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An Infrared Laboratory for the Study of Planetary Materials (IRIS): First Results of Impact Rock Studies

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Abstract

We present the results of a study about the mid-infrared reflectance properties of impact rocks from the Nördlinger Ries impact crater. Spectra from separated components of suevite, melt glass, devitrified glass and matrix show a high degree of similarity, reflecting the high abundance of amorphous materials.

1. Introduction

Infrared spectroscopy allows determining directly the mineralogical compositions of planetary surfaces via remote sensing. For the interpretation of the remote sensing data, laboratory spectra of analogous materials are necessary for comparison.

IRIS (**I**nfra**R**ed for **I**nterplanetary **S**tudies) is a laboratory focused on building a database of mid-infrared spectra for the interpretation of expected data from BepiColombo, Europe's first mission to Mercury, anticipated to be launched in 2016 and arriving in 2022. On board is a mid-infrared spectrometer (MERTIS-Mercury Radiometer and Thermal Infrared Spectrometer). This instrument allows mapping spectral features in the 7-14 µm range, with a spatial resolution of ~500 m [1].

The mid-infrared part of the electromagnetic spectrum contains strong diagnostic features for many expected mineral phases on the surface of Mercury like the Christiansen feature, Reststrahlen Bands, and the transparency feature, which help to characterize mineral phases. Our results will be incorporated in the Berlin Emissivity Database (BED) that compiles all reference spectra for this mission [2,3,4].

The main focus of our MERTIS related studies is to assess the effects of surface processing on the material properties. The surface of Mercury is exposed to radiation, heat, and particles, as well as impacts of large bodies and micrometeorites. This affects the structure and thus spectral properties of the mineral phases on the surface. Any infrared study of this material will have to take these effects into account for the interpretation of the MERTIS data [4,5].

To achieve this, we will use both natural rock samples (impact melt rocks, lunar samples), but also analogue materials (e.g., lunar regoliths, experimentally shocked rocks). A further focus will be space weathering by analyzing samples that underwent artificial space weathering in laboratory [5].

Here we present mid-infrared analyses of impact rocks from the Nördlinger Ries crater in Germany, a 15 million year old structure with a diameter of 26 kilometres [6]. It is an ideal starting point to obtain spectra from a series of impact rocks, since it is one of the best preserved larger impact structures [6]. The rocks of interest are the suevites, a polymict impact breccia which contains the most highly processed material from the impact. These are the dark glass inclusions formed from quenched molten rock, lithic and mineral clasts in all stages of shock metamorphism, embedded in a particulate matrix. These fragments formed mainly of material from the basement rock: granite, gneiss and amphibolite [6]. We present first mid-infrared spectra from outer suevite samples, material originating from the ejecta blanket surrounding the impact structure. They are also from a quenched bottom layer that contains glassy material [7].

2. Techniques

The IR/IS laboratory at the Institut für Planetologie at the WWU Münster centers around a Bruker Vertex 70 infrared system using DTGS and soon MCT detectors for mid-infrared studies (2–20µm) and near infrared (0.6–2.5µm). Analyses are conducted under high vacuum to avoid atmospheric bands. For reflectance measurements, a Bruker 513 variable geometry stage allows to measure samples with independent incidence and emergence angles. In the first part of our study, we analyzed the impact rocks in the mid-infrared using the DTGS detector in vacuum, using incidence and emergence angles of 20°/30° and 30°/30°. Always 512 scans were added.

Parts of the samples was crushed before analysis (GR) and contain the whole size range from <25 µm to mm; further measurements are from polished blocks (PB).

3. Results

Figure 1 shows an overview over the mid-infrared analyses of bulk suevite, glassy and slightly altered melt inclusions, and the fine-grained matrix in which the glass is embedded. The measurements from the polished blocks show an expected higher intensity, while the analyses of the crushed samples show lower intensities due to their high porosity. Interestingly, all samples have very similar major features – dominating bands at 9.4-9.5 µm and 21-22 µm, which is typical for the SiO_2-rich glass and highly shocked phases which make up most of the material. A feature at 18.8 µm is a sign of a higher degree of crystalline contents in the matrix materials as well as in the devitrified glass. In addition, some shoulders appear in these two components between 8 and 9 µm, also indicating crystalline materials.

4. Summary and Conclusions

First results in the mid-infrared of separated glasses and matrix from suevite impact rocks from the Nördlinger Ries impact crater show a high degree of homogeneity, reflecting the high abundance of amorphous material. Future work will include a wider range of materials, analyzed in various grain sizes.

5. Acknowledgements

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References

[1] Benkhoff, J. et al.: BepiColombo—Comprehensive exploration of Mercury: Mission overview and science goals, Planetary and Space Science, Vol. 58 pp. 2–20, 2010.

[2] Helbert, J. and Maturelli, A. The emissivity of a fine-grained labradorite sample at typical Mercury dayside temperatures, Earth and Planetary Science Letters, Vol. 285, pp. 347-354, 2009.

[3] Hiesinger, H. et al.: The Mercury Radiometer and Thermal Infrared Spectrometer (MERTIS) for the BepiColombo mission, Planetary and Space Science, Vol. 58, pp. 144–165, 2010.

[4] Rothery, D. et al.: Mercury's surface and composition to be studied by BepiColombo, Planetary and Space Science, Vol. 58, pp. 21–39, 2010.

[5] Rout, S.S. et al.: Growth of Nano Iron Inclusions in Films Produced by Pulsed Laser Irradiation of Olivine: Simulations of Space Weathering on Mercury, Lunar and Planetary Science conference XLIV, 18-22, 2013 in The Woodlands, 2013.

[6] Stöffler, D. et al: Ries Crater and Suevite Revisited-Observations and Modeling Part I: Observations, Meteoritics & Planetary Science, Vol. 48, pp. 515-589, 2013.

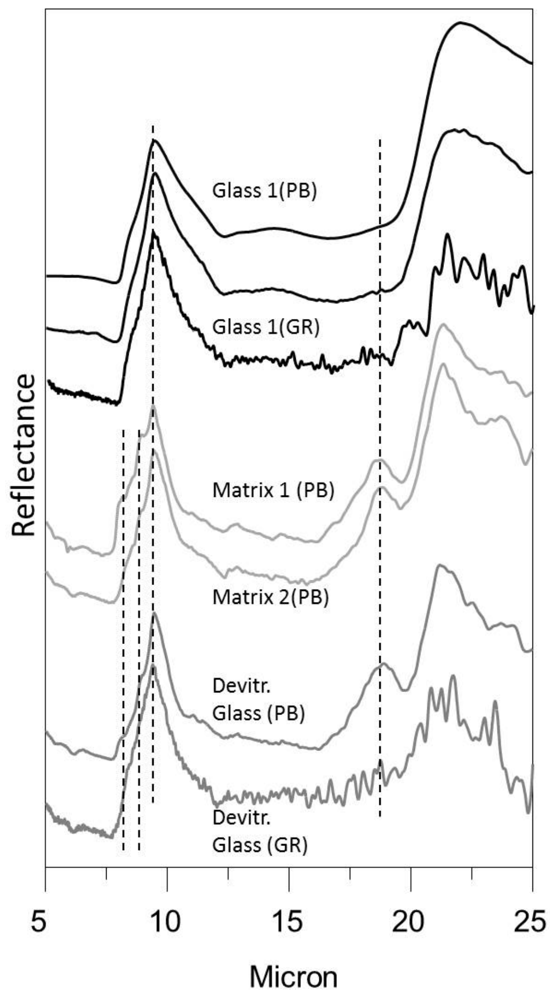

Figure 1: Mid-infrared spectra of various components in suevite. (GR) = Coarse grains; (PB)= Polished block.