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Spectral Clustering of Hermean craters hollows

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The Mercury Dual Imaging System (MDIS, Hawkins et al., 2007) onboard NASA MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) spacecraft, provided high-resolution images of “hollows”, i.e. shallow, irregular, rimless, flat-floored depressions with bright interiors and halos, often found on crater walls, rims, floors and central peaks (Blewett et al., 2011, 2013). The formation mechanism of these features was suggested to be related to the depletion of subsurface volatiles (Blewett et al., 2011, Vaughan et al., 2012).
To understand the hollows' mineralogical composition, which can provide new insights on Mercury's surface characterization, we applied a spectral clustering method to different craters where hollows are present. We chose, as first test case, the $\sim$20 km wide Dominici crater due to previous multiple spectral detection (Vilas et al., 2016). We used the MDIS WAC dataset covering Dominici crater with a scale of 935 m/pixel through eight filters, ranging from 0.433 to 0.996 μm. First, the images have been photometrically corrected using the Hapke parameters (Hapke et al., 2002) derived in Domingue et al. (2015). We then applied a statistical clustering over the entire dataset based on a K-means partitioning algorithm (Marzo et al., 2006). This approach was developed and evaluated by Marzo et al. (2006, 2008, 2009) and makes use of the Calinski and Harabasz criterion (Calinski, T., Harabasz, J., 1974) to identify the intrinsically natural number of clusters, making the process unsupervised. The natural number of ten clusters was identified and spectrally separates the Dominici surrounding terrains from its interior, as well as the two hollows from their edges. The units located on the brightest part of the south wall/rim of Dominici crater clearly present a wide absorption band between 0.558 and 0.828 μm. Hollows surrounding terrains typically present a red slope in the VNIR with a possible weak absorption band centered at 0.748 μm, while the interior of Dominici crater shows almost no absorption between 0.558 and 0.828 μm, but a possible absorption towards the IR is still evident. This detection is similar to what was described in Vilas et al. (2016), even if it is not located in the crater center as previously reported.
The application of the clustering technique provides results similar to those reported in Vilas et al. (2016) and permits a deeper detailed study of the terrain spectral differences such as the discrimination of areas with a possible diagnostic absorption indicative of sulfides (e.g. MgS as suggested by Vilas et al., 2016). In addition, we were able to separate possible intermediate terrains that can be defined as “spectral transition” terrains, likely a mixture between the previously mentioned terrains (MgS, Vilas et al., 2016), or new compositional units. The next step is to choose other targets to apply the same clustering technique in order to characterize the different crater hollows presented on Hermean surface.