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Early Results for the Geochemistry of Vesta from Gamma Ray and Neutron Spectroscopy

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In December of 2011, the Dawn spacecraft began low altitude mapping of asteroid 4 Vesta. At low altitudes, Dawn's Gamma Ray and Neutron Detector (GRaND)[1] is sensitive to gamma rays and neutrons produced by cosmogenic nuclear reactions and radioactive decay occurring within the top few decimeters of the surface. From these nuclear emissions, the abundance of several major- and minor-elements, such as Fe, Mg, Si, K, and Th can be determined. Dawn will remain in a circular, polar low altitude mapping orbit (LAMO) for up to 16 weeks, enabling the determination of global maps with a spatial resolution of a few hundred kilometers.

If the howardite, eucrite, and diogenite (HED) meteorites are representative of Vesta's crustal composition, then GRaND will be able to map the mixing ratios of whole-rock HED end-members, enabling the determination of the relative proportions of basaltic eucrite, cumulate eucrite, and diogenite as well as the proportions of mafic and plagioclase minerals. GRaND will also search for compositions not well-represented in the meteorite collection, such as evolved, K-rich lithologies, outcrops of olivine from Vesta's mantle or igneous intrusions in major impact basins, and possible source regions for the mesosiderites. GRaND will globally map the abundance of H, providing constraints on the delivery of H by solar wind and the infall of carbonaceous chondrite materials.

The chemical data acquired by GRaND will be analyzed within the broader context of the Dawn mission, and will be compared to and integrated with maps of mafic mineral abundances, geologic provinces, gravity, shape and topography. The compositional data acquired by Dawn will provide a more complete picture of Vesta's thermal history and evolution, supplementing geochemical data from HED meteorite studies. GRaND's elemental specificity and depth sensitivity provides a unique view of a compositionally-diverse protoplanet, complementing data acquired by Dawn's Visible-Infrared (VIR) spectrometer and framing camera (FC).

We will present our initial analyses of GRaND data acquired in LAMO. Results from a few weeks of mapping are promising. Strong neutron and gamma ray signatures have been detected that can be analyzed to determine the abundance of H, Fe, Mg, Si, neutron absorption, and average atomic mass. The data acquired by GRaND reinforce the conclusion that Vesta is unusual compared to smaller asteroids, because its surface elemental composition shows considerable variation on a global scale. By this conference, we will be able to answer many of the science questions addressed by Dawn's Geochemistry investigation.[1]

[1]Prettyman T.H. et al. (2011), Dawn's Gamma Ray and Neutron Detector, Space Sci. Rev., DOI 10.1007/s11214-011-9862-0.