

Visible and Infrared Spectroscopy of Grosvenor Mountains 95535, howardite

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1. Introduction

In order to strengthen the linkage between Vesta and HED spectral composition, a set of HED meteorites (33 samples) have been investigated with different laboratory setups at INAF-IAPS. Among these, the SPectral IMager facility is a laboratory VIS-IR spectrometer [1] developed to support the DAWN mission [2], which is now in orbit around Ceres. Here, we report reflectance spectral data related to powdered samples (<75 μ m) of one howardite, Grosvenor Mountain 95535, measured by means of the SPIM facility.

2. Petrographic description

Grosvenor Mountain 95535 (GRO95535) is an antarctic meteorite that does not show severe weathering (type A/B, [3]). It belongs to a pairing group consisting of GRO 95534, 95535, 95574 and 95581, (GRO 95602 was suggested to be paired with these, but its distinct cosmic-ray exposure age shows it is not paired with them [4]) The pairing group shows a groundmass of orthopyroxene and pigeonite and plagioclase (grains up to 0.2 mm), with a few larger mineral clasts and rare polymimetic lithic clasts up to 2.5 mm across. Microprobe analyses show a wide range in pyroxene compositions: Wo1-44, Fs14-80, En6-80, but with coarse-grained orthopyroxenes clustered around Wo1-4, Fs21-38, En60-78 [6]. Plagioclase compositions are An86-93 [3]. Monomineralic pyroxene clasts (\leq 3 mm) have mineral compositions that correspond to diogenites, basaltic eucrites and cumulate eucrites [5, 6].

3. Visible and Infrared Imaging Spectroscopy of Gro 95535

SPIM is a spare of the spectrometer on Dawn spacecraft [7]. It works in the 0.22-5.05 μ m spectral

range, with a spatial resolution of 38x38 μ m on the target. Two bidimensional focal plane arrays, one for the visible between 0.22 and 1.05 μ m (spectral resolution of 2 nm) and one for the IR between 0.95 and 5.05 μ m (spectral resolution of 12 nm) allow to obtaining the spectral coverage. Thanks to the alignment of the bidimensional 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 chip 13 of GRO95535 [6] in form of powder with diameter <75 μ m was analyzed. Ten adjacent lines (fig.1) were acquired on the powder, thus an area of 9 mm x 0.38 mm. We can observe that the average spectrum of GRO 95535 is characterized in the VNIR range by the two strong Fe²⁺ absorptions at 1 and 2 μ m that are indicative of dominant pyroxene mineralogy (fig.2). The broad absorption band in the IR centered at 3 μ m is due to water (likely of terrestrial origin). Several features that appear at about 1.4, 2.5 and 3.75 μ m are instrumental artifacts, while the feature around 4.2 μ m is due to ambient CO₂. The SPIM capability is to have a spectral image and thus to investigate pixel by pixel the single spectrum, or a spectral cluster, to better characterize the mineralogy of the sample. Although in a single pixel we can observe the effect of more mineral phases, in this case we observe on almost all these pixels the spectral features of orthopyroxene (fig.3). Furthermore, we can say that there are differences in orthopyroxene composition, in fact we observe different positions of the 1 μ m absorption band that represent variations of Ca and/or Fe [8,9] in M1 and M2 octahedral sites.

4. Figures



Figure 1: RGB crop image of GRO95535 powder. Ten adjacent lines have been acquired on the sample, at consecutive steps of 0.038 mm, matching the spectrometer slit width. Thus the observed area corresponds to 9x0.38 mm.

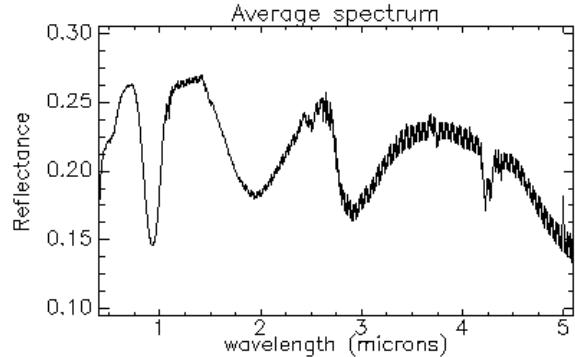


Figure 2: VIS-IR average reflectance spectrum of GRO95535 powder

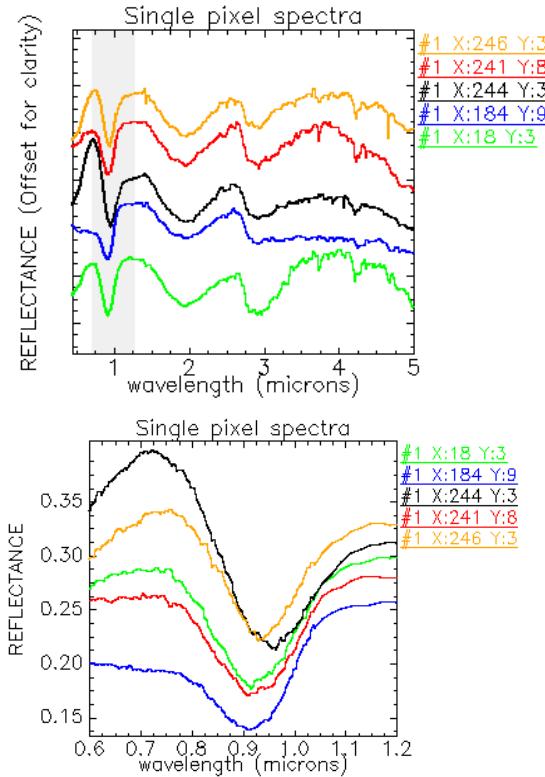


Figure 3: Single pixel spectra on GRO 95535 powder and crop of spectra at 1μm band.

5. Summary and Conclusions

The peculiarity of SPIM stands in the combination of the high spatial resolution imaging, high spectral resolution and wide spectral range. With these technical features, SPIM is capable to collect spectral images data on minerals and rock slabs hence potentially to better identify mineralogy features of components with grain size greater than 0.038 mm. In fact, although the average reflectance spectra in the 0.45-5.0 μm range show that pyroxene dominates the mineralogy of the analyzed samples, the high spatial resolution allowed to observe the spectral variability of the pyroxene. In particular, the different position of 1-micron band could be attributed to an increasing of iron or calcium in the structure.

Acknowledgements

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References

- [1] De Angelis S., et al., The Spectral Imaging facility: setup characterization, *Rev.Sci.Instruments*, submitted, (2015)
- [2] Russell, C.T. et al., “Dawn: A journey in space and time”, *Planetary and Space Science*, 52, pp 465–489, (2004).
- [3] Meteoritical Bulletin Database
- [4] Cartwright J.A., Ulrich O., Mittlefehldt D.W., The quest for regolithic howardites. Part 2: Surface origins highlighted by noble gases. *Geochimica et Cosmochimica Acta* 140, 488–508 (2014).
- [5] Lunning H. Y., McSween Jr. and A. W. Beck , Heterogeneity in the vestan regolith: evidence from the Gro 95 HED pairing group. 76th Annual Meteoritical Society Meeting, 5254, (2013)
- [6] Mittlefehldt David W., Herrin Jason S., Quinn Julie E., Mertzman Stanley A., Cartwright Julia A., Mertzman Karen R., Peng Zhan X., Composition and petrology of HED polymict breccias: The regolith of (4) Vesta *Meteoritics & Planetary Science* 48, 2105-2134 (2013).
- [7] De Sanctis M.C., et al: The VIR Spectrometer, *Space Sci Rev* DOI 10.1007/s11214-010-9668-5, 2010.
- [8] Klima Rachel L., Pieters Carle M., Dyar M. Darby Spectroscopy of synthetic Mg-Fe pyroxenes I: Spin-allowed and spin-forbidden crystal field bands in the visible and near-infrared *Meteoritics & Planetary Science* 42, Nr 2, 235–253 (2007)
- [9] Klima Rachel L., Dyar M. Darby, Pieters Carle M. Near-infrared spectra of clinopyroxenes: Effects of calcium content and crystal structure *Meteoritics & Planetary Science* 46, Nr 3, 379–395 (2011)