PRELIMINARY 8-COLOR MAP OF THE SHAKESPEARE QUADRANGLE ON MERCURY

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Introduction

After three flybys, the MErcury Surface, Space Environment, GEochmistry and Ranging (MESSENGER) spacecraft orbited Mercury for four years until April 2015, providing the first complete map of its surface thanks to the Mercury Dual Imaging System (MDIS). The Wide-Angle Camera (WAC) observed Mercury with 12 different filters, from 433.2 nm to 1012.6 nm. Thus, three major color units have been identified according to the slope and the reflectance of spectra [1]: high-reflectance plains, intermediate terrain, and low-reflectance material. A variation in the abundance of an opaque component depending on the unit is expected to explain this classification. Two minor color units were also identified: the red spots which seem to have a pyroclastic origin, and the so-called bright crater floor deposits, today known as hollows.

Data set and goals

Data set:

Since the images from the filters at 698.86, 947.0 and 1012.6 nm are not enough to cover the quadrangle, we use data from 8 of the 11 filters available (433.2, 479.9, 558.9, 628.8, 748.7, 828.4, 898.8 and 996.2 nm) for the scientific analysis, while filter at 700 nm was used only for calibration.

For the mapping, Mercury's surface has been subdivided into 15 quadrangles. Some of these quadrangles have already been mapped [2,3]. Here we present for the first time a preliminary 8-color mapping on the Shakespeare quadrangle, which extends from 22.5° to 65° in latitude and from 180° to 270° in longitude (see Fig. 1).

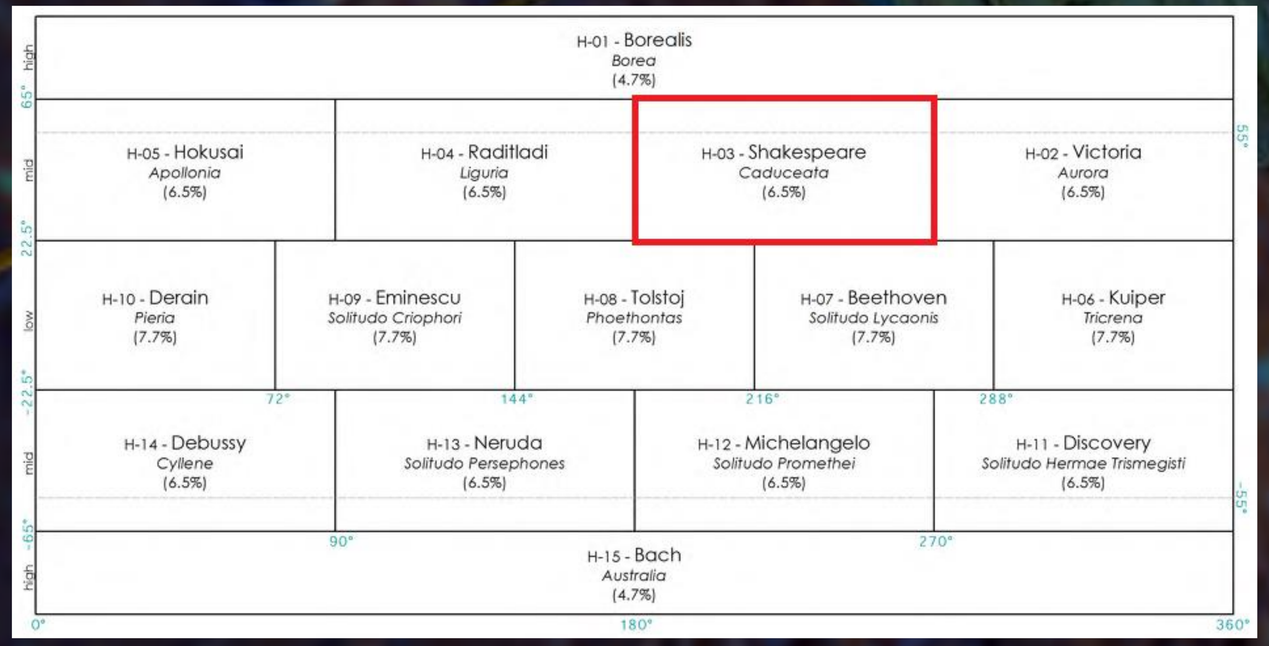

Fig. 1: Location of the Shakespeare quadrangle (red rectangle) with respect to the other quadrangles

Goals:

This 8-color map will be compared to the planetary geological map of the same quadrangle to evidence the correlation between the geological units of Shakespeare (as defined by [4]) and the spectral properties and discuss the differences.

This preliminary work is part of an international collaboration between Italian, English and French teams, whose aim is to map the Mercury's surface merging geological units and spectral units. The objectives of these works are 1) to integrate color units with morpho-stratigraphic ones for this quadrangle and 2) to define regions of interest in support to the future BepiColombo mission, thus participating to its observational strategy.

Methods

To produce the Shakespeare quadrangle 8-color map, we used the software ISIS provided by USGS. We first downloaded and imported MESSENGER raw data of the Shakespeare quadrangle into ISIS format. We georeferenced the data by using the SPICE kernel for each image. We then performed a radiometric calibration to remove, for instance, the current dark and the flat field, and we projected the data using an equirectangular projection. Afterwards, we applied the Hapke photometric correction, testing several sets of parameters [5,6]. We selected the Hapke model parameters for the combined data set [5, table 3]. The photometric correction is used to report the data at standard illumination conditions, such as those frequently used in laboratory (incidence angle i=30°, phase angle φ=30° and emission angle e=0°). Finally, we coregistered the images to obtain an 8-color mosaic of Shakespeare quadrangle.

References and acknowledgments

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Preliminary results

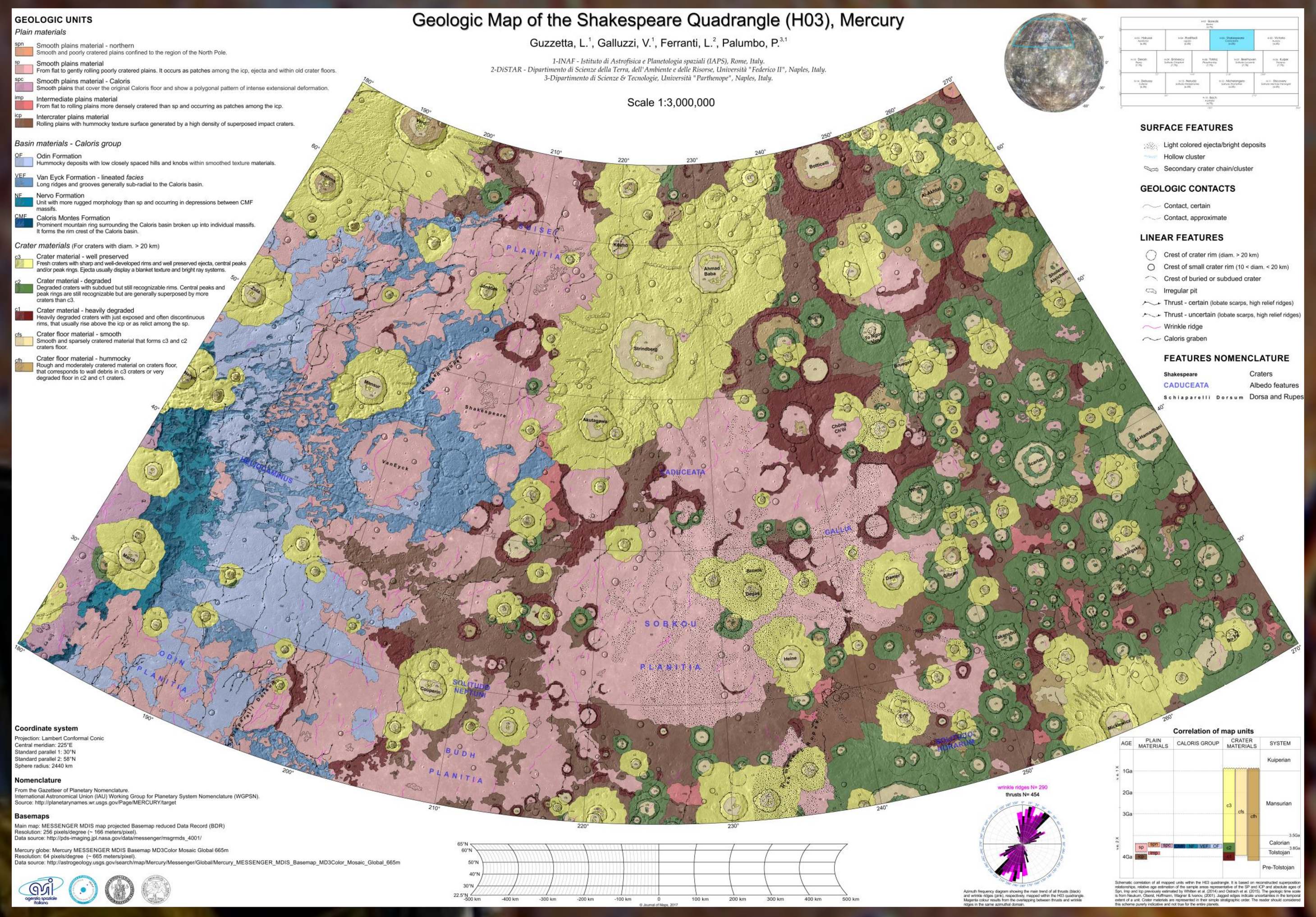

Fig. 2: Geological map of the Shakespeare quadrangle [4]

The geological map of Shakespeare is shown on the left (from [4], see Fig. 2).

We applied techniques of analysis, such as RGB color combinations [7,8], to emphasize differences in composition. Here we show two preliminary maps of Shakespeare (more than 50% of the quadrangle is mapped): the first is a monochrome map at 996.2 nm (see Fig. 3), the second is a RGB map (see Fig. 4) with filters at 996.2, 748.7 and 433.2 nm, respectively.

Both last maps show a great variety of terrains in the South part of Shakespeare. The color units are globally well correlated with the geological units (e.g. ejecta and bright deposits in Sobkou Planitia and in the cratered regions). On the RGB map (Fig. 4), a color contrast between West and East parts of the mapped quadrangle can be distinguished, even if this has to be confirmed by a spectral analysis. Indeed, the East part of Shakespeare seems to be more yellow than the West part, which is consistent with a reddening of this more cratered, so older part of the quadrangle. Thus, East is likely to be more mature (i.e. more degraded by space weathering) than West. This is encouraging to pursue a more detailed spectral analysis and a future discussion to correlate spectral characteristics, which could be associated to spectral units, and units defined in the geological map from [4].

Moreover, some features like the Akutagawa and Degas craters, which appear really blue on the RGB map, do not show in the planetary geological map a specific unit separated from crater floor material.

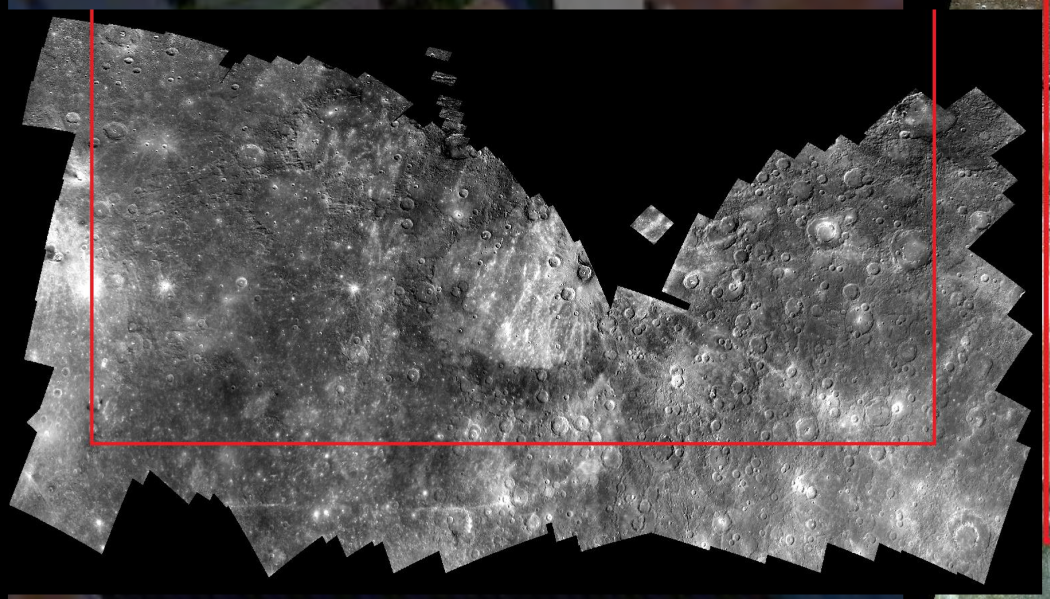

Fig. 3: Monochrome map of the Shakespeare quadrangle at 996.2 nm. The red rectangle depicts the Shakespeare quadrangle.

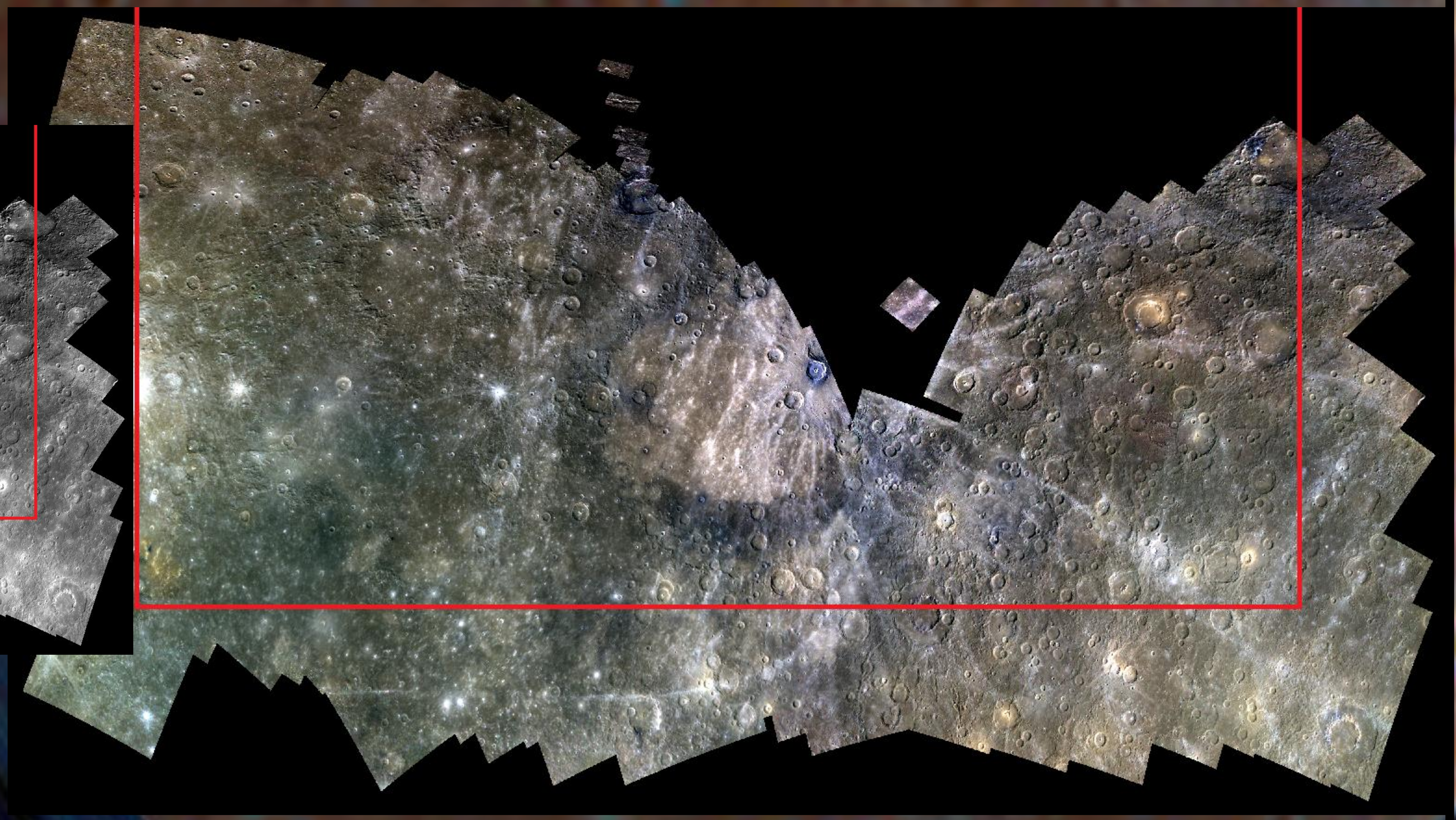

Fig. 4: RGB map of the Shakespeare quadrangle (R=996.2 nm; G=748.7 nm; B=433.2 nm). The red rectangle depicts the Shakespeare quadrangle.

Conclusions and future works

First comparisons between geological units and color units show that the color variability from the preliminary produced RGB map (Fig. 4) seem to be consistent with variation between different terrains. Yet, some geological units seem to have higher spectral variability in specific regions which will be investigated in more details in the future. Moreover, it seems that the higher cratered, so older regions of the East are characterized by a more reddish aspect, i.e. a more mature surface.

Future works:

The whole quadrangle will be soon completely mapped with a 8-color mosaic. We will start to analyze in a more systematic way the spectral variability considering the combination already used in the literature (such as in [7]). Moreover, we will work on the 8 channels spectral variability looking to define some spectral units which could be associated to specific terrains and see how they can be integrated into a planetary geological map. In addition, this spectral analysis will notably help us to investigate which kind of space weathering occurs on Mercury's surface.