ANALOGS FOR THE TERRANES OF MERCURY: A FTIR STUDY IN PREPARATION OF THE BEPICOLOMBO MISSION.

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Introduction: The MERTIS (MErcury Radiometer and Thermal Infrared Spectrometer) onboard the BepiColombo ESA/JAXA mission to Mercury will map the surface of Mercury in the wavelength range of 7-14 µm. For the accurate interpretation of these spectra, a database of analog materials is needed.

In preparation of the future MERTIS spectra, we have studied a wide range of natural mineral and rock samples such as impact rocks and meteorites under varying conditions [e.g. 3-5]. Synthetic glasses mimicking compositions measured by MESSENGER and synthesized in laboratory experiments were also studied [6-9].

FTIR Measurements: For the bulk powder FTIR diffuse reflectance analyses, powder size fractions of representative mixtures (0-25 µm, 25-63 µm, 63-125 µm, and 125-250 µm) were measured. The samples were mixed based on compositions modeled in [8],using synthetic glasses [6] and natural crystalline minerals.

For mid-infrared analyses from 2-20 µm, we used a Bruker Vertex 70 V infrared system with a MCT detector at the IRIS laboratory at the Institut für Planetologie in Münster. Analyses were made under low pressure to reduce atmospheric bands. Expected spectral features in this wavelength region are the Christiansen Feature (CF), a characteristic reflectance low, the Transparency Feature (TF) typical for the finest size fraction, and the Reststrahlen-Bands (RB), the vibrational modes of the materials.

Results: (Figure 1) Typical representative spectra are presented in Fig.1: ID 349 Low-Mg NVP (Northern Volcanic Plains) shows olivine features at 9.4-9.5 µm and 10.5-10.6 µm, despite the dominance of glassy material (86.9 wt%).

The spectrum of ID 350 Low-Mg NVP, with lower glass content is dominated by crystalline features, pyroxene and feldspar bands at 9.4 µm, 9.9 µm, 10.2 µm, 10.5-10.6 µm, and 10.8 µm. Spectrum ID 174 Low Mg II Glass is an example of a pure glass spectrum, dominated by a single feature at 9.6 µm.

Discussion: In order to interpret the laboratory spectral data, the spectra have to be correlated with properties of the samples. A classical way is to use the CF, since it is recognizable even in very noisy spectra. The CF is correlated, e.g., with the chemical composition of the material. Comparing the CF with the SiO_2 abundance (Fig.2), we see a correlation similar to that of typical terrestrial rocks [10]. Also, the hermean mixtures form a cluster with other synthetic samples based on Mercury compositions [7-9].

The SCFM index expresses the degree of polymerization ($SiO_2/SiO_2+CaO+FeO+MgO$) [10]. Most of the results from this study fall below the terrestrial correlation line (Fig.3). The results show similarities to the intermediate, and basaltic terrestrial rocks.

A preliminary comparison with one of the few spectra from the surface of Mercury obtained by ground-based telescopes [11] (Fig.4) shows a CF at 8.5 µm, RBs at 9.3°µm, 9.9°µm, and 11°µm. A potential TF is visible at 12.4°µm.

The olivine-rich ID 347 High-Mg Province mixture reproduces the CF of the hermean spectrum (Fig. 4), and the RB at 9.3 µm. A broad feature at 11°µm overlaps with the narrower band of the surface spectrum at the same location. Plagioclase and enstatite-rich ID 357 High-Mg NVP mixture has a low-point at 8.5 µm, and RB at 9.4°µm and 9.9°µm. These features are similar to the CF at 8.5 µm and the second and third RB (9.3°µm and 9.9°µm) of the hermean sample.

Summary and Conclusions: Spectra of mixtures based on the composition of hermean surface regions can be divided into olivine- and pyroxene-rich groups. Preliminary comparison with a spectrum of the hermean surface show some similarities, but none of our spectra is able to reproduce the remote sensing data entirely.

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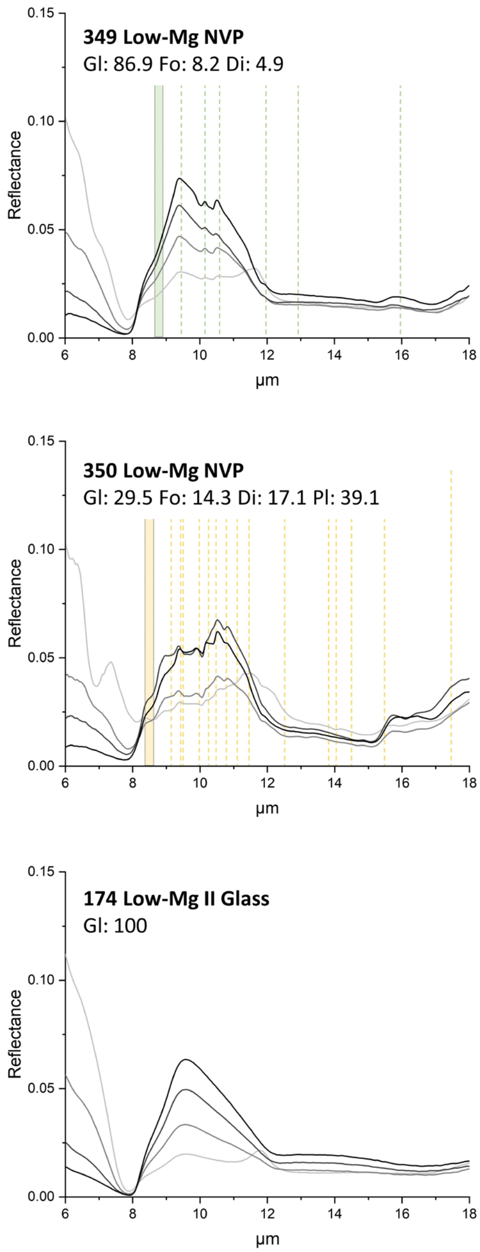

Figure 1: Mid-infrared spectra characteristic for the studied mixtures. ID 349 Low-Mg NVP is dominated by glass with olivine features, ID 350 Low-Mg NVP by pyroxene bands.

Figure 4. (right) Comparison of a telescopic spectrum of the surface of Mercury (red) [11] to the spectra of the 0-25 µm grain size fraction of two representative samples, i.e., ID347 and ID357.

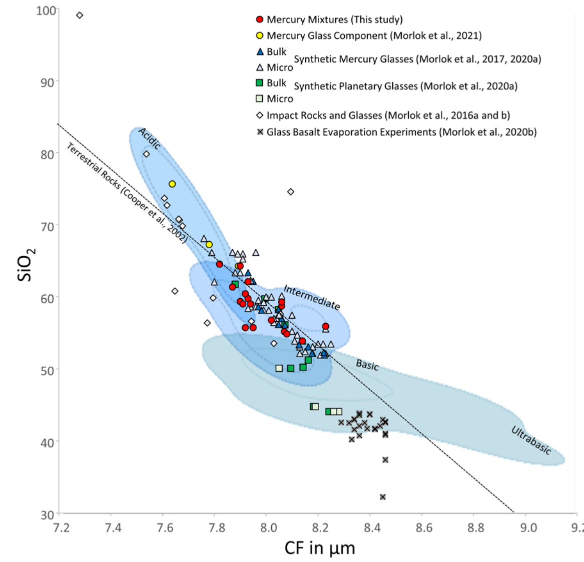

Figure 2. Comparison of CF and SiO_2 abundance. Results from this study (red) and other analogs for Mercury fall along the terrestrial correlation line

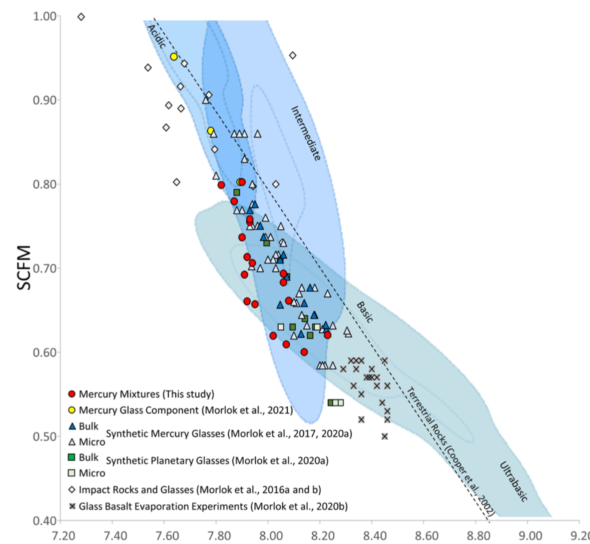

Figure 3. Comparison of the SCFM-index and the CF.