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Global classification of MESSENGER spectral reflectance data and lab spectra comparison.

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The MESSENGER spacecraft continues to provide new data that change our views on the nature of Mercury's surface. Assuming that surface composition can be derived from spectral reflectance measurements with the use of statistical techniques, we have employed unsupervised hierarchical clustering analyses to identify spectral units from MESSENGER s Mercury Atmospheric and Surface Composition Spectrometer (MASCS) observations.

To retrieve the number and spectral shapes of the different components present in the dataset, we collected all MASCS observations to date ($>$ 1.5 milion spectra). Because there are no photometric corrections for MASCS available yet, the data were normalized to the reflectance level at 700 nm, yielding a ratio nearly independent of incidence and emission angles. Independent tests on laboratory data show that this approach is effective in reducing phase angle variations. The data were then interpolated to a fixed spatial grid, averaging the sub-pixel spectra. The product is a map of reflectance ratio, along with error and frequency maps to address potential error in the process and to assess reliability. This is the first global geographically registered cube-image of averaged MASCS spectra. We produced a spatial grid resolution between 4 pixels per degree (ppd) for global analyses and 0.5 ppd for regional studies. The unsupervised hierarchical clustering of the global MASCS cube-image produces a tree of data partition, starting from two mega-regions (Fig 1). The first mega-region (MR1) comprises equatorial to mid-latitudes and the second (MR2) the two poles. The boundaries of MR2 at high northern latitudes approximate those of the volcanic northern plains [4]. MR2 areas show redder MASCS spectra than do MR1 areas. The spectral units show some correlation with surface units mapped by visible image acquired by MESSENGER and documented the presence of distinct spectral units on Mercury, as characterized by MASCS observations.Moreover, it seems to closely match some Gamma Ray Spectrometer elemental abudances results and global distribution of pyroclastic geological features. Following iteration produces finer separation of the surface in smaller regions. Each region average spectra is compared with reflectance spectra collected at the Berlin PEL laboratory. Here the angular dependency is treated as in the MASCS data, via normalization at 700nm. This allow us to start a geological and geochemical interpretations of MASCS observations [6,7]. The materials selected aim to explore the analogs for Hollow-Forming Material on Mercury theory in [5] : a komatiitic substrate with superimposed sulfides layer, due flotation in melted lava during volcanic eruption. We used komatiite spectra from PEL sample collection and various Mg-, Ca- and Mn- bearing sulfides [6,7]. both at low and high temperature to explore the thermal schok effect on sulfide volatilization and on komatiitic substrate.

Fig 1. Global MASCS cube-image rougher partition. The two mercurial mega-regions.

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