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Spectral analyses of asteroids' linear features

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Abstract

Linear features are commonly found on small bodies and can have a geomorphic or tectonic origin. Generally, these features are studied by means of morphological analyses. Here we propose a spectroscopic analyses of linear features of different asteroids visited by space missions, in order to search for correspondence between spectral properties and origin of linear features.

1. Introduction

Four basic types of linear features have been identified on small bodies: grooves, troughs, ridges and modifications of crater shapes [1]. In turn, grooves can be divided in two types, basing on their origin: tectonic grooves are generated by subtle topographic changes or by fractures (filled by down-draining regolith), whereas geomorphic grooves are due to ejecta deposited on the surface.
In this work we analyse spectral properties of asteroids' linear features and search for a possible link with their origin.

2. Data

We study spectral data from the following asteroids: Eros, Lutetia, Vesta and Ceres. Eros has been observed by the NIS spectrometer (on board the NASA NEAR mission), covering the spectral range 0.8-2.5 μm [2]. Lutetia has been observed during the ESA/Rosetta flyby from the VIRTIS-M imaging spectrometer [3], whereas Vesta and Ceres have been the target of the Dawn mission and were extensively observed from the VIR mapping spectrometer [4]. VIRTIS-M and VIR are very similar instruments, composed of an optical head, composed of a visible (0.2-1 μm) and an infrared (1-5 μm) channel and having imaging properties.

We considered also NIRS data (JAXA/Hayabusa mission) from Itokawa [5], but currently no linear features have been detected on this asteroid.

3. Preliminary results

3.1 Eros

The Eros surface is dominated by tectonic grooves [6]. The MSI camera data did not show albedo variations in correspondence of grooves, with the exception of features near the Selene crater which show an albedo decrease [7]. Analysis of NIS data will allow identifying possible variations of pyroxene band depths (centered at 1 and 2 μm, respectively).

3.2 Lutetia

Lutetia is also dominated by tectonic grooves, in some cases associated to albedo variations [8]. VIRTIS data identified albedo increase in correspondence only of one groove (Figure 1) [9]. However, due to its radial orientation, we cannot discard that this groove has a geomorphic origin.

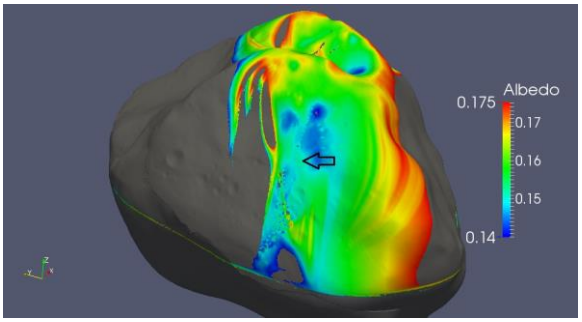

Figure 1. Albedo map of Lutetia [9]. The arrow indicates the groove.

3.3 Vesta

Vesta shows different types of linear features on its surface, i.e. graben (a particular type of trough) [10], geomorphic grooves, tectonic grooves and ridges. Graben are never associated to albedo or spectral changes. The same is true for tectonic grooves, even if in this case some exceptions occur (i.e. darkening) [9]. On the other side, geomorphic grooves are always associated with albedo decrease (Figure 2), indicating a different composition (since grain size is thought to be constant [10]). Finally, the peculiarity of ridges is the color, often bluer (i.e. lower spectral slope) than surroundings, probably indicator of a younger age.

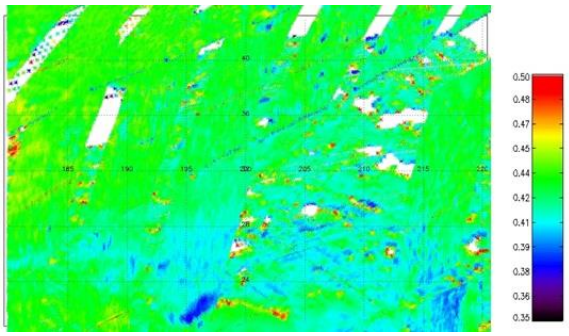

Figure 2. Albedo map of a Vesta region [9]. The bluer markings (i.e. lower albedo) correspond to geomorphic grooves.

3.4 Ceres

Ceres shows linear features of different origin. Their spectral analysis is in progress and is based on absorption bands at 2.7 μm and 3.1 μm, due to hydrated and ammoniated materials, respectively [11], as well as to visible and infrared albedo.

4. Conclusions

The analysis performed so far identifies that linear features of structural origin (tectonic grooves and troughs) are generally not associated to spectral variations. However, some exceptions occur and concern fractures, probably because of exposition of subsurface, which can have a different composition with respect to the surface.
On the other hand, geomorphic grooves and ridges can be discriminated on spectral maps, due to their different albedo, colour or depth of absorption bands. This indicates that this type of feature is generally composed by a material different than surroundings, and the difference can concern composition, physical properties or age.
Further spectral analyses are in progress to confirm these results.

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