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Spectral analysis of Mercury's hollows using MASCS/MESSENGER data

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Abstract

Because their possible link with volatile component, Hollows on Mercury need to be investigate to better constrain the evolution of amount of volatile species on Mercury. In this study, we analyse spectral properties of different part of hollows using data from Mercury Atmospheric and Surface Composition Spectrometer (MASCS) onboard MErcury Surface, Space ENvironment, GEochemistry and Ranging (MESSENGER) probe to better constrain spectral properties of Hollows.

1. Introduction

Mariner 10 and MESSENGER flybys allowed to highlight bright patches on Mercury and especially in several impact crater floors (BCFDs) [1]. In orbit around Mercury, the Mercury Dual Imaging System (MDIS) instrument produced images with a higher spatial resolution. This observations allowed to see that bright patches are composed of several small and irregular depressions [2]. These features, named hollows, are shallow with a flat floor and surrounded by bright haloes.
Sublimation of a volatile component was proposed as a formation scenario for hollows [1, 2], due to the similarity between hollows, swiss-cheese terrains on Mars [3] and several sublimation features on icy moons like Europa and Triton [2]. Also, low reflectance material (LRM) interpreted as host material of hollows are enriched in Ca, Mg, S and C compare to the rest of the Mercury's surface [4].
Spectrally, hollows appear brighter and less red than the average surface of Mercury. Vilas et al., (2015) identified an absorption feature around 600 nm in hollows of Dominici crater rim and Hopper crater, consistent with the presence of CaS and MgS. Also, Thomas et al., (2016) investigated several hollows using both MASCS and MDIS and found differences between hollow's floor and bright haloes in grain-size and spectral features. This study focuses on several BCFDs and hollows in Tyagaraja, Hopper and Eminescu impact craters. Spectral properties are investigated using spectral parameters in the three range of wavelengths: ultraviolet (UV), visible (VIS) and near infrared (NIR).

2. Data set and method

The MASCS instrument is composed by two spectrometers, the Ultraviolet and Visible Spectrometer and the Visible and InfraRed Spectrograph (VIRS). The VIRS spectrometer is composed of two detectors (VIS and NIR) and it is necessary to apply a correction before the analysis of spectra. So, we applied a specific algorithm developed by [6].
For each target, several footprints of MASCS are selected in different part of the BCFD or in the hollows (for example floors and haloes). Also, a footprint on the crater floor is used to constrain spectral properties of surrounding terrain.
Spectral analysis is based on 3 spectral parameters: the UV downturn [7], VIS-slope and NIR-slope [8].

3. Results

First, observations are about BCFD in Tyagaraja impact crater, the value of VIS-slope and UV downturn are greater in the BCFD than in the crater floor (surrounding terrains).
Second observations used are in Hopper impact crater. MASCS footprints allows to determine spectral parameters according to the percentage of BCFDs in the footprint. The value of VIS-slope and UV-downturn increase with the percentage of BCFDs and are greater, in the BCFD, than for the crater floor.
Currently, hollows around the central peak of Eminescu impact crater are analysed. MASCS footprints in this region have an area around 1 km^2, and that allows to differentiate spectra from hollow's floor and bright haloes. The reflectance value at 750 nm is higher in the haloes than in the hollow's floor (Fig. 1).

Also, the VIS-Slope, NIR-slope and the UV-downturn values are higher in the bright halo than in the hollow's floor. The hollow's floor has a VIS-slope lower than the crater floor deposit, while haloes have a higher VIS-slope than the crater floor. This result is consistent with the hypothesis that hollows are formed by sublimation of a "red" volatile component [4].
In summary, hollow's floors appear less red than their surrounding terrains (crater floors) but bright halo and BCFDs appear redder. BCFDs in Tyagaraja and Hopper craters seems to be composed principally of bright haloes with a little part of hollow's floors.

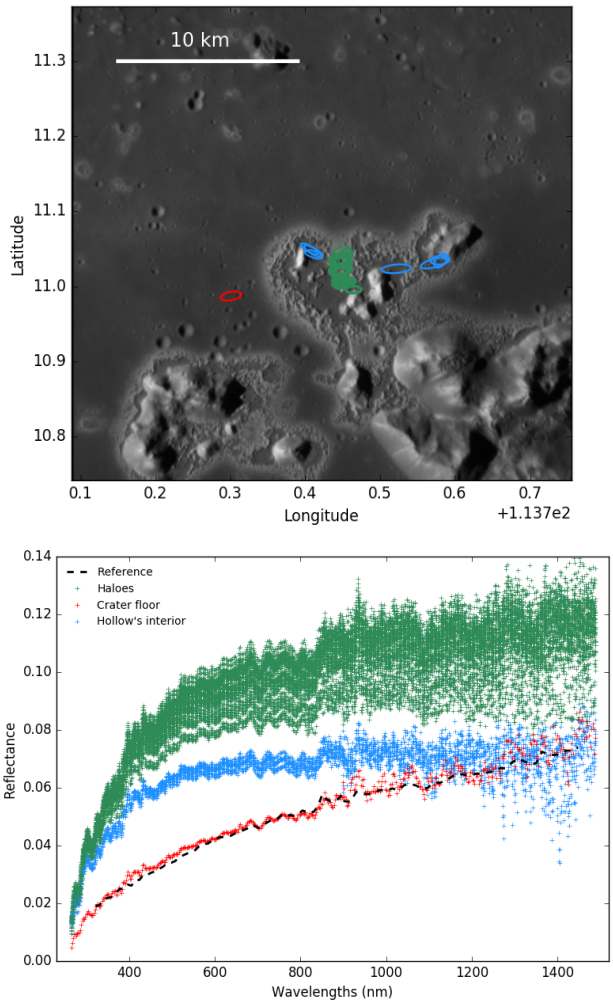

Figure 1: Hollows in Eminescu impact crater (10.66°N, 245.79°W). Top: MASCS footprints used in this analysis on a NAC MDIS image (35.23 m/pixel). Bottom: Spectras from the footprints on the top and reference spectra (black dashed line, [9]).

4. Conclusions and futur works

Hollows and BCFDs can be distinguished from surrounding terrains by spectral properties using spectral parameters. Moreover, hollow's floors show spectral features different from bright haloes, not only by the absolute reflectance. The objective of this project is to better constrain the evolution of volatiles species in Mercury during its history and could be exploitable for the selection of future targets for BepiColombo mission.

Acknowledgements

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