Unsupervised clustering analysis of spectral data for the Rudaki area on Mercury. Mario D'Amore[1], Jörn Helbert[1], Gregory M. Holsclaw[2], Noam R. Izenberg[3], William E. McClintock[2], James W. Head[4] and Sean C. Solomon[5], [1]Institute for Planetary Research, DLR, Rutherfordstrasse 2, Berlin, Germany; [2]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80303, USA; [3]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA;[4]Department of Geological Sciences, Brown University, Providence, RI 02912, USA; [5]Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964, USA.

Introduction: We present a study of spectral reflectance on Mercury focused on an area that encompasses the craters Kuiper, Rudaki, and Waters. The goal is to analyze possible connections among different terrain types. The study region is geologically and spectrally classified as heavily cratered intermediate terrain (IT) and mixed patches of high-reflectance red plains (HRP) and intermediate plains (IP), on the basis of multispectral images taken by the Mercury Dual Imaging System (MDIS) [1]. Recent analysis of observations by the Mercury Atmospheric and Surface Composition Spectrometer (MASCS) instrument on the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft with an unsupervised hierarchical clustering method shows at global scales a comparable number of units [2,3]. Analyses on the local scale reveal a larger number of units and with a substantially more complex relationship among units.

Data and analysis: MDIS observations characterize [1] the area essentially as a background of heavily cratered IT admixed with patches of likely younger HRP and IP.

From the results of global-scale unsupervised hierarchical clustering [2], the area is primarily classified as a homogeneous expanse of the equatorial region (ER) cluster. Finer clustering shows that the study area belongs to the core ER, with some smaller patches of a transitional sub-unit. This sub-unit is a transitional region between global ER and the polar region (PR) cluster.

To investigate this result further in a regional context we focus on MASCS data for the study area extracted from the Berlin MASCS database [3]. We apply the approach described earlier [2,4] to a region between 250° and 340°E and between 0° and 20°S. The reflectance data are normalized at 700 nm wavelength as a first-order photometric correction and then averaged on a global grid with a resolution of 1 pixel/degree, resulting in a interpolated regular grid of hyperspectral MASCS data. Fig. 1 shows as an example three channels of the hyperspectral dataset. Even just from the reflectance values at these three wavelengths, spatially coherent units can be identified.

Overall, the area exhibits a unit of low

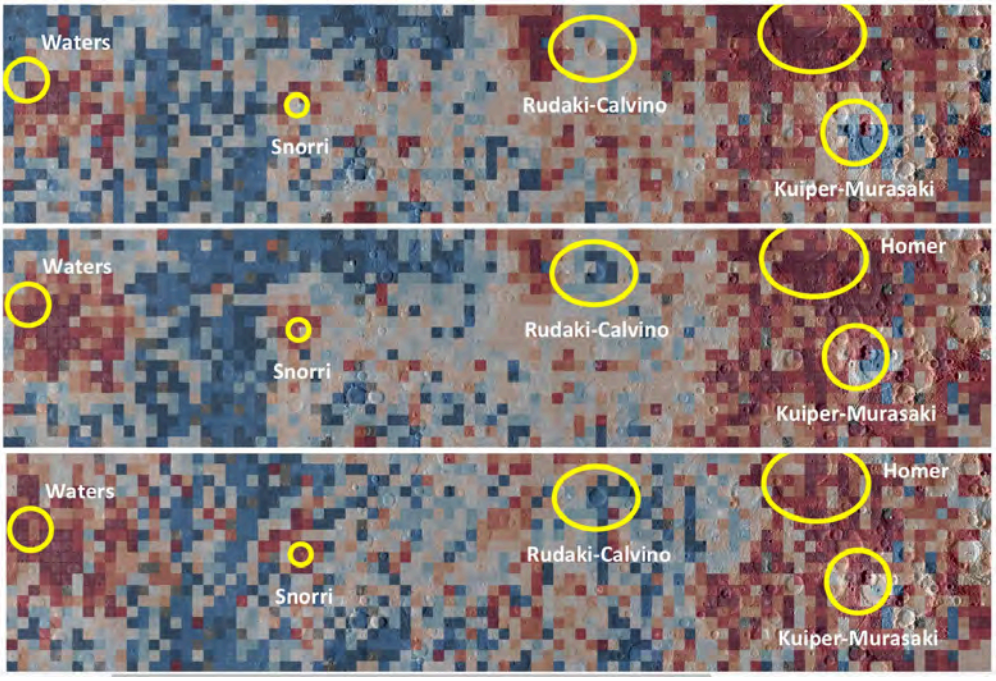

Fig. 1. Study area overlaid with regridded MASCS normalized reflectance. The top image uses the reflectance at 350 nm, the middle at 450 nm, and the bottom at 650 nm (for all wavelengths blue is the smallest value, red the highest).

normalized reflectance (concentrated on the west side), interleaved with a unit exhibiting intermediate to high-normalized reflectance.

An interesting mix of the two units occurs at the small crater Snorri (Fig. 1). Even given that the diameter of this crater of around 0.5° of arc is less than the map resolution, the extent of high-normalized reflectance material spans about 3–4° of arc. This extent might allow a constraint on the depth of excavation of material from a subsurface layer of different composition, following the approach of Ernst et al. [5]. From the depths of excavation of craters in the dark unit in this area, this unit is probably less than 1 km thick here.

A detailed look of the Kuiper-Murasaki region (Figure 2) shows the power (and spatial limitation) of our methodology and the use of a regular grid. Murasaki crater appear to be low in normalized reflectance, whereas Kuiper shows higher values, consistent with the findings of D'Incecco et al. [6].

Outlook: This example analysis of a portion of the MASCS dataset [7] shows that the spectral characteristics of local areas may now be studied in considerable detail. The study area provides an interesting test case for exploring our approach on a regional scale. The area encompasses the craters Kuiper, Rudaki, and Waters. The area has been geologically classified from MDIS color data as intermediate plains but has patches of smooth high-reflectance and intermediate plains.

The spectral characteristics of the area tell a richer history among the different units, and the interconnections can be used to understand better the complex vertical and lateral heterogeneity of near-surface crustal composition. Combining the geological interpretation derived from MDIS with the spectral information from MASCS and geochemical information from the Gamma-Ray Spectrometer and X-Ray Spectrometer should deepen insight into the structure and compositional diversity of Mercury's crust.

References: [1] Denevi, B. W. et al. (2009), *Science*, 324, 613-618; [2] Helbert, J. et al. (2013), *JGR*, in preparation; [3] D'Amore, M. et al. (2012), *LPS*, *43*, 1413; [4] Helbert, J. et al. (2013), *LPS, 44*, this meeting; [5] Ernst, C. M. et al. (2010), *Icarus, 209*, 210-233; [6] D'Incecco, P. et al. (2013), *LPS, 44*, this meeting; [7] D'Amore, M. et al. (2013), *LPS, 44*, this meeting.

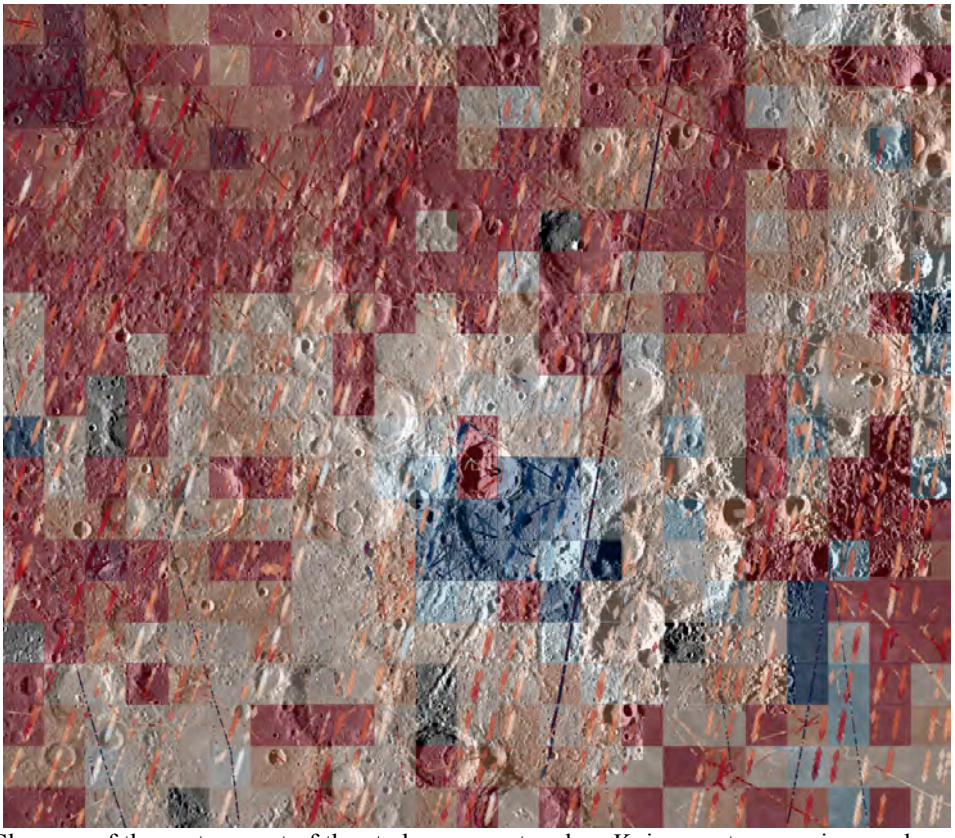

Fig. 2. Close-up of the eastern part of the study area centered on Kuiper crater superimposed on the edge of Murasaki crater. The regularly gridded MASCS normalized reflectance data at 350 nm ranges from 0.433 (blue) to 0.521 (red).