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# Key features of Gegania and Lucaria quadrangles of the asteroid Vesta

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## Abstract

A mineralogical analysis of equatorial troughs and Lucaria tholus is performed.
Preliminary results confirm that troughs are graben, probably formed by tensile stresses due to an impact, and suggest a different formation mechanism between the troughs in the Lucaria and Gegania quadrangle.
The comparative analysis performed on the three tholi of Vesta suggests a similar history for Lucaria and Aricia and a different one for Brumalia.

## 1. Introduction

The NASA-Dawn mission orbited the asteroid (4) Vesta from 16 July 2011 to 5 September 2012 [1], taking multicolor and hyperspectral images by means of the Framing Camera (FC), e.g. [2], and the Visible and InfraRed spectrometer (VIR), e.g. [3], and mapping the surface elemental composition by means of the Gamma Ray and Neutron Detector (GRaND) [4]. In particular the FC and VIR data allowed us to derive mineralogical maps of the Vesta surface (e.g. [5]).
Vesta's surface has been divided into fifteen quadrangles (four for northern and southern latitudes, five at equatorial latitudes, and the two poles), each one with different geologic and mineralogical characteristics.
This work focuses on the most important features observed in the Gegania and Lucaria quadrangles. Our study takes into account the maps derived from VIR data, i.e. albedo, photometrically corrected band depths, temperature-corrected band centers [6], and from shape model, i.e. topographic and slope maps [7], respectively.

## 2. The quadrangles as a whole

The Gegania and Lucaria quadrangles span latitudes from 22°S to 22°N and extend from 0° to 72°E and from 72°E to 144°E longitudes, respectively.
Combining the FC mosaic and the distribution of the pyroxene band centers (Figure 1), we can discern three macro-regions, each one with different geological and topographic characteristics and with different ages: the *Northern Region* (approximately poleward of 15°N), old, heavily cratered and howarditic, *the Central Region*, large and eucritic, and the *Southern Region* (approximately poleward of 5°S), young, smooth and included in the Rheasilvia basin, generated by the last large impact occurred on Vesta [4].
Here we give a detailed analysis of the most interesting features of the Central Region, i.e. the equatorial troughs and the Lucaria tholus.

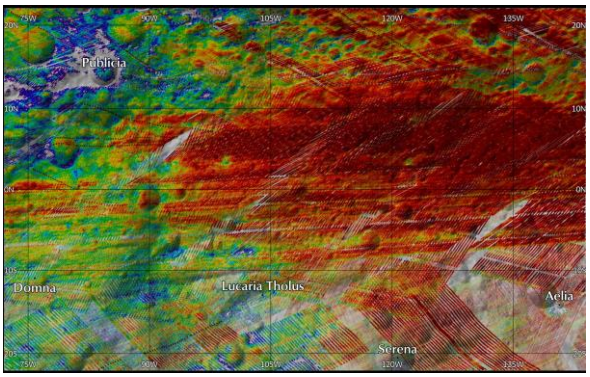


Figure 1: Map of the pyroxene BII center overimposed on the FC mosaic of the Lucaria quadrangle. Composition spans from howarditic (blue) to eucritic (red).

## 3. Equatorial troughs

The equatorial troughs extend from 30°E to 120°E longitudes, and are spread between latitudes 15°S and 5°N.

Band center analysis reveals that Lucaria troughs have a composition similar to surroundings, indicating that the troughs are most probably grabens rather than fractures or grooves, more commonly found on other asteroids [8]. This is in agreement with results of fault-displacement analysis [9].

Their orientation is parallel to the rims of the Rheasilvia basin, suggesting a common origin [8, 9]. According to currently proposed scenarios, grabens can have formed by tensile stresses on the surface produced by an impact [10] or by shear deformation (with the Vesta core playing a role) [11].

The latter scenario should include metamorphism events and therefore would be confirmed by detecting formation of glass or melts, mixture of different grain-sized regolith, and thermal shocks. Glass and melts would cause an albedo decrease, as observed in eucrite samples [12]. Similarly, a different grain size would be revealed by albedo and band depth variations [13]. None of these effects is observed in correspondence with the Lucaria troughs (Figure 2). On the other side, thermal shock does not seem to produce observable spectral variations, as inferred by the spectrum of the shocked eucrite A-87272 (RELAB catalogue). Therefore, the definition of a method to detect shocked eucrites currently provides the sole possibility to prove the past occurrence of metamorphism.

Unlike the Lucaria troughs, the Gegania troughs have a different composition with respect to the surroundings and this can imply different formation mechanisms for troughs contained in the two quadrangles.

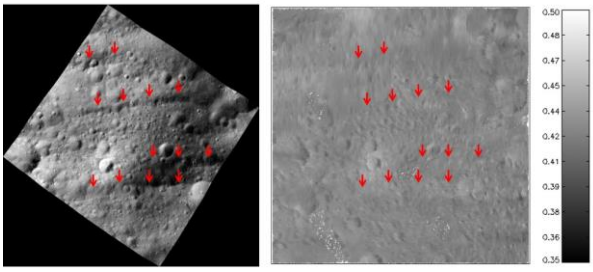


Figure 2. FC observation (left) and VIR albedo map at 1.2 μm (right) [6] of equatorial troughs (indicated by the red arrows) in the Lucaria quadrangle. Latitude spans from 19°S to 0° and longitude from 75°E to 94°E

## 4. Lucaria Tholus

Lucaria (12°S 107°E) is one of the three tholi identified on the Vesta surface, Aricia (12°N 166°E) and Brumalia (7°S 318°E) being the other two. Volcanism and mass wasting are the suggested explanations for the tholi origin [14]. The former hypothesis is the most probable for Brumalia, as inferred by VIR observations [15, 16].

A detailed morphological and mineralogical analysis reveals several analogies between Lucaria and Aricia, which appear to be different than Brumalia. All the three tholi are located near linear features, but only Brumalia presents the same orientation of the close features. In addition, Brumalia hosts diogenites (unlike Lucaria and Aricia) whereas Lucaria and Aricia contain dark material (unlike Brumalia). This could suggest a similar history for Aricia and Lucaria and a different one for Brumalia.

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