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# Multidisciplinary analysis of Ganymede's Melkart impact crater

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## 1. Introduction

The Jovian satellite Ganymede is a unique object to study relationships between chemical and physical surface properties and geological and/or morphological surface features [1]. Geological features like impact craters of various surface composition, sizes, morphologies and crater retention ages as well as tectonic surface features (e.g. Sulci) are of special interest. For instance, impact craters provide information about the impact itself, the substrate characterizing the impact site, as well as the material involved in the impact process. In this work, we investigate the Melkart impact crater, located at 10°S, 186°W on the surface of Ganymede (Figure 1). This represents an example of simultaneous observation acquired by the Near Infrared Mapping Spectrometer (NIMS) [2], obtaining spectra between 0.7 and 5.2 micron, and by the Galileo Solid State Imaging (SSI) camera [3] with relatively high spatial resolution. Hence, the scope of this work is to combine both a geomorphological and compositional analysis in order to find any correlation between the results.

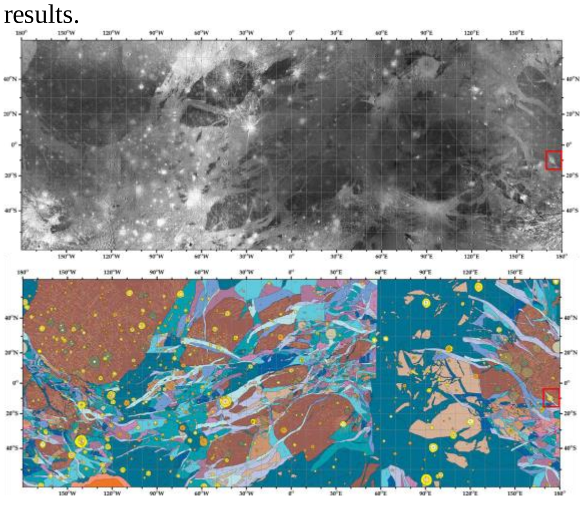

**Figure 1:** Above: Global image mosaic of Ganymede incorporating Voyagers 1 and 2 and Galileo imagery, Below: Global geological map of Ganymede (for unit description see [4]).

## 2. Dataset and Methods

Melkart is a 107 kilometers crater characterized by a central dome, which is generally thought to be formed by warm soft ice uplifted from several kilometers below the surface, hence representing the lower crust of Ganymede [5]. In addition, it is interesting because it is located located between the Marius Regio, which is the dark ancient cratered terrain, and the younger bright grooved and smoothed area. To characterize this interesting crater, we performed both a geomorphological and spectral clustering analysis of this area. We produced a higher detailed geological map using the SSI Melkart mosaic in order to better identify the geological units characterizing this crater (Figure 2). This underlines the different structures present on the Melkart crater and its closest surroundings.

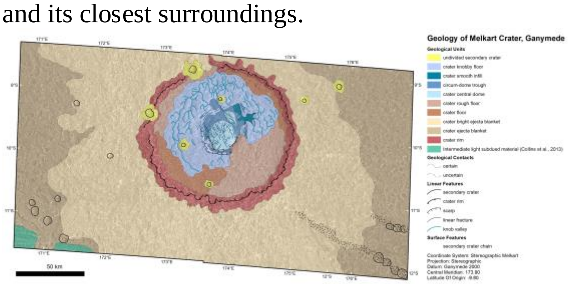

**Figure 2:** High-resolution geological map of the Melkart impact crater based on SSI images.

Then, we applied on the NIMS dataset (wavelength ranges between 1.2 to 4.8 μm) a spectral clustering technique based on a K-mean algorithm that allow us to separate in clusters our studying areas, and characterized each one by an average multi-color spectrum, and its associate variability. We applied the spectral clustering technique on the absorption band at 1.5 micron to understand the behavior of the water ice band depth (Figure 3). Such technique has been extensively validated using different spectral dataset on different areas on Mars, Iapetus, Phobos, Charon and Mercury. [6,7,8,9,10,11,12]. In addition, the relative geographical information of each spectrum is maintained in the process, hence the resulting clusters, can be geolocated on the studied surface and correlations with geographical features can be investigated.

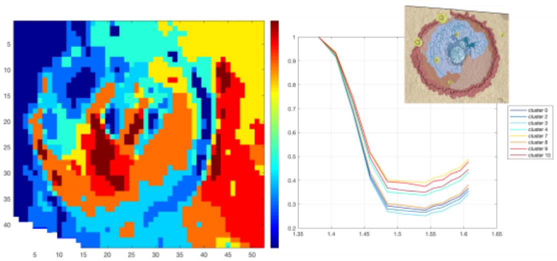

**Figure 3:** The eight clusters identified by exploiting the spectral clustering technique on the NIMS dataset. Each cluster (image on the left) and the corresponding plot (image on the right) is characterized by a unique color.

## 3. Preliminary results and future works

Figure 3 shows the results coming from the spectral clustering technique. This analysis separates the Melkart NIMS data in eight different clusters and the corresponding spectra. As outlined from the spectra, multiple differences appear within the Melkart crater, hence suggesting a much greater variability than the previously reported, i.e. the compositional difference between dark and bright/impact crater terrain [3,4]. Indeed, within the dark terrain, we found 4 clusters (clusters 4, 7, 9 and 10), while within the bright unit we identified other 4 clusters (clusters 0, 2, 3 and 9). Comparing the results coming from the geological analysis and the compositional analysis, we found that the knobby and rough floor of the Melkart crater are identified by two different spectral units. In addition, the central dome is more similar to the knobby floor of the crater from a compositional point perspective.

In the next future, from the clusters results obtained, we will use a technique that estimates the relative amounts of crystalline and amorphous $H_2O$ ice based on measurements of the distortion of the 1.5 μm spectral absorption band [13]. The next step will be. The final step will be to show maps of the fraction of crystalline ice, overlined onto the Melkart SSI images searching for correlations between crystallinity and geomorphological units.


## Acknowledgements

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