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Remote Sensing of Planetary Surfaces: Spectroscopy of Planetary Analogs for the BepiColombo Mission

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Abstract

We present mid-infrared spectra bulk powders and from in-situ studies of surface analogues for Mercury synthesized based on remote sensing data from MESSENGER.

1. Introduction

The IRIS (Infrared and Raman for Interplanetary Spectroscopy) laboratory generates spectra for the ESA/JAXA BepiColombo mission to Mercury. Onboard is MERTIS (Mercury Radiometer and Thermal Infrared Spectrometer), which allows to map spectral features in the 7-14 µm range, with a spatial resolution of about 500 meters [1-5]. Glass, which can form in impacts and in volcanic processes, lacks an ordered microstructure and represents the most amorphous phase of a material. It forms in events typical for the formation of the surface of Mercury [5-7]. Using synthetic analogs based on the observed chemical composition of planetary bodies allows us to produce infrared spectra of bodies from which no material in form of meteorites is available so far [8]. In this study, we present synthetic analogues for surface regions of Mercury based on results of the MESSENGER mission [9], and petrological experiments and modelling [10-12].

2. Samples & Techniques

Bulk glasses were synthesized based on the chemical composition for surface areas on Mercury from the MESSENGER X-ray spectrometer data [9], following a procedure described in [8]. Further glassy and crystalline analogue material was produced in petrological experiments simulating the petrologic evolution of early Mercurian magmas under controlled temperatures, pressures and oxidation states [10-12]. For this presentation, we selected spectra from the high-Mg NVP (Northern Volcanic Plains) region (Fig.1), produced at 0.1 GPa and 1210°C [10-12]. For the FTIR diffuse reflectance analyses, powder size fractions 0-25 µm, 25-63 µm, 63-125 µm, and 125-250 µm were measured from 2-18 µm. We used a Bruker Vertex 70 infrared system with a MCT detector at the IRIS laboratories at the Institut für Planetologie in Münster. Analyses were conducted under low pressure to reduce atmospheric bands. Additional FTIR microscope analyses of polished thick sections were made from the experimental runs with a Bruker Hyperion 2000 System at the Hochschule Emden/Leer. A 250×250µm sized aperture was used for all analyses.

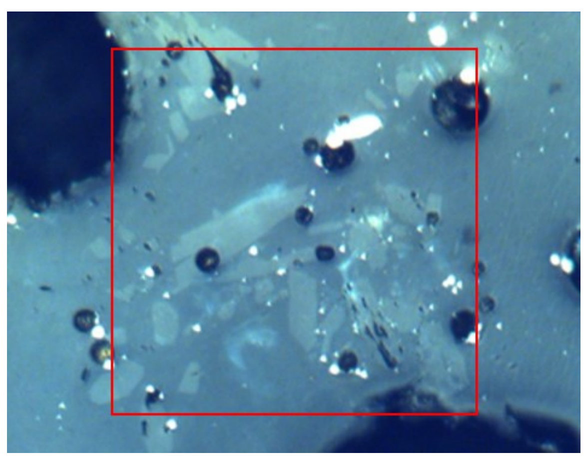

Fig.1. Optical images of the high-Mg glass sample with the composition of the Northern Volcanic Plains area. The bright parts are crystalline phases, the

darker parts are glass. The red box marks the aperture of 256×256 µm.

3. Results

The spectra of the surface regolith exhibit a strong, dominating feature at 9.8 µm, typical for glassy material (Fig.2) [8]. Two important additional characteristic bands for remote sensing, the Christiansen feature (CF; the position of lowest reflectance), and the Transparency Feature (TF; characteristic of the finest grain size fraction) are located at 8.0 µm and at 11.9 µm, respectively. The micro-FTIR analyses of the experimental sample analogs for the high-Mg NVP (Fig.3) show strong crystalline features at 9.3 µm, 9.9 µm, 10.4 µm and 11.6 µm, with minor features at 13.8 µm and 14.7 µm. The CF is at 8.1 µm, enstatite features mixed with diopside bands [13]. The spectra of glassy material is similar to the glass with the regolith composition, with a single strong band at 9.7 µm and a CF at 7.9 µm.

4. Discussion & Conclusions

Results of our ongoing study of analogue materials for the surface of Mercury show consistent spectral features for the glass and the crystalline components in relation to its chemical composition. First in-situ micro-FTIR studies of crystalline phases show a variety of pyroxene bands. These confirm earlier micro-analytical studies of the samples [10]. Future analyses will cover a wider range of bulk samples for the surface of the planet, as well as more detailed in situ studies of the phases formed in the petrological experiments under various temperature and pressure regimes. The results will be made available via a database [1].

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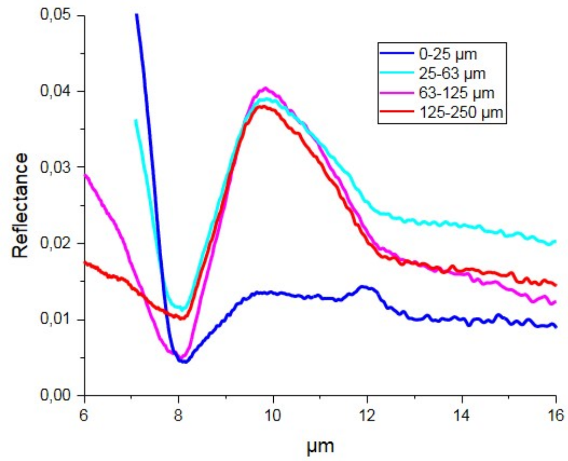

Fig.2: Mid-infrared reflectance spectra of powdered bulk glass with a composition analogue to surface regolith from Mercury [9]. The features are typical for amorphous materials, showing a featureless strong band in this region [8].

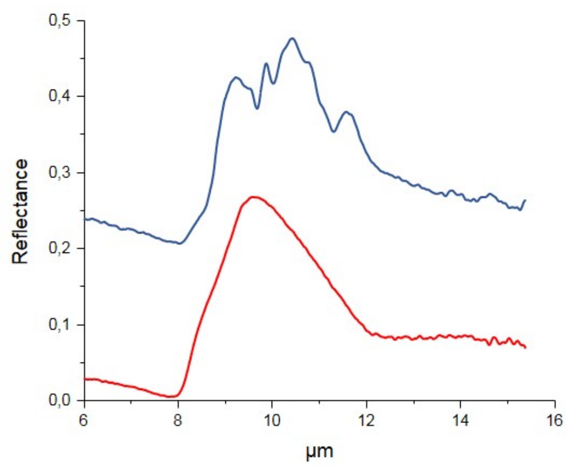

Fig.3: Micro-FTIR analyses of High-Mg Northern Volcanic Plains region (Fig.1). Blue: crystalline phases, red: glass.

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