SPECTRAL CURVATURE IN THE VISIBLE AS AN INDICATOR OF MERCURY'S SPACE-WEATHERING.
O. Barraud[1], S. Besse[2], M. D'Amore[1] and J. Helbert[1], [1]German Aerospace Center (DLR) - Institute of Planetary Research, Rutherfordstrasse 2, 12489 Berlin (Oceane.Barraud@dlr.de), [2]European Space Agency (ESA), European Space Astronomy Centre (ESAC), Villanueva de la Cañada, Spain.

Introduction: Spectroscopy is a key tool for investigating surface composition and space-weathering of planetary bodies. Because of its proximity to the Sun, Mercury's surface is exposed to extreme conditions and environment (e.g. extreme temperature variation, high rate of impact). Among the youngest features at the surface of Mercury are the hollows [e.g. 1]. Multispectral observations by the Mercury Dual Imaging System (MDIS) wide angle camera (WAC) onboard MESSENGER revealed that hollows exhibit a reflectance twice higher than the average surface of Mercury and a weak absorption feature centered around 630 nm [e.g. 1, 2]. Spectral reflectance measured by the Mercury Atmospheric and Surface Composition Spectrometer (MASCS) lack absorption features even for the hollows materials observed with MDIS [3]. However, MASCS spectra exhibit a strong concave curvature between 300 and 600 nm, unique to hollows [3]. Here, we present an analysis of the MASCS spectral curvature on the entire surface of Mercury in order to investigate the relationship between curvature, composition and space-weathering.

Dataset and Method: The Visible and InfraRed Spectrograph (VIRS), the surface component of MASCS sampled the reflectance of Mercury between 300 to 1450 nm with a spectral resolution of 5 nm. MASCS/VIRS is composed of two detectors: a visible (VIS) detector operating between 300 and 1,050 nm and a NIR detector sensitive to wavelengths between 900 and 1,450 nm. In this study, only the reflectance measured by the VIS detector is used.

Data filtering. The MASCS/VIRS data are filtered by instrument temperature and incidence angle. The data recorded in the highest temperature regime of MASCS (temperature exceeding 40°C) are not used. Viewing geometry affects the spectral reflectance which is more sensitive to the topography at high incidence angle. Therefore, MASCS/VIRS data obtained at incidence angle higher than 75° are deleted.

Curvature parameter. The curvature parameter is calculated as described in [3] and correspond to the coefficient of the squared power of the polynomial fit of the reflectance spectrum between 300 and 600 nm. The curvature is then normalized to that of the reference spectrum provided by [4], who computed it from

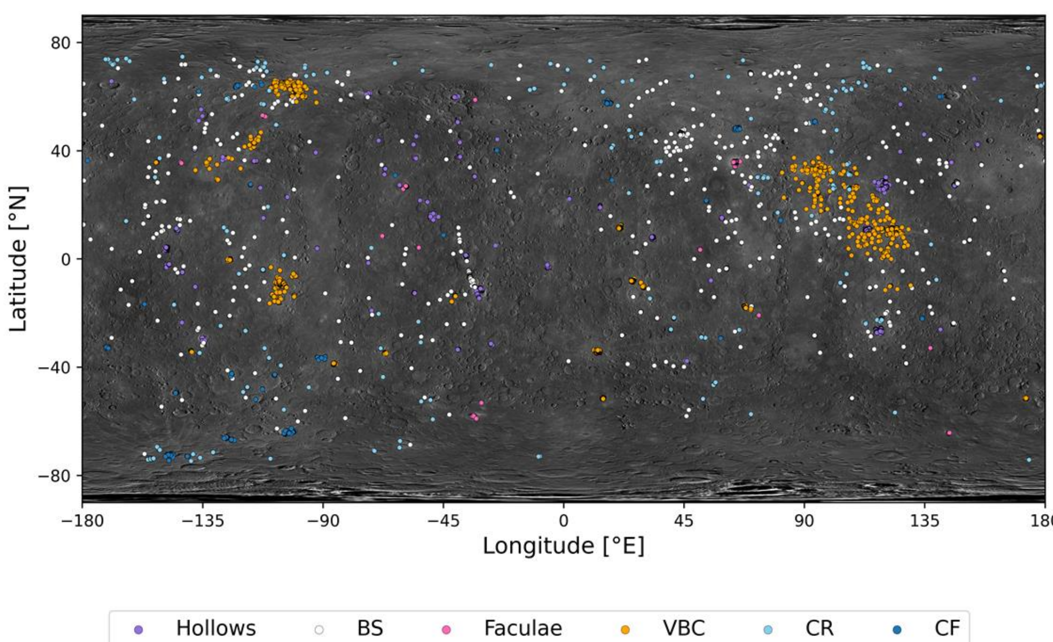

Figure 1 : Spatial distribution of MASCS/VIRS footprints with curvature parameter higher than 5. Each dot represents the center point of the footprint. The size of the dot is not representative of the footprint resolution. BS: bright spots; CR: crater rims; CF: crater floors; VBC: very bright craters.

an average of 850,000 spectra of Mercury's surface. Thus, Curvature parameter equals to 1 is representative of Mercury's mean surface. [3] showed that the curvature parameter varies between -5 and 7 in a range of spectral units (low reflectance material, Faculae, high reflectance red plains, etc.) while in the hollows the parameter ranges from 5 to 17. In this study we selected the MASCS/VIRS observation with a curvature parameter higher than 5.

Results: Observations with a curvature greater than 5 represent 11,834 footprints, i.e. 0.32% of the MASCS data obtained under the same conditions (filtered by temperature and angle of incidence). These 11834 footprints map 693 different features (spectral or geological) on Mercury's surface. These features are classified in 6 geological units: hollows, bright spots, very bright craters, crater rims, crater floors and faculae using the MDIS/WAC global base map at a spatial resolution of 166 meters/pixel (which is at least 3 times better than MASCS resolution). Around 73% of the units mapped in this study are the youngest features on Mercury: bright spots, hollows and very bright craters. 25% are crater floors or crater rims without previously identified hollows. 2% are classified as Faculae.

The spatial distribution of the MASCS/VIRS footprints with high spectral curvature is shown in Fig.1. The highest amount of units with high curvature values are located around 90°E and -90°E. Due to the orbital parameters of Mercury (obliquity, resonance, rotation period), its surface undergoes large temperature variations each diurnal period. Thermal modeling predicts the presence of “cold” poles around 90°E and -90°E “hot” poles around 0°E and 180°E [5].

Discussion: This work shows that spectral curvature of the MASCS/VIRS spectra is related to both the age of the geological features and the weathering undergoes by the surface. High curvature values around the cold poles suggests that thermal processing of the surface reduces spectral curvature in the visible range. [6] demonstrated by comparing MASCS data with laboratory measurements that the curvature of MASCS spectra in the hollows could be due to the presence of sulfides such as CaS, NaS and/or MgS and/or chlorides. Laboratory measurements demonstrated changes in the overall spectral characteristics of sulfides after thermal processing at Mercury’s hot poles temperatures (> 700K) [7]. MgS and CaS both exhibits variation in reflectance level and slope after the thermal processing. Further analysis is therefore needed to understand whether the spectral curvature observed in these materials is modified after heating to the temperature of Mercury's hot poles. To investigate this hypothesis further laboratory measurements of Mercury analog materials for a range of temperatures and thermal histories are key. These laboratory measurements will be needed also to interpret the future observations of BepiColombo which will greatly improve our understanding of Mercury’s surface.

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