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# V-type asteroids: a tale of two parent bodies?

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## Abstract

The majority of basaltic V-type objects, found in the inner main belt, are dynamically linked to the asteroid Vesta, the only large basaltic differentiated object in the main belt. The discovery of small basaltic objects in the middle/outer main belt (MOVs) not dynamically linked to Vesta points out that Vesta could not be the parent body for all the basaltic objects in the Solar System.

We performed an improved statistical analysis using several spectral parameters in the visible, near-infrared and VNIR range in order to assess similarities and differences in the surface composition of Vesta family objects and other V-type asteroids. Our results strongly suggest that MOVs do not have an origin compatible with Vesta.

## 1. Introduction

In the last decades several main belt asteroids have been found showing a basaltic composition, similar to those of Vesta and basaltic HED achondrite meteorites. The majority of these objects, classified as V-type according the most recent taxonomy [1], are thought to be originated from a huge collisional event on the south pole of Vesta [2], and show orbital parameters (*a,e,i*) close to Vesta itself.

V-type asteroids were also found outside the boundaries of the dynamical family: while at least one group could be considered as *"fugitives"* [3] from the Vesta family through resonant and/or non-gravitational effects, it is difficult to explain other V-types not dynamically linked to Vesta. Some of them reside on the other side of the 3:1 mean motion resonance with Jupiter [4,5] and, according to the current dynamical models, it would be very unlikely that a fragment survived through the passage of such a powerful resonance.

The classical scenario suggested that in the early Solar System only Vesta has achieved the size and conditions to retain large amounts of radioactive elements, in order to produce the necessary heat to melt the original chondritic material and form a core, a mantle and a basaltic crust. Recent laboratory studies on meteorites [6] has proven that at least five other large asteroids (D > 150 - 300 km) in the main belt should have undertake a complete differentiation. These elusive basaltic bodies, probably "battered to bits" in the early phases of our Solar System, could be the parent bodies of basaltic asteroids not dynamically linked to Vesta; or our understanding of differentiation processes in the early Solar System could be incomplete [7].

## 2. Results

In order to highlight similarities and differences in the surface composition of V-types, belonging and not belonging to the Vesta dynamical family, we performed a statistical analysis on spectral parameters (reflectivity gradients, band centres, band separation) computed for 115 V-type asteroids. We divided our sample in six dynamical classes: vestoids (or Vesta family), fugitives, low-inclination, Inner Other (IOs), V-type NEAs and Middle/Outer V-types (MOVs). We also compared our sample with HED meteorites spectra taken from the RELAB database [8] and spectra of the surface of Vesta taken by the VIR spectrometer on board of the Dawn mission [9].

Our analysis has proven that while V-type dynamical classes in the inner main belt (Vesta family, fugitives, low-inclination, IOs) show compatible spectral parameters, this seems not to be the case for V-type NEAs and MOVs. The extreme variation of spectral properties found on NEAs could be due to a balance between space weathering processes and a rejuvenation of surfaces, although a different origin could not be excluded. MOVs show spectral parameters, location in the main belt and sizes incompatible with Vesta, strongly pointing towards an origin from a different basaltic parent body.

## References


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