INVESTIGATING THE ORIGIN OF BRIGHT MATERIALS ON VESTA: SYNTHESIS, CONCLUSIONS, AND IMPLICATIONS.
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Introduction: The surface of Asteroid (4) Vesta is highly heterogeneous as revealed by the Dawn spacecraft that is currently orbiting this asteroid and returning images with an unprecedented pixel scale as small as ~20 m in Framing Camera (FC) clear and color filter images and ~50 m in the VIR spectrometer [1]. While the average albedo of Vesta of ~0.38 in the visible wavelengths [2,3] is one of the highest among all asteroids, Vesta shows the largest variation of albedos and colors among asteroids imaged by spacecraft from close distances. Distinctive bright and dark areas observed on Vesta are associated with various geological features showing remarkably different forms. Here we report our understanding of the origin of the areas that are distinctively brighter than their surroundings.

Properties of Bright Materials: A complete survey of all bright materials on Vesta [4] suggests that the largest concentrations of bright materials are located on the walls and/or in the ejecta of some large craters. But not all large craters have associated bright materials. Almost all large-scale bright material deposits appear to be located in the mid-southern latitudes between 0º and 60º S, while from longitude ~315º to ~135º there are noticeably fewer instances. There are also numerous small distinctive bright spots, most of which resolve into small craters, some as small as ~50 m in diameter, with bright annuli or bright ejecta at higher resolution. The bright spots are possibly ubiquitous across Vesta, but their distribution is probably non-uniform.

The albedos of bright material on crater walls and in bright ejecta are up to ~40% higher than the average albedo of Vesta; bright spots are ~20% brighter. Hapke's modeling for some bright areas with limited available geometries does not show distinctively different phase function and macroscopic roughness. A preliminary analysis of FC color images shows that, with one exception, bright materials have relatively deeper 1-µm pyroxene band compare to surrounding areas [5].

As seen from the spectroscopic data, bright materials in general show deeper and wider absorption in both 1-µm and 2-µm pyroxene bands [6]. Bright areas appear to be dark at thermal wavelengths near 5-µm, confirming that their high brightness is dominated by high albedo rather than topography [6]. The similar band centers of bright materials and surrounding areas suggests similar pyroxene compositions. The deeper absorption is consistent with either or both different grain sizes and different space weathering status.

Origin of Bright Materials: We currently have two working hypotheses for the origin of bright materials on Vesta. These hypotheses are not mutually exclusive, and each may play a role in specific cases.

The first hypothesis is lithological diversity. The association of large-scale bright material with morphologically fresh craters could suggest that these impacts have exposed an inherently high-reflectance lithological unit. Slumping of crater wall materials exposes the bright lithology and forms the bright slope material. Tiny craters are likely relatively young as the smallest craters will be the first to be obliterated by continuing impacts and ejecta deposition. We have not yet established whether this lithology is from crustal rock units or from ejecta from previously formed craters.

On the other hand, the relatively stronger ferrous-iron absorption band [6] and high albedo [5] of bright materials may indicate that they are simply typical Vestan lithologies that have been recently exposed and thus unweathered. There is evidence that mixtures of similar mafic minerals with different featureless bright or dark components are associated with craters of different morphological ages of craters [7].

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References: [1] Russell et al. (2012) *LPS XLIII*, 1633; [2] Tedesco et al. (2002) AJ 123, 1056; [3] Li et al. (2011) AGU Fall Meeting; [4] Mittlefehldt et al. (2012) *LPS XLIII,*1680; [5] Schroder et al. (2012), this meeting; [6] Capaccioni et al. (2012) *LPS XLIII,* 2217; [7] Pieters et al. (2012) *LPS XLIII,* 1254.