OH and Water on Vesta? T. B. McCord[1], and J.-Ph. Combe[1], [1]Bear Fight Institute, P.O. Box 667, Winthrop WA 98862, tmccord@bearfightinstitute.com, [1] jean-philippe_combe @ bearfightinstitute.com[1]

Introduction: The Dawn spacecraft [1] will begin orbiting Vesta in mid 2011, and a wide variety of science issues are to be addressed using the data to be returned from the three main instruments and tracking of the spacecraft orbits. One of these is a search for OH and related molecular groups in the surface materials. This possibility is suggested by the discovery of absorptions in the Moon's reflectance spectrum in the 3-µm spectral region by the M^3 spectrometer on the Chandrayaan-1 spacecraft and two other independent spacecraft confirming observations that are interpreted to be due to OH and perhaps H_2O on/in the surface material of the Moon [2, 3, 4].

The Moon Case: Since the announcement of the discovery for the Moon, the M^3 data have been undergoing analysis to explore the characteristics and behavior of the spectral absorptions, to help identify their source(es), and to study the processes involved [5, 6, 7]. The conclusion is that the most likely process creating the OH is solar-wind-proton-induced hydroxylation. The solar wind is composed mostly of H^+ and e^- plasma with energy ~1 KeV at the Moon. The process is likely to operate especially efficiently in the oxygen-rich (~45 wt %) lunar soil because the soil is unusually chemically active due to micrometeoroid and particle-radiation bombardment in vacuum. The resulting fine soil grains have complex and irregular surfaces, creating huge surface areas, and the internal crystal structure of the grains are heavily damaged [e.g. 8]. These surfaces and the crystal defects contain dangling oxygen bonds that are reactive with H^+ to form OH, and to a lesser extent, H_2O and perhaps other forms of H–O molecular groups [7]. Efforts are now underway to understand the processes involved [9].

The Vesta Case: The solar wind flows throughout the solar system and so it baths all airless body surfaces. Thus, the suspected process of OH production in the lunar soil also should occur elsewhere, where chemically-reactive, oxygen-containing silicate soils exist. Vesta may be such an object. Thus, an effort is being made to search for OH in the Dawn Mission observations and to study its properties, if present. A comparison with the lunar case may reveal more about the processes and aid in extending the search to other objects. Since hydroxylation is a form of chemical space weathering, it may be related to other forms of weathering, such as formation of nano-phased reduced iron, found in the lunar soils [10]. Study of OH formation may aid the study of these other processes.

Yet, Vesta may be different from the Moon. For example, the solar wind flux is affected by magnetic fields, such as the Earth's field when the Moon is in parts of its orbit. So, if Vesta has a magnetic field, it may affect the OH production, and the lack of OH or distinctive OH distributions could suggest such a field. Further, Vesta seems to have a mostly mafic composition compared with the Moon, from study of telescopic reflectance spectra [11]. But, for the Moon, it appears that OH is preferentially formed or retained in feldspathic rather than mafic material [5-7]. In addition, the solar wind flux will be somewhat less and of lower energy at Vesta compared with the Moon, and Vesta's surface temperature is also lower.

The obvious choice of Dawn data sets to use in this study is the spectral images to be obtained by the Visual and Infrared spectrometer (VIR) [1,12], covering the spectral range 0.25-5 µm. VIR's extended spectral range compared with that for M^3 beyond the 3-µm region where the OH-related features are found will aid in studying any Vesta OH spectral features. Further, Vesta's lower surface temperatures compared with the Moon's will reduce the contamination by thermal emission of the absorptions [7, 9] in the reflection spectra for Vesta.

Another data set of interest in this study is that for the Gamma Ray/Neutron Detector (GRaND) [1, 12]. It is sensitive to hydrogen, although not specifically to the particular molecular group with which the hydrogen might be associated, such as OH. Further, GRaND measures much deeper (~1 meter) into the surface than does the optical spectrometer (<1 mm) and so will be sensitive to different deposits, and its spatial resolution is much lower than for VIR. Still, correlations might be found and would be informative.

Modeling of the possible results of the search for OH on Vesta and identification of the possible interpretations for both positive and negative findings is underway, and examples will be presented.

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