EPSC Abstracts
Vol. 12, EPSC2018-407-1, 2018
European Planetary Science Congress 2018

Datasets Fusion Techniques as the tool for analyzing the crustal properties of terrestrial and icy bodies to address their formation and geologic evolution in the Solar System

Piero D'Incecco (1), Edgard Rivera-Valentín (2)
(1) Arctic Planetary Science Institute, Berlin, Germany (piero.dincecco@planetaryscience.de), (2) Lunar and Planetary Institute, Universities Space Research Association, Houston, TX, USA (rivera-valentin@lpi.usra.edu)

Abstract

Multiple new space missions are now providing an increasing amount of data with improved quality to meet the challenges of Solar System exploration. Here, we propose the use of GIS methodologies for exploiting such remotely sensed data in order to perform a parallel investigation of the crustal properties of terrestrial and icy bodies. We name these procedures as "Datasets Fusion Techniques" (DFTs).

So far, we have successfully tested the use of DFTs on two rather different planetary environments, Mercury and Venus.

1. Successful DFTs tests

1.1 DFTs on Mercury

The MESSENGER MDIS and MASCS datasets have been combined to identify the eventual presence of horizontal and vertical compositional heterogeneities in the shallow crust of the planet. Impact deposits can in fact preserve and display the compositional heterogeneities occurring within the crust and the mantle of the planet [1]. A number of units have been defined on the basis of geologic criteria, retrieving all MASCS observations contained within each of these units from millions of globally distributed observations [2]. In this way, geologic interpretation was combined with spectral information [3,4]. On Mercury, the DFTs were applied both on a local scale (i.e., Figs. 1, 2) and on a global scale, extending this analysis to 121 impact craters uniformly distributed over the surface of the planet.

The results from the local and global scale investigations confirm that the geologic context and spectral characteristics of some impact deposits actually indicate the occurrence of vertical and horizontal compositional heterogeneities in the shallow crust of Mercury [3,4]. The identification of such compositional diversities also allowed us to reconstruct the pre-impact local stratigraphy beneath two impact craters.

1.2 DFTs on Venus

1. We applied the DFTs on Venus combining Magellan SAR and the Venus Express VIRTIS datasets. The eastern flank of Idunn Mons, Imdr Regio's large volcano, was identified by VIRTIS as one of the regions with relatively high values of thermal emissivity at 1 μm wavelength [5]. The main goal was to identify location and extent of the sources of such anomalies, thus the lava flows responsible for the relatively high emissivity observed by VIRTIS over the eastern flank of Idunn Mons. In this case, DFTs were performed iterating the geologic mapping made over Magellan radar images of the same area with modeling of the blurring caused by the scattering of the 1 μm radiation in the atmosphere. We tested eight different configurations (Fig. 3) [6].

Results show that the best-matching configuration is assigning high values of emissivity to the Idunn Mons' flank lava flows.

2. DFTs and future missions

The automated application of DFTs for global scale study of the characteristics of the shallow crust of Mercury involved the simultaneous use of more than 4 million spectra, with an evident stress for the hardware components. The SQL spatial queries so far developed acted lightening the weight of the data processing on the hardware components; however, future missions [i.e., 7] may constitute a challenge in terms of Database Management System and data processing.

In conclusion, the future perspective of DFTs applications can be summarized with the following key points:

- Improving the synergy between the different constituents of DFTs, managing in the best way the interactions between hardware, OS, GIS software, SQL spatial queries and database. This can be achieved by continuously monitoring the data processing time.

- Applying the DFTs to other cases of study to exploit the full potential of these methodologies for the investigation of the mantle and crustal properties of other bodies of the Solar System, such as Venus, Mars, the Moon or the icy moons of Saturn.

3. Figures

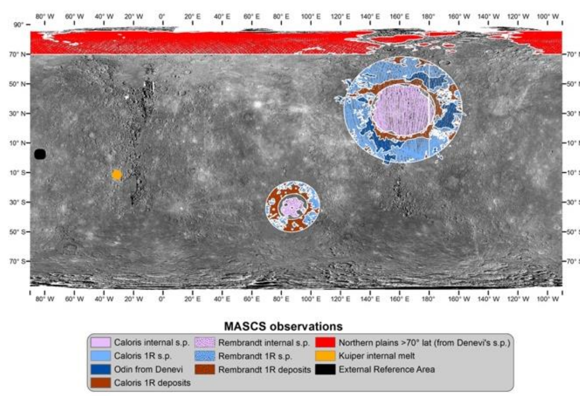

Figure 1 – MASCS spectral observations falling within a number of units, defined for Rembrandt and Caloris basins, and for the northern plains.

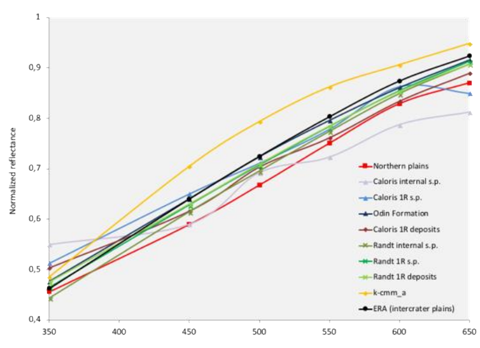

Figure 2 – Spectra extracted from the units in Fig.1.

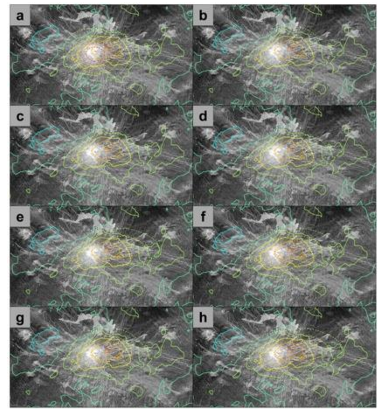

Figure 3 - Overlay between the 1 μm thermal emissivity as observed by VIRTIS (continuous lines) and the thermal emissivity as resulting from the eight simulations (dashed lines)

References

[1] Rivera-Valentin, E. G. and Barr, A. C., 2014. Estimating the Size of Late Veneer Impactors from Impact-induced Mixing on Mercury. The Astrophysical Journal Letters, Volume 782, Issue 1, article id. L8, 6 pp., doi:10.1088/2041-8205/782/1/L8.

[2] Izenberg, N.R., et al., 2014. The low-iron, reduced surface of Mercury as seen in spectral reflectance by MESSENGER. Icarus 228, pp. 364-374, http://dx.doi.org/10.1016/j.icarus.2013.10.023.

[3] D'Incecco, P., et al., 2015. Shallow crustal composition of Mercury as revealed by spectral properties and geological units of two impact craters. Planetary and Space Science, Volume 119, p. 250-263, doi:10.1016/j.pss.2015.10.007.

[4] D'Incecco, P., et al., 2016a. A geologically supervised spectral analysis of 121 globally distributed impact craters as a tool for identifying vertical and horizontal heterogeneities in the composition of the shallow crust of Mercury. Planetary and Space Science, Volume 132, p. 32-56, doi:10.1016/j.pss.2016.08.004.

[5] Smrekar, S. E., et al., 2010. Recent hot-spot volcanism from VIRTIS Emissivity data. Science, 328, 5978, 605-608.

[6] D'Incecco, P., et al., 2016b. Idunn Mons on Venus: location and extent of recently active lava flows. Planetary and Space Science, ISSN 0032-0633, http://dx.doi.org/10.1016/j.pss.2016.12.002.

[7] Glaze, L., et al., 2017. VICI: Venus In situ Composition Investigation, #EPSC2017-346.