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Ungrouped achondrite NWA 7325: Infrared and Raman study of a potential sample from Mercury

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Abstract

We analyzed the ungrouped achondrite NWA 7325 using Raman and FTIR spectroscopy in order to characterize the main mineralogy, and to provide infrared data for remote sensing purposes. Both Raman and FTIR results show a mineralogy dominated by anorthitic feldspar and diopside.

1. Introduction

The ungrouped achondrite Northwest Africa (NWA) 7325 was found 2012 in Western Sahara. The sample consists of 35 pieces with a total weight of 345 g. First analyses revealed a unique sample with high plagioclase and Cr-diopside abundances, and minor occurrences of olivine [1, 2]. Zoned and lath-like plagioclase in veins within pyroxene and areas around mafic silicates indicate a period of rapid cooling and crystallization in the evolution of the rock [1]. The Al/Si and Mg/Si ratios as well as especially the very low Fe content are similar to the surface properties of Mercury. Thus NWA 7325 is speculated to be the first sample from this planet [2].
Here, we present first mid-infrared and Raman data from a 12 gram sub-sample of NWA7325. Besides further characterization of the mineralogical composition of the meteorite, the (infrared) spectral information will be also useful to compare it with available data from Mercury based on ground based observations (e.g., [3]) or for the future space mission BepiColombo, which will reach Mercury in 2022 and have a unique mid-infrared spectrometer (MERTIS) on board [4].

2. Techniques

Mid-Infrared spectroscopy:

The outside/crust of the unprepared sample was first analysed in the reflectance mode at an aperture of 4 mm under vacuum.
Following this, we measured random spots of four polished thin sections using apertures of 4 mm and 0.25 mm, again under high vacuum (Fig.1).
The mid-infrared measurements were made using a Bruker Vertex 70 infrared system at the IRIS laboratory at the Institut für Planetologie in Münster. All analyses were made under vacuum, with variable incidence and exit angles (20°/30° and 30°/30°), and always 512 scans added, in a wavelength range from 2 to 25 µm. In order to show the variations, the presented results are normalized on the strongest feature.

Raman Spectroscopy:

Raman measurements were performed with a confocal HORIBA Jobin Yvon LabRam HR-800 Raman microscope. The laser excitation wavelength was 532 nm with a laser power of ~5 mW. A 50 x objective was used.

3. Results

An overview of the mid-infrared results is shown in Figure 1 (analyses at incidence/exit angles 30°/30°), together with reference spectra for the major minerals, anorthite [5] and diopside. Since the major features in the 8-12 µm overlap for both phases, it is difficult to distinguish the minerals. Generally, the spots from the four thin sections and the crust show only small variation, even at a small aperture of 0.25 mm, indicating a large degree of mineralogical homogeneity. The main feature for anorthite at 10.6 µm overlaps directly with the main band of the NWA 7325 spectra (Fig.1), while the second characteristic band at 8.7 µm is slightly shifted compared to the 9.1 µm of the meteorite sample (which overlaps with a shoulder in the anorthite spectrum at this point). Smaller anorthite bands at 13.2 and 13.9 µm are clearly visible in the meteorite spectrum. Similarly, the diopside 'twin'-feature at 10.4 and 10.9 µm is reproduced by the meteorite data, while the second strong feature at 8.8 µm is slightly shifted. Also, two minor bands at 14.9 and 15.7 µm clearly show up in the NWA 7325 spectra. The Christiansen-Feature of NWA 7325 (8.2 µm) falls directly between those of anorthite and diopside confirming the mixture of the two phases.

Raman spectra (Figure 2a,b) confirm the IR analyses. Both, the presented diopside (Fig. 2a) and anorthite (Fig. 2b) spectra are representative for a series of

similar analyses across a thin section. Main features at 486.2 cm^{-1}, 504.9 cm^{-1} and 559.7 cm^{-1} for anorthite as well as the double peaks at 326.3 cm^{-1} and 395.8 cm^{-1} in addition to the main peaks at 667.4 cm^{-1} and 1012.1 cm^{-1} for diopside are confirmed by reference analyses [6] and [7].

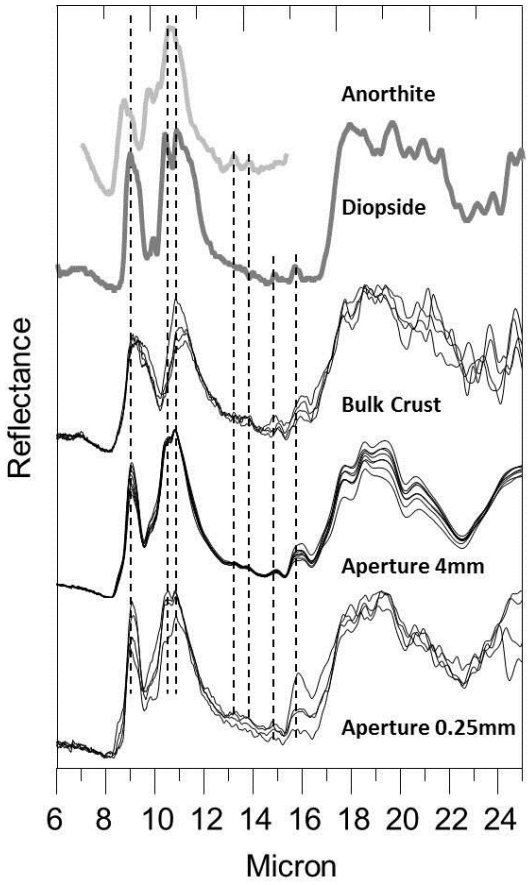

Figure 1: Overview of the mid-infrared spectra for the crust and spots on thin sections. In all cases the results of several measurements were normalized on the strongest feature to demonstrate the variations.

Acknowledgements

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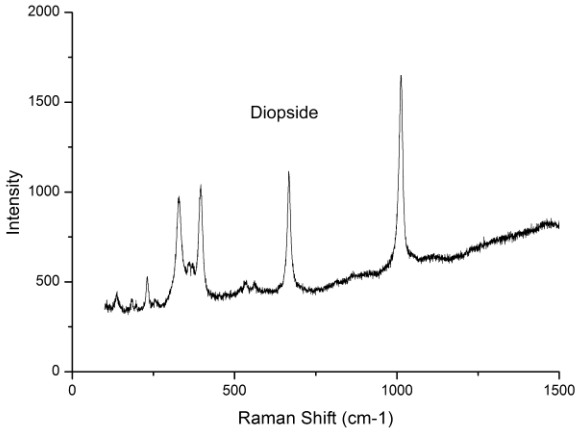

Figure 2a: Raman spectrum of diopside.

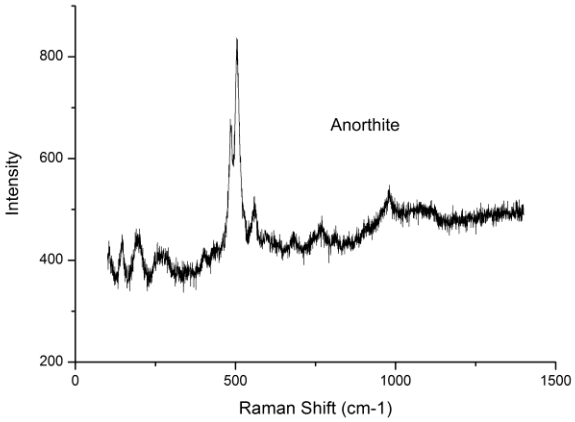

Figure 2b: Raman spectrum of anorthite.

6. Summary and Conclusions

Mid-infrared and Raman results for NWA 7325 show that the mineralogy is dominated by plagioclase (anorthite) and diopside. Further investigations will be presented at the meeting.

References

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