PLANETARY SCIENCE RESEARCH DISCOVERIES
CosmoSparks
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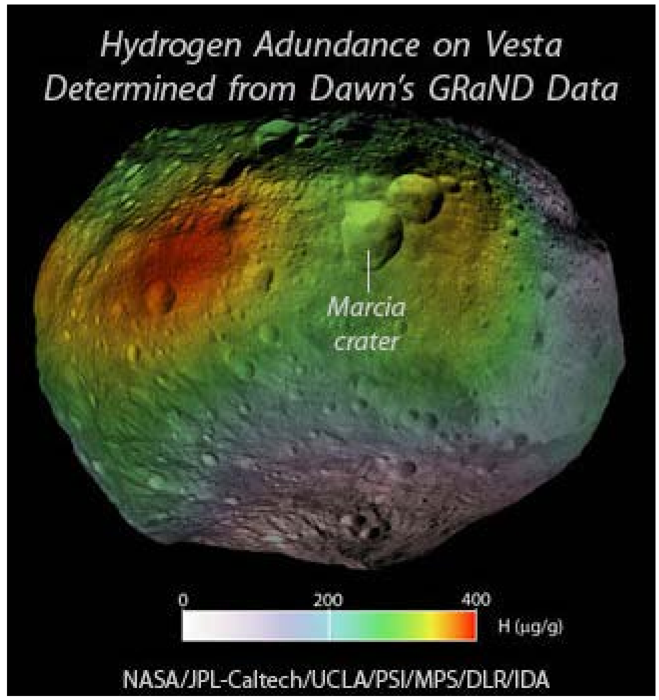
Volatiles on Vesta



NASA's Dawn spacecraft left Vesta on September 4, 2012 (PDT) after more than 13 months in orbit gathering 31,000 images, 20 million visible and infrared **spectra**, thousands of hours of gamma ray and neutron spectra, and gravity measurements. The data are amounting to some surprising, new discoveries about the role of volatiles in the evolution of Solar System bodies.

Thomas Prettyman (Planetary Science Institute, Tucson) and coauthors report on the elemental abundances in Vesta's **regolith** determined from Gamma Ray and Neutron Detector (GRaND) data collected from December 2011 to May 2012 while in the lowest mapping orbit. First and foremost the data from Vesta (global Fe/O and Fe/Si ratios in particular) confirm it as the **differentiated** parent body of the achondritic meteorites known as the HEDs—the three linked groups of: howardites, eucrites, and diogenites. This verifies the theory of the Vesta-HED connection that was founded on cosmochemical analyses on the HEDs and the perfect spectral match of these meteorites with the 0.9 and 1.9 micrometer absorption bands of pyroxene in the spectra of Vesta itself. Prettyman and coauthors also report a new, unexpected result from the GRaND data that contrasts with the generally-low volatile contents measured in the HEDs. They found hydrogen in the regolith and determined that roughly 30% of Vesta's surface has hydrogen abundances ≥ 250 µg/g with the highest concentrations in the oldest, lowest **albedo** regions (see map). The authors suggest the hydrogen accumulated gradually on Vesta's surface as debris of hydrated minerals from the innumerable impacts of carbonaceous **chondrite** material.

Brett Deveni (Johns Hopkins University Applied Physics Laboratory) and coauthors report on the patches of unusual pitted terrain they discovered in the clear-filter Framing Camera images also acquired during Dawn's lowest mapping orbit. The largest occurrence of pitted terrain is at Marcia crater (~70 kilometers in diameter, see map for location) where they also identified impact melt deposits. The rimless pits at Marcia crater are ~30 meters to ~1 kilometer in diameter and are typically <50 meters deep. While analogous surface features are known on Mars, similar pitted terrain has not yet been observed on other asteroids or volatile-poor airless bodies, such as the Moon or Mercury. Taking into account the presence of hydrogen in Vesta's regolith and the inference of volatiles in the origin of Martian pitted terrain, Deveni and coauthors suggest a sequence of events on Vesta: impacts (like the one that formed Marcia crater) heated the volatile-bearing regolith causing the explosive escape of gas into space and formation of pits at the surface.

Finding details of Vesta's geologic evolution in the data returned by NASA's Dawn mission, coupled with cosmochemical analyses of the HED meteorites, help us understand the role of volatiles not only on this asteroid, but also in the evolution of bodies across our Solar System. As these analyses continue, the spacecraft is moving on to reach dwarf planet Ceres in 2015.

For more:

· Denevi, B. W., Blewett, D. T., Buczkowski, D. L., Capaccioni, F., Capria, M. T., De Sanctis, M. C., Garry, W. B., Gaskell, R. W., Le Corre, L., Li, J.-Y., Marchi, S.. McCoy, T. J., Nathues, A., O'Brien, D. P., Petro, N. E., Pieters, C. M., Preusker, F., Raymond, C. A., Reddy, V., Russell, C. T., Schenk, P. Scully, J. E. C., Sunshine, J. M., Tosi, F., Williams, D. A., and Wyrick, D. (2012) Pitted Terrain on Vesta and Implications for the Presence of Volatiles, *Science Express,* doi: 10.1126/science.1225374. [***Abstract***]

· Prettyman, T. H., Mittlefehldt, D. W., Yamashita, N., Lawrence, D. J., Beck, A. W., Feldman, W. C., McCoy, T. J., McSween, H. Y., Toplis, M. J., Titus, T. N., Tricarico, P., Reedy, R. C., Hendricks, J. S., Forni, O., Le Corre, L., Li, J.-Y., Mizzon, H., Reddy, V., Raymond, C. A., and Russell, C. T. (2012) Elemental Mapping by Dawn Reveals Exogenic H in Vesta's Regolith, *Science Express,* doi: 10.1126/science.1225354. [***Abstract***]

· ***Dawn Mission Website***

· ***Dawn Sees Hydrated Minerals on Giant Asteroid***, Dawn Mission news item.

· **PSRD** articles ***about Vesta***.

Written by Linda M. V. Martel, Hawai'i Institute of Geophysics and Planetology, for ***PSRD***.

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http://www.psrd.hawaii.edu

psrd@higp.hawaii.edu