HERMEAN COMPLEX CRATERS SEEN IN A NEW LIGHT - FIRST RESULTS FROM MERTIS MSB#5.

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Introduction: Studying complex impact craters and especially their ejecta and central peaks provides insights into the composition of a planet's subsurface. These materials likely originate from great depth, depending on factors such as crater size, target properties, and impact conditions [1]. This study aims to enhance our understanding of Mercury's crustal stratigraphy.

Using data from the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) mission [2], several studies [3,4] already investigated the spectral properties of 121 globally distributed impact craters on Mercury's surface in the wavelength range of 300 - 1450 nm using MESSENGER's Mercury Atmospheric and Surface Composition Spectrometer (MASCS) [5]. These studies identified a potential global N-S dichotomy in the composition of the shallow crust and short-range horizontal heterogeneities.

During BepiColombo's 5th swing-by at Mercury (MSB#5) on December 1st, 2024, the Mercury Radiometer and Thermal Infrared Spectrometer (MERTIS) [6-8] acquired spectral data of the Hermean surface in the wavelength range of 7-14 µm for the first time from a spacecraft. The obtained spectral data cover 186 complex impact craters which have been previously covered by MASCS [4]. For this study we only focus on those 48 craters that are covered by pixels from MERTIS which only lie within the crater, as we want to compare those measurements with spectra from the central peaks taken from the MASCS included in the Mercury Surface Spectroscopy (MeSS) database [9,10].

Data and Methods: Due to the relatively large distance of ~40,000 km to the surface, the ground resolution of MERTIS varies between 26 and 30 km/pixel. Consequently, only the interiors of craters larger than ~40 km can be investigated with the flyby data. Once in orbit, MERTIS will deliver spectral data with a pixel scale of ~500 m, which will enable us to investigate the spectral properties of impact craters in greater detail.

To ensure a high S/N ratio, we have currently restricted our study to high temperature areas between 60°N and 60°S latitude. Within this area we investigated the aforementioned 48 complex impact craters. We used crater diameters as a proxy for the approximate depth from which the craters brought material to the surface [e.g.,1] and measured these diameters with OpenCraterTool [11].

The MERTIS coverage of each individual crater ranges from just a few pixels for the small craters to more than 1500 overlapping pixels for the two largest craters. Distinguishing between different geologic features or units, like central peaks and crater floors within the craters is complicated or sometimes impossible due to the large pixel sizes. Consequently, we only examined the crater interiors as a whole (Fig. 1). We therefore calculated preliminary average emissivity spectra for the crater interiors of 30 of the identified craters.

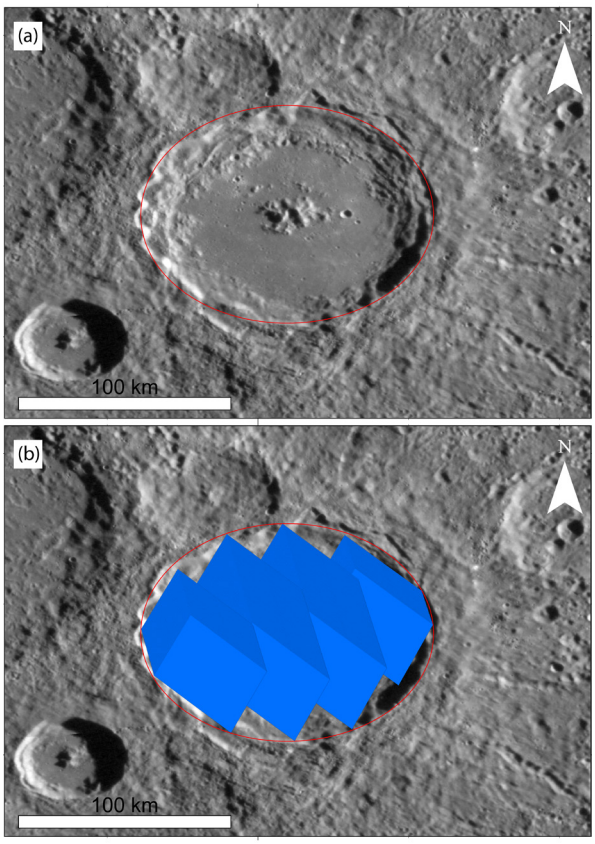

Figure 1: Example for the coverage of the MERTIS data of an unnamed 100 km diameter crater at 160°W/42°S. (a) shows the marked crater in red on the MDIS mosaic (166 m/pixel). (b) shows the MERTIS pixel coverage in blue (295 pixels).

After calibration of the TIS data, the spectral emissivity is acquired by dividing the measured radiances by the radiance of a surface with unit

emissivity. Since Mercury's thermal emission is highly anisotropic, a thermophysical model is required to retrieve accurate emissivity values. For this purpose, the numerical thermal roughness model developed by [12] was adapted to the geometry of MSB#5 and preliminary spectral emissivities were computed. A detailed explanation of the methodology can be found in [13].

Preliminary Results: The 30 investigated impact craters show a diameter range of 46 km to 188 km and are distributed all over the study area (Fig. 2). They show a wide variation of spectral characteristics and possible shifts of the Christiansen Feature (CF), but so far, no obvious correlation with the crater diameter is noticeable. However, since these are preliminary data further investigations will be performed in the near future.

Outlook: We will further investigate the spectral characteristics of the complex impact craters covered by MERTIS and MASCS, aiming to improve our understanding of Mercury's upper crustal composition. Therefore, we will also aim to examine the different geologic units, such as central peaks, crater floors, and ejecta blankets, at least for the larger craters, as the materials from these distinct units are believed to originate from varying depths [1].

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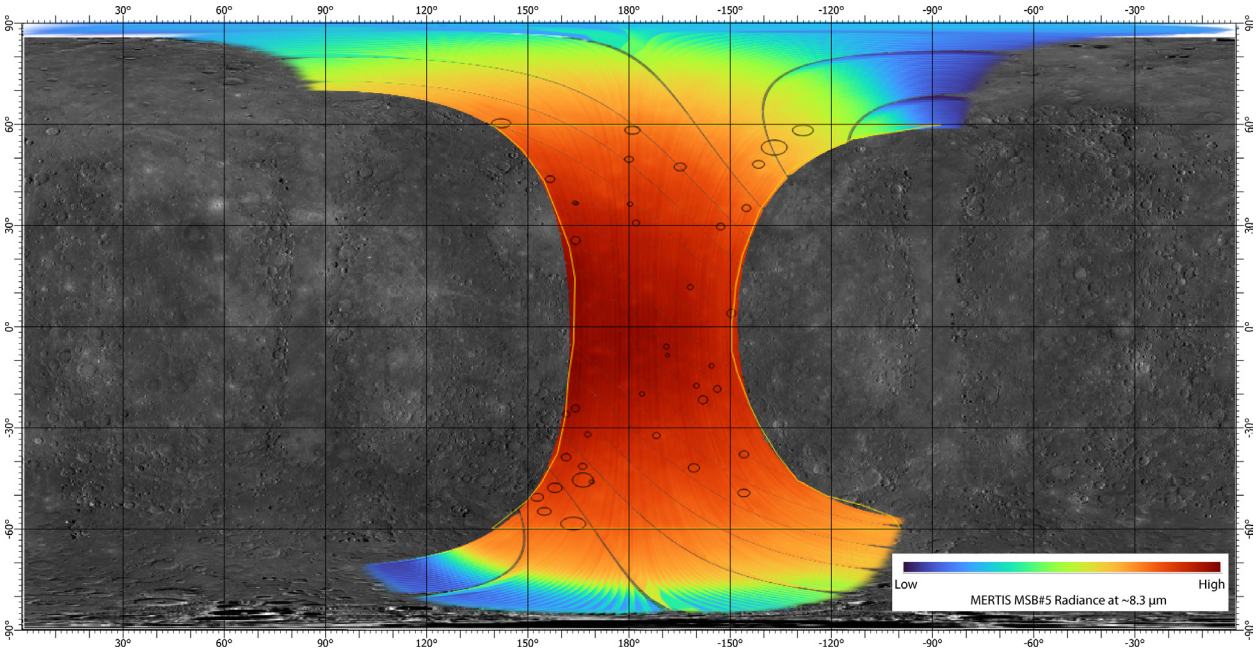

Figure 2: Color-coded radiance map (~8.3 µm) of MERTIS MSB#5 data. Low radiances are shown in blue and high radiances are indicated in red. Black circles mark the investigated complex impact craters that have been covered by MERTIS during MSB#5 and MASCS during the MESSENGER mission.