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Mid-Infrared Studies of Impact Rocks: Suevite from the Nördlinger Ries Crater, Germany

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Abstract

Bulk suevites, impact rocks from the Ries impact crater, are very similar in their mid-infrared spectra. Red suevite exhibits a higher content of crystalline fragments compared to the Ottingen suevite. The Christiansen Feature (CF) reflects the felsic composition of the basement rocks in the area of the impact, mainly granite and gneiss. The shift of the CF in the smallest size fraction may indicate small differences in the composition of the finest fraction e.g. due to smaller grain sizes or greater strength of a (mafic ?) mineral fraction.

1. Introduction

Infrared spectroscopy allows determining the mineralogical compositions of planetary surfaces via remote sensing. To interpret the remote sensing data, laboratory spectra of analog materials are necessary. Our work at the IRIS (InfraRed spectroscopy for Interplanetary Studies) laboratory produces spectra for a database of for the ESA/JAXA BepiColombo mission to Mercury. Onboard is a mid-infrared spectrometer (MERTIS-Mercury Radiometer and Thermal Infrared Spectrometer). This unique device allows us to map spectral features in the 7-14 µm range, with a spatial resolution of ~500 m [1-4]. Here, we present mid-infrared spectra of suevite impact rock from the Nördlinger Ries impact crater in Southern Germany (25 km in diameter). The surface of Mercury was exposed to heavy impact cratering in its history. So the effects of impact on spectral properties are of high interest.

2. Samples and Techniques

The study focuses on bulk suevite containing a mixture of rocks shocked in all stages from I to IV, and melt glasses. In addition, we will also look at the components like fine-grained matrix or embedded melt glasses [5].

The selected rocks were ground in a steel mortar, the rock powder was dry sieved into four size fractions from 0 to 250 µm. For the mid-infrared analyses we used a Bruker Vertex 70 infrared system with a MCT detector for a spectral range from 2 to 20 µm at the IRIS laboratory at the Institut für Planetologie at the WWU Münster. Analyses were conducted under near vacuum (3 mbar) to avoid atmospheric bands. For reflectance measurements, a Bruker 513 variable geometry stage allowed us to measure samples with independent incidence and emergence angles.

3. Figures

Normal ***suevite*** (here from Ottingen) (Fig.1) consists of a porous matrix of fine-grained rock, melt glass and crystalline basement rocks in all stages of shock metamorphism [5]. The dark blue spectrum is the size fraction from 125-250 µm, light blue 63-125 µm, pink 25-63 µm and brown from 0-25 µm. In the spectral range of MERTIS (7-14 µm) the Christiansen Feature (CF) is between 7.6 and 7.8 µm for size fractions 250 – 25 µm. For the finest fraction (smaller 25 µm) the CF is at 8.1 µm. The Transparency feature (TF) appears in the finest size fraction at 12 µm. There is only one Reststrahlenband at 9.4 µm, indicating a highly amorphous structure of the material. ***Red suevite*** (Fig.2) from the Polsingen quarry is characterized by their red color owing to a high hematite content. The materials resembles a coherent, dense melt rock, differences between these components are not visible. Also, there are differences in bulk chemistry (alkalis and SiO_2) between the suevites [5,6,7]. The CF occurs between 7.8 µm for sizes >25 µm, and at 8.1 µm for the finest size fraction. The TF band appears at 12 µm in size fractions < 63 µm, the strongest Reststrahlen feature is at 9.5 µm. Furthermore, weak Reststrahlen bands or shoulders are between 8.2 and 8.8 µm. These indicate higher contents of crystalline components from granite and gneiss fragments [8]. The CF is at 7.7-7.9 µm, the TF at 11.8 in the finest size fraction.

4. Conclusions

Both bulk impact rocks are very similar in their mid-infrared spectra. Red suevite exhibits a higher content of crystalline fragments compared to the Ottingen suevite. The CF reflects the felsic composition of the basement rocks in the area of the impact, mainly granite and gneiss [8]. The shift of the CF in the smallest size fraction may indicate small differences in the composition of the finest fraction e.g. due to smaller grain sizes or greater strength of a (mafic?) mineral fraction. The RS features are similar to those of experimentally shocked feldspars [9]. Further analyses will cover a wider range of suevite components.

5. Acknowledgements

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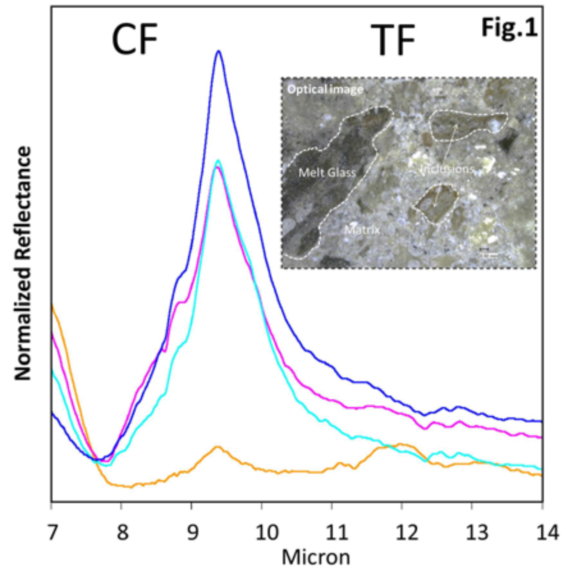

Figure 1: The FTIR spectra show mainly amorphous features. Optical image of a typical suevite area with fragments of glass and rock.

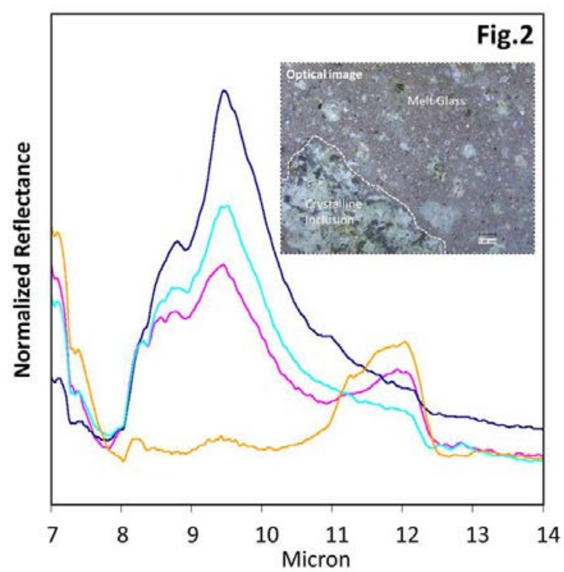

Figure 2: The optical image of a typical area in a red suevite shows mainly a coherent melt rock with abundant crystalline fragments.