x9 mm at different wavelengths. The spectrometer and the IR detector are cooled at 130K and 80K, respectively, in order to reduce the background noise due to thermal emission. The spectrometer is installed inside a thermo vacuum chamber (TVC) cooled with liquid nitrogen in order to avoid vapour condensation. The optical layout of the spectrometer is based on an Offner configuration. Hyper-spectral cubes are built up observing the target moving on a scanning sample holder. Two lamps provide the light sources for the VIS channel (120 W) and the IR channel (108 W). The illuminating system supports two distinct optical fibres for the VIS and IR channel; the illumination and emission angles are 30° and 0° with respect to the normal to the sample surface, respectively.

3. Visible and Infrared Imaging Spectroscopy of Howardites

Analyzed samples were in powder form with diameter <75 μm. Ten adjacent lines were acquired from each sample, thus an area of 9 mm x 0.38 mm

has been analyzed over each powder sample. The spectra are showed in figure 1 and are shifted in reflectance for a better comparison. The average spectra of CRE-01400 and EET-87509 have a reflectance value of about 30% in the NIR, while the EET-87513 is darker with an average reflectance of 15% in the NIR.

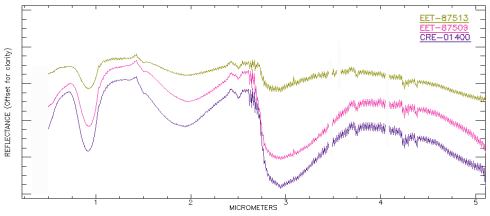

Figure 1: VIS-IR average reflectance spectra of three analyzed howardites.

The spectra are characterized in the VNIR range by the two strong Fe^{2+} absorptions at 1 and 2 μm that are indicative of dominant pyroxene mineralogy. The broad absorption band in the IR centered at 3 μm is due to water. The samples EET-87513 and EET-87509 also show a weaker feature near 0.5 μm that can be due to iron. Several features that appear at about 1.4, 2.5 and 3.75 μm are instrumental artifacts, while the feature near 4.2 μm is due to ambient CO_2.

3. Conclusions

The SPIM facility is a VIS-IR imaging spectrometer that is used in support of missions to Solar System rock bodies. The high spatial resolution (38 μm) allows to study in great detail minerals and rocks both of terrestrial and extraterrestrial origin. In this study preliminary measurements of three meteoritic samples (howardites) in powder form are presented. Reflectance spectra in the 0.5-5.0 μm range show the pyroxene-dominating mineralogy of the analyzed samples.

Acknowledgements

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