A Study of Thermal Expansion on the Predicted Mercury Surface Minerals: Preparing for MERTIS on BepiColombo

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The MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) mission unveiled that most of the detectable surface of Mercury is constituted by low-Fe and Mg-rich basalts [1,2], dismissing the previously assumed widespread presence of more felsic materials - as on the Moon's surface. In this background, the BepiColombo mission will be fundamental to reveal the residual igneous crust of the Mercury surface, in order to assess its petrogenesis.
The Mercury Radiometer and Thermal Infrared Spectrometer (MERTIS) on BepiColombo will be able to provide thermal infrared (TIR) emissivity spectra from 7 to 14 μm. This wavelength range is very useful to identify the structural properties of several silicates, and the position of the emissivity bands provides hints on the solid solutions. In addition to space-weathering degradation and impact-induced structural modifications, the thermal expansion driven by the daily temperature variation of the surface of Mercury significantly affects the crystal structure and density of the present minerals and, consequently, their thermal infrared spectral signature. This behaviour has been recently demonstrated for several common terrestrial mineralogical phases [3,4,5], and could be even predicted for other silicates. A more difficult interpretation of the spectra arises, of course, from the simultaneous presence of different minerals, each one with its characteristic thermal expansion coefficient.
In addition to the temperature-dependent spectral variations of single constituents (e.g. plagioclases, olivine, pyroxenes), the DLR Planetary Emissivity Laboratory (PEL) is measuring emissivity spectra of linear mixtures that most likely could be present on the surface of Mercury. To this aim, spectra of binary compositions (e.g., anorthosite, gabbro) and their single-phase components are measured along the MERTIS wavelength range in vacuum from low to high-temperatures - up to 450°C.

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