EPSC Abstracts
Vol. 6, EPSC-DPS2011-782, 2011
EPSC-DPS Joint Meeting 2011

Application of classification methods for mapping Mercury's surface composition: analysis on Rudaki's Area

F. Zambon (1), M. C. De Sanctis (1), F. Capaccioni (1), G. Filacchione (1), C. Carli (1), E. Ammannito (2) and A. Frigeri (2)
(1) INAF - Istituto di Astrofisica Spaziale e Fisica Cosmica, Via del Fosso del Cavaliere, 100, 00133 Roma, Italy
(2) INAF - Istituto di Fisica dello Spazio Interplanetario, Via del Fosso del Cavaliere, 100, 00133 Roma, Italy
(francesca.zambon@iasf-roma.inaf.it)

1. Introduction

During the first two MESSENGER flybys (14th January 2008 and 6th October 2008) the Mercury Dual Imaging System (MDIS) has extended the coverage of the Mercury surface, obtained by Mariner 10 and now we have images of about 90% of the Mercury surface [1]. MDIS is equipped with a Narrow Angle Camera (NAC) and a Wide Angle Camera (WAC). The NAC uses an off-axis reflective design with a $1.5°$ field of view (FOV) centered at 747 nm. The WAC has a refractive design with a $10.5°$ FOV and 12-position filters that cover a 395 -1040 nm spectral range [2].

The color images can be used to infer information on the surface composition and classification methods are an interesting technique for multispectral image analysis which can be applied to the study of the planetary surfaces. Classification methods are based on clustering algorithms and they can be divided in two categories: unsupervised and supervised. The unsupervised classifiers do not require the analyst feedback, and the algorithm automatically organizes pixels values into classes. In the supervised method, instead, the analyst must choose the "training area" that define the pixels value of a given class [3]. Here we will describe the classification in different compositional units of the region near the Rudaki Crater on Mercury.

2. Data set description

For the our analysis we consider WAC calibrated data of the region near the Rudaki Crater. This region appears heterogeneous and presents different types of terrains: high albedo areas, smooth planes, rough areas and craters. However, the spectra are very similar each other and lack clear absorption bands diagnostic of mineral composition, thus retrieving compositional information based on the available data is a difficult task. We analyzed the spectral feature of the single area with the ISODATA unsupervised classification method. Unsupervised methods are useful when relatively little a priori information about the data is available [4]. ISODATA is one of the most used clustering algorithm in remote sensing and require to use only a limited number of parameters like the number of classes to be retrieved, the number of iterations, the threshold, etc. In this study we let the algorithm choose from 3 to 10 classes with a threshold of 5% and 3 iterations. Before proceeding with the classification, the WAC images were preprocessed: we applied the Hapke-Henyey-Greenstein photometric model [5] for the photometric correction (figure 1) to the mercator-projected multispectral cube using the parameters described in [6].

3. Classification analysis and results

With the above parameters ISODATA classification produced four different classes. The classes distribution are shown in figure 2. Analyzing the mean spectra of each class we derive that the spectra differ mainly for their reflectance level. The pixels colored in red represent the regions with the lowest reflectance; the red class also includes the regions in shadow. The green class in general characterize the rough regions, but we find that this class also inside the Rudaki Crater. The green class extends outside the crater border in the smooth plane nearby (figure 2). The blue class is typical of the entire smooth plane region. The highest reflectance area are classified as yellow class. Although ISODATA can't distinguish the high albedo region from illuminated edge of the craters, the algorithm gives four class that can be considered different units. The spectra of the different units differ mainly for the albedo level. The results obtained with ISODATA can be used for a finer classification, using the mean spectra obtained as "training area" for a supervised classification algorithms. In this way, it is pos-

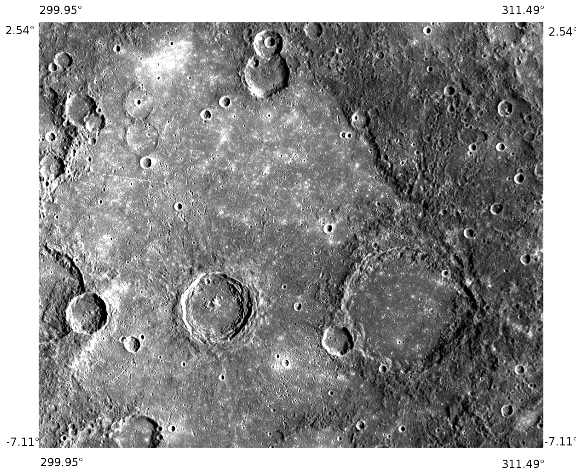

Figure 1: The Rudaki Area at 433 nm (F filter), photometrically corrected and projected using mercator projection.

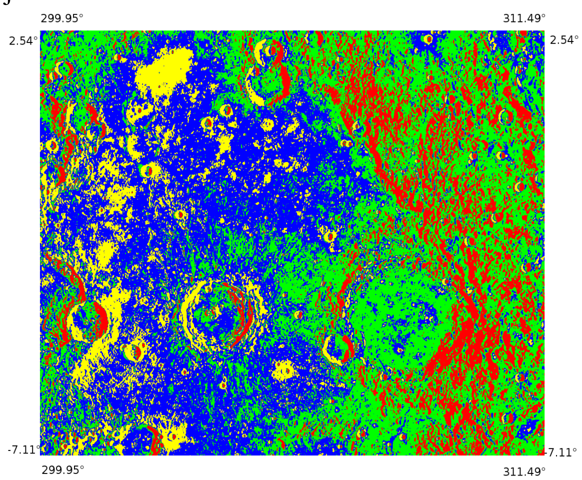

Figure 2: ISODATA classification of the Rudaki Area.

sible, for instance, to separate the illuminated edge of the craters from the high reflectance area and the shadow regions from the low reflectance area.

4 Conclusion

Despite the small spectral differences and the absence of clear absorptions bands, it is still possible adopting classification algorithms to identify different morphological units in WAC images of the Rudaki Area on Mercury, even if it is extremely difficult to extrapolate their mineralogy due to the lacking of clear spectral features. The classification of these data give indications of the presence of different mineralogical units in the Rudaki northern plains, confirming the presence of albedo and spectral slopes variations related to compositional heterogeneities on Mercury's Rudaki region.

Further improvements of the classifications could be possible with higher spatial and spectral resolution data. Thanks to data acquired during the orbital phase both of the MESSENGER and the future Bepi Colombo (SIMBIO-SYS) missions [7], will be possible to have a better knowledge of the spectral compositions of the Mercury's surface [8].

Acknowledgements

This work is supported by an Italian Space Agency (ASI) grant.

References

[1] Denevi, B. W. et al., The evolution of Mercury's crust: A global perspective from Messenger, Science, Vol. 324, pp. 613-118, 2009.

[2] Solomon, S. C. et al., MESSENGER mission overview, Space Sci Rev, Vol. 131, pp. 3-39, 2007.

[3] Adams, J. B., Gillespie, A. R., Remote sensing of landscapes with spectral images, Cambridge University Press, 2006.

[4] Mamarsadeghi, N. et al., A fast implementation of the ISODATA clustering algorithm, IJCGA, Vol. 17, pp. 71-103, 2007.

[5] Hapke, B., Theory of reflectance and emittance spectroscopy, Cambridge University Press, 1993.

[6] Domingue, D. L. et al., Whole-disk spectrophotometric propreties of Mercury: Synthesis of MESSENGER and ground-based observations, Icarus, Vol. 209, pp.101-124, 2010.

[7] Flamini, E. et al., SIMBIO-SYS: The spectrometer and imagers integrated observatory system for the Bepi-Colombo planetary orbiter, Planetary and Space Science, Vol. 58, pp. 125-143, 2010

[8] Rothery, D. et al., Mercury's surface and composition to be studied by BepiColombo, Planetary and Space Science, Vol. 58, pp. 21-39, 2010.