FTIR STUDIES OF PLANETARY MATERIALS: THE IMPACT OF TEMPERATURE AND VACUUM ON SPECTRAL FEATURES.

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Introduction: The Mercury Radiometer and Thermal Infrared Spectrometer (MERTIS), launched onboard the BepiColombo Mercury Planetary Orbiter (MPO), operates in the wavelength region of 7-14 µm. This range is well suited to map the mineralogy of the hermean surface at a resolution of about 500 m [1-4]. Temperature and pressure have an effect on mid-infrared spectra [e.g., 5-7]. Therefore, we conducted studies of samples in our collection under simulated hermean surface conditions. The results will also be of interest for the comparison with remote sensing data of other planetary surfaces (e.g. moon, [5]).

Samples and Techniques: For these analyses, we used a Bruker VERTEX 70v IR spectrometer at the IRIS (Infrared & Raman for Interplanetary Spectroscopy) laboratory in Münster with a Harrick heating stage in a Praying Mantis Diffuse Reflectance Accessory to measure mid-infrared reflectance of mineral powders. Temperatures within the sample chamber ranged from room temperature up to 723 K. The pressures are of the order of 10^{-3} Pa. Here we present the spectra of the finest size fraction (<25 µm) of forsterite, enstatite, and labradorite. Of particular interest are the Christiansen Feature (CF) (a reflectance low), the Transparency Feature (TF), typical for the finest particles, and the Reststrahlenbands (RBs), representing the molecular 'fingerprint` of the materials.

Results: The heated sample itself emits. This emitted radiation is partly scattered into the interferometer, modulated, and back directed to the sample. This causes a complex superposition of detected signals. Therefore, intensities of the signal are affected, resulting in a decreasing intensity with increasing temperature [5-7]. At temperatures over 400°C, spectra show high noise and were omitted (Fig.1).

For the forsterite (ID 249), the CF shifts from 8.91 µm at room temperature to 8.77 µm at 400°C. Similarly, the TF shifts from 12.96 µm to 12.55 µm. The shift of the RBs varies, with a clear shift of the 9.35 µm feature to 9.53 µm. The strong RB at 10.59 µm also shifts, but at temperatures over 300°C an inflection appears in the 10.5 µm-11.0 µm range, which increases in intensity with temperature, and which is also observed in the other samples.

Similar, enstatite (ID 53) has the CF shifting from 8.41 µm (24°C) to 8.31 µm (400°C), while the determination of the exact position of the TF at higher temperatures was not possible. Of the RBs, the feature at 8.8 µm (24°C) shifts to 8.9 µm (400°C). Labradorite (ID 28) shows only a small shift of the CF (7.96 µm to 7.93 µm at 350°C), while the TF moves significantly from 12.09 µm to 11.94 µm at 350°C.

Summary and Conclusions: Our ongoing work using a heating and vacuum set-up in reflectance provides a fast method to investigate the spectral behaviour of minerals und realistic planetary conditions. However, the impact and mitigation of potential artefacts requires future attention. For general studies and investigation of parameters (e.g., shift of band positions) under varying environmental conditions the technique shows promise.

References: [1] Benkhoff J. et al. (2020) *Planetary and Space Science* 58: 2-20. [2] Hiesinger H. et al. (2020) *Planetary and Space Science* 58: 144–165. [3] Stojic, A.N. et al. (2021) *Icarus* 357: 114162. [4] Reitze M.P. et al. (2021) *EPSL* 554: 116697. [5] Donaldson Hanna et al. (2017) *Icarus* 283: 326-342. [6] Reitze (2016) *19th EGU General Assembly*, Abstract #17491 [7] Reitze et al., (2018) *LPSC XLIX*, Abstract #1983

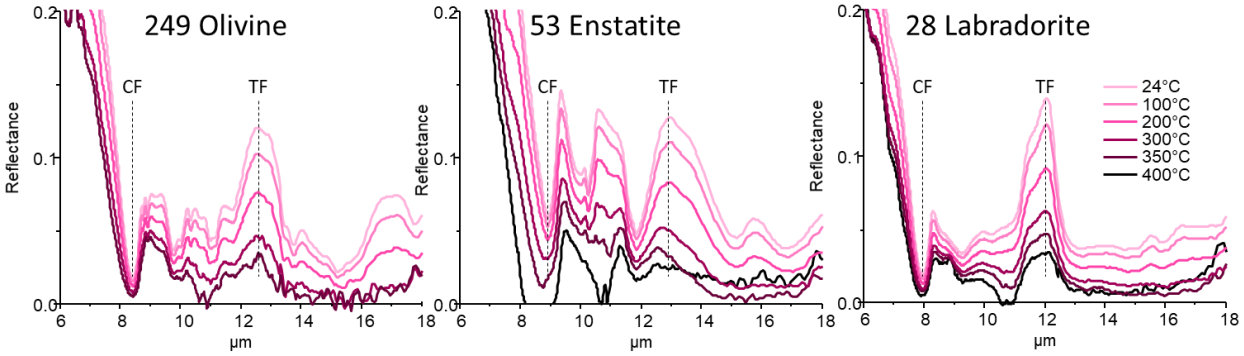

Figure 1: Mid-infrared reflectance spectra of the finest powdered size fractions (<25 µm) for common minerals in the temperature range from room-temperature (24°C to 400°C). CF: Christiansen Feature, the Reflectance Minimum; TF: Transparency Feature, typical for the finest size fractions.