CLASSIFICATION OF MESSENGER MASCS DATA. M. C. De Sanctis[1], F. Capaccioni[1], G. Filacchione[1], E. Ammannito[2], [1]INAF-IASF, via del Fosso del Cavaliere, 100, 00133 Rome, Italy, mariacristina.desanctis@iasf-roma.inaf.it, [2]INAF-IFSI, via del Fosso del Cavaliere, 100, 00133 Rome, Italy,

Introduction: The MESSENGER spacecraft flew by Mercury as part of its journey to Mercury orbit insertion. The Mercury Atmospheric and Surface Composition Spectrometer (MASCS) [1,2] observed Mercury during two flybys, including high-spatial-and spectral-resolution visible to near-infrared (IR) spectra of the Mercury surface. The Visible and InfraRed Spectrograph (VIRS) component of MASCS consists of two linear photodiode arrays (VIS and NIR) covering a spectral range 320-1450 nm. We applied two classification methods to MASCS data relative to the second flyby (October 6, 2008) in order to extract information on the mineralogy of Mercury. The classification of these data will permit to obtain mineralogical maps of Mercury surface, giving indication of the different mineralogy and maturity of the soils present on the Hermean surface.

Data analysis: The data were pre-processed as follows:

- Radiance data were translated to I/F removing the solar contribution.
- Photometric correction has been applied (the phase remains fairly constant throughout the MASCS data, although the incidence/emission angles change considerably) using the Lommel-Seelinger scattering law.
- VIS and NIR data were collected in a single spectrum, after removal of all spectra with reflectance < 0 and/or of the sky observations.
- Also the spectral region between 800 and 950 nm was removed due to the high noise level in the spectra

The data set show very similar featureless spectra. The main differences are in the reflectance levels and in the spectral slopes. Two different approaches have been used to analyze MASCS data of the two Messenger flybys: ISODATA unsupervised classification and a classification based on the spectral slopes in different wavelengths' ranges [3].

Spectral Slopes Classification: The spectral range has been divided in three regions, S1 (299nm-550 nm), S2 (550nm-799nm) and S3 (950nm-1490nm) and the spectral slopes have been determined using a linear fit on the spectra normalized at 550 nm. In Figure 1 are shown the scatter plots of the spectral slopes plotted against each other, and in Figure 2, the projection on ground of the different spectral slopes. The spectral slopes show significant variations along the ground path.. The most relevant finding is in the region of Rudaki Planitia which exhibits the minimum of S1 (and partially also of S2) and the maximum of S3.

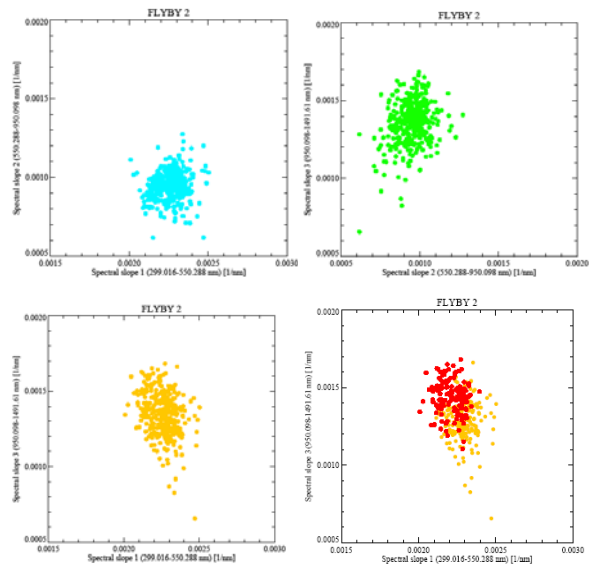

Figure 1: a) scatter plots of the spectral slopes (cyan: S2 Vs. S1; green: S3 Vs. S2; yellow: S3 Vs. S1; red: S3 Vs. S1 of points between 300° and 320° longitude).

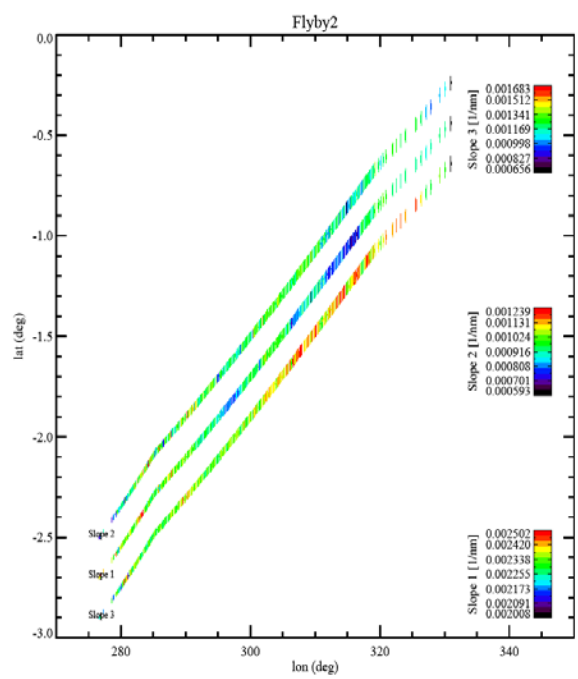

Figure 2: projection on the ground track of the different spectral slopes. The projections of S3 and S2 have been offset in latitude for clarity.

According to [4] the plains unit filling the crater Rudaki exhibits embaying boundaries indicative of material emplaced as a flow, and it has a distinct color signature relative to its surroundings. The peculiar nature of this unit is confirmed by our analysis.

ISODATA Classification: ISODATA unsupervised classification calculates class means evenly distributed in the data space, then iteratively clusters the remaining pixels using minimum distance techniques. To enhance the spectral differences we have normalized the spectra to an average reflectance spectrum for each flyby. This allows to enhance variation of different regions with respect to the average spectral behaviour. We identify 5 different classes and the average associated spectra are plotted in Figure 3. The classes have been ordered for relative reflectance with respect to the mean values. This means that classes 1 and 2 have lower reflectance respect to the average reflectance of the fly-by, while classes 4 and 5 show larger reflectance. The distribution of those classes on ground is reported in Figure 4, where in blue is shown the ground track while in red the classification of each spectrum along the track. Most of the spectra are classified in classes 2,3,and 4 and only few data belong to class 1 and 5. The distribution of the different classes reflects different surface terrains. During the first part of the fly by, Messenger ground track is on cratered terrains (between longitude 275° and 295°). On these terrains the data set shows the largest variability. Several spectrally different zones can be identified. Most of them can be associated to topographic features on the surface (craters, intercrater terrains). Afterwards, the Hermean surface shows less spectral variety and MDIS images show smoother terrains with a very smooth area in Rudaki plain (about longitude 302°-308°). Here the classification found spectra that belong mainly to class 3 and 2.

Conclusions: the results of this analysis are promising, showing the possibility to recognize spectral differences in the mercury soil. It must be recalled that MASCS data cover a larger spectral range with respect to MDIS, including shorter and longer wavelengths. We can see that spectral variability is quite large in these additional ranges, providing further indication on the composition and maturity of the Hermean soils.

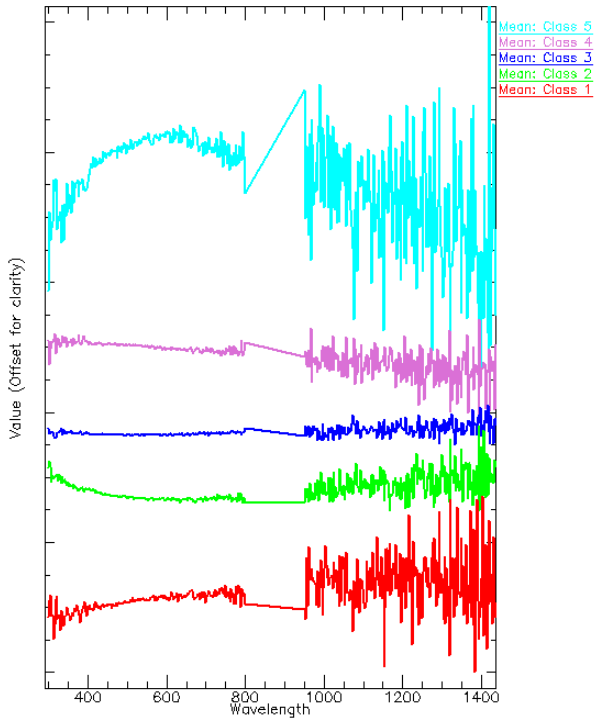

Figure 3. Mean spectra of the different classes. The spectra have been offset for clarity and the classes have been ordered for relative reflectance with respect to the mean values.

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References:

[1] Mc Clintok et al. (2008) *Science*, *321*, 62.
[2] Solomon et al. (2008), *Science*, *321*, 59
[3] Filacchione et al. (2007), *Icarus*, *186*, 259-290.
[4] Head et al., (2007), *Space Sci Rev*, *131*, 41–84.

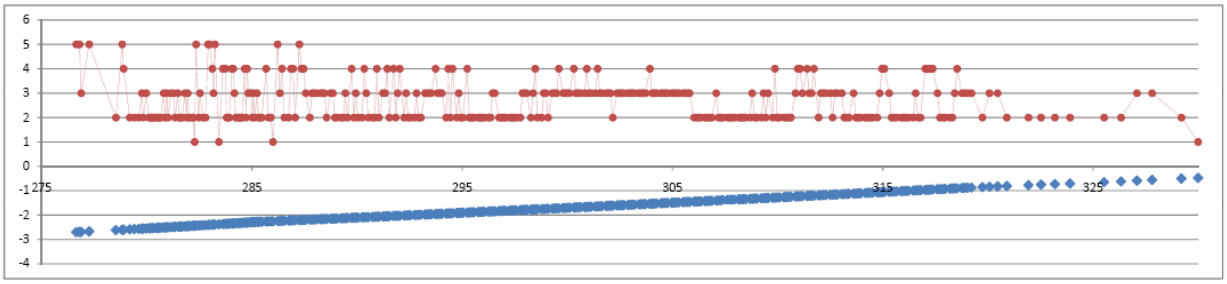

Figure 4: Distribution of the classes (red) in correspondence of the ground track (blue).