

TYPES AND DISTRIBUTION OF BRIGHT MATERIALS ON 4 VESTA. D.W. Mittlefehldt¹, Jian-Yang Li², C.M. Pieters³, M.C. De Sanctis⁴, S.E. Schroder⁵, H. Hiesinger⁶, D.T. Blewett⁷, C.T. Russell⁸, C.A. Raymond⁹, R. A. Yingst¹⁰, and the Dawn Science Team, ¹NASA Johnson Space Center, Houston, TX, USA, david.w.mittlefehldt@nasa.gov, ²University of Maryland, College Park, MD, USA, ³Brown University, Providence, RI, USA, ⁴Istituto di Astrofisica Spaziale e Fisica Cosmica, Roma, Italy, ⁵Max-Planck-Institut für Sonnensystemforschung, Katlenburg-Lindau, Germany, ⁶Westfälische Wilhelms-Universität Münster, Germany, ⁷Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA, ⁸University of California, Los Angeles, CA, USA, ⁹Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, Planetary Science Institute, Tucson, AZ, USA.

Introduction: A strong case can be made that Vesta is the parent asteroid of the howardite, eucrite and diogenite (HED) meteorites [1]. As such, we have over a century of detailed sample analysis experience to call upon when formulating hypotheses regarding plausible lithologic diversity on Vesta. It thus came as a surprise when Dawn's Framing Camera (FC) first revealed distinctly localized materials of exceptionally low and high albedos, often closely associated. To understand the nature and origin of these materials, and how they inform us of the geological evolution of Vesta, task forces began their study.

An initial step of the scientific endeavor is to develop a descriptive, non-genetic classification of objects to use as a basis for developing hypotheses and observational campaigns. Here we present a catalog of the types of light-toned deposits and their distribution across Vesta. A companion abstract [2] discusses possible origins of bright materials and the constraints they suggest for vestan geology.

Bright Materials Categories: Bright materials were first categorized using approach and survey orbit clear filter FC images, with maximum resolutions of ~250 m/pixel. The initial categories were revamped using high altitude mapping orbit (HAMO) images with resolutions of ~65 m/pixel, and are currently being vetted and updated using low altitude mapping orbit (LAMO) imagery with resolutions of ~20 m/pixel. Bright materials are divided into six types.

Type 1 Crater wall/scarp material. This bright material is exposed in the walls of craters. The definition was left open to include bright materials that might occur on scarps, but none has yet been found. Type 1 material typically occurs as an irregular and generally discontinuous band high on the walls of fresh craters (Fig. 1a). Crater wall material is often associated with dark materials inside craters.

Type 2 Radial material. Radial material occurs as light-toned, linearly distributed material radial to fresh craters (Fig. 1b). These craters often display Type 1 materials, but not always. Radial material is often asymmetrically distributed around the crater, and regions free of radial material typically lie outside areas

the crater interior free of bright materials. Radial material is sometimes associated with dark material.

Type 3 Spot material. Approach and survey orbit images show unresolved bright spots distributed widely across the surface of Vesta. With the increased resolution of HAMO and LAMO imaging, these bright spots mostly resolve to small fresh craters with bright annuli (Fig. 1a). Thus, this type may simply be a small-scale variant of the Type 2 radial material. One distinction between spot material and radial material is that the while former is continuous around the crater, the latter often is not. Spot material is retained as a distinct category because its distribution may inform us of the distribution across Vesta of shallow-level bright lithologies. There may be a continuum in crater sizes with surrounding bright material from Type 3 to Type 2, but this remains to be established.

Type 4 Slope material. This category includes bright materials that occur on the walls of craters with a characteristic wedge shape, with the narrow point down-slope from the wide edge (Fig. 1a, c). Slope material occurs in many craters that do not contain obvious Type 1 or Type 2 materials. However, with the increased resolution of LAMO images, crater wall material is now observed in some craters where previously it was not. Continued investigation may reveal more common associations between Types 1 and 4.

Type 5 Diffuse plains material. Diffuse plains materials occur only in a limited number of locations on Vesta. In approach and survey orbit images, Type 5 materials are not obviously associated with specific craters and do not have regular geometric shapes such as exhibited by the radial material (Fig. 1d). This type was defined based on images that were not photometrically normalized to standard illumination and viewing conditions. Potentially, this type may be an artifact of lighting geometry on low, undulating hummocks. This issue is being worked.

Type 6 Patchy material. There is only one instance of patchy material. This type of material was found within ~3 crater radii on one side of a fresh crater containing Type 4 slope material (Fig. 1c). Radial material is not prominent around this crater; only faint radial

lighter-toned streaks are present. Again, because the images used to define this type were not photometrically normalized to standard illumination and viewing conditions, patchy material may simply reflect the interplay of lighting geometry on moderately fresh, hummocky ejecta. This issue is being worked. This type may be abandoned.

Distribution and Discussion: Although our bright materials catalog is fairly complete for km-scale features, we are still examining HAMO and LAMO images to identify additional occurrences. Nevertheless, we think the catalog is sufficiently complete to allow for a preliminary assessment of the distribution of bright materials across Vesta.

Large-scale bright material deposits (*i.e.* excluding Type 3) do not appear to be uniformly distributed (Fig. 1e). The Rheasilvia basin contains fewer instances of bright material deposits. The most southerly large crater with significant bright material deposits lies at latitude/longitude -64° , 0° . It contains crater wall and slope material (Types 1 and 4), and the region hosts numerous instances of Type 3 spot material, inside and outside the crater (Fig. 1a). Even in LAMO images, some of the spot material does not resolve as being bright ejecta around a small crater. Possibly there are subtypes of spot material, small craters with bright annuli and blocks of bright material resting on the surface.

Most of the prominent bright material deposits lie roughly between the equator and -60° (Fig. 1e). How-

ever, they are not uniformly distributed in longitude. The region from $\sim 315^\circ$ to $\sim 135^\circ$ hosts noticeable fewer instances of large-scale bright materials. Within this region are a few large fresh craters (types cr3 or cr2 of [3]) that do not contain crater wall, slope or radial bright materials. This suggests that the dearth of bright materials within this region is not the result of space weathering having obscured them; rather, the lithology that engenders the bright materials is rare or absent.

Because of the small scale of bright spots, we cannot yet confidently discuss the distribution of Type 3 materials across Vesta and they are not shown in Fig. 1e. HAMO imagery reveals instances of spot material in regions where it was not obvious from survey orbit imagery, and LAMO imagery likely will reveal yet more. Possibly, spot material is ubiquitous across Vesta. However, examination of HAMO images from within the region that is poor in large-scale bright deposits only reveals a few possible instances of spot material, and there are few, if any, instances of spot material within the Rheasilvia basin. Thus, these regions appear to have low number densities of spot material relative to other regions of Vesta.

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References: [1] Drake M. J. (2001) *MAPS*, 36, 501–513. [2] Li J.-Y. et al. (2012) *LPS XLIII*, this conference. [3] Jaumann R. et al. (2012) *Science*, submitted.

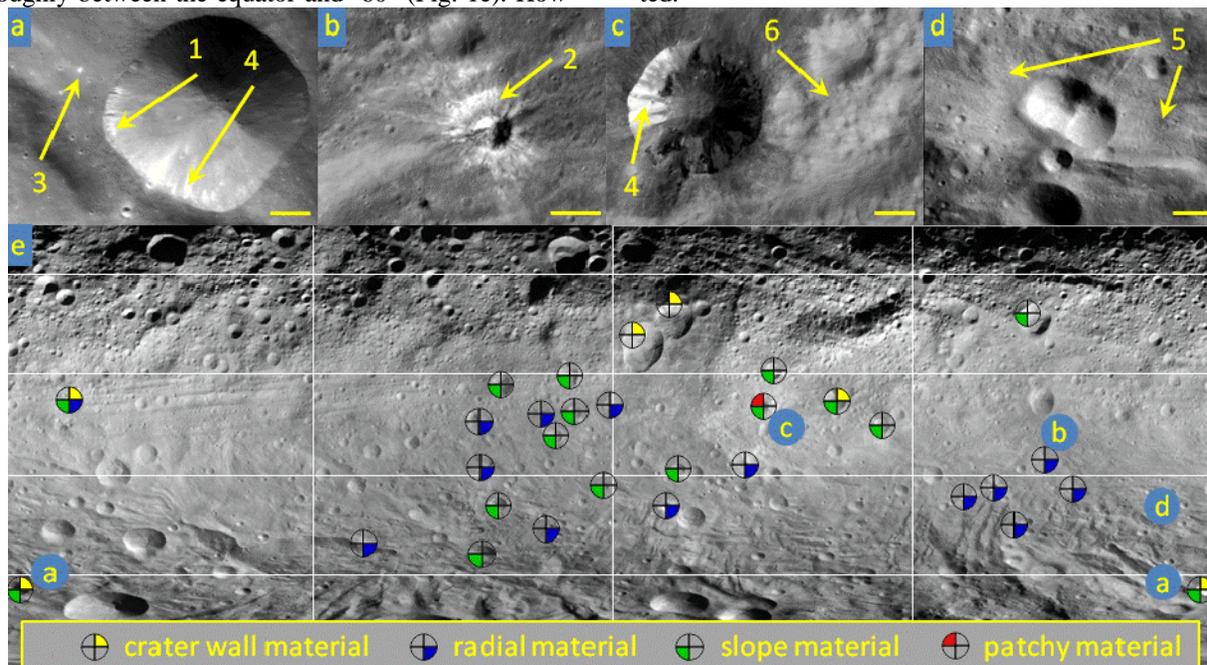


Figure 1. Examples and preliminary global distribution map of bright materials. Scale bars (a through d) are 5 km. Grid spacing (e) is every 90° longitude from 0° , and every 30° latitude from 30° N. Locations of type examples are indicated by letter in the global map. Images courtesy of NASA/ JPL-Caltech/ UCLA/ MPS/ DLR/ IDA.