TEMPERATURE AND SPECTRAL PHASE EFFECTS ON HED METEORITES: IMPLICATIONS FOR DAWN AT VESTA

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Introduction: Asteroid 4 Vesta is the first target of NASA's Dawn mission, which is expected to begin its yearlong orbital mission in July 2011. The Framing Camera (FC), one of the three scientific instruments onboard the spacecraft [1], contains a set of 7 filters ranging from 0.44 to 0.97 microns in addition to a clear filter. While the VIR spectrometer on Dawn has larger spectral coverage (0.25-5 microns) and spectral resolution (2-10 nm), Dawn FC has higher spatial resolution (up to ~20 m) than VIR (~50 meters).

Spectral phase effects on Vesta have been already detected and approximately quantified by [2]. [2] noted a change in the intensity of Vesta's 1-micron band with increasing phase angle. Hence we expect to see a wavelength dependent phase effect, which will alter the reflectance values of FC data depending on the band pass of the filter and viewing geometry (mainly phase angle). Beside the viewing geometry we expect also to observe spectral changes due to surface temperature, which will likely be present in the spectrometer data. Temperature uncertainties arise when spacecraft spectral data, obtained at much colder surface temperatures (80-300K), is interpreted using laboratory calibrations developed at room temperatures (~300K). In an effort to pre-quantify these phase angle-, and temperature-induced spectral effects, we conducted a series of laboratory studies of HED meteorites.

Methodology: Laboratory spectral measurements (0.3-25 microns) of Moama eucrite and orthopyroxene PYX032 (analog for a diogenite) at different phase angles (18-120 deg) were measured at the University of Winnipeg Planetary Spectrophotometer Facility. Data of temperature spectral series was obtained from two published sources [3,4], and reanalyzed after resampling to Dawn FC wavelength ranges. Spectral band parameters like Band I and II centers, Band Area Ratio (BAR) and band depths were measured using methods described in [5].

Results: Using laboratory spectral measurements of HED meteorites at different phase angles and temperatures we have developed a set of equations to correct Dawn FC color images and VIR cubes for temperature and phase angle effects. We noted a general increase in band depths and BAR at the shortest phase angle (13 deg) and a shallow decline between 30-90 deg and a dramatic drop between 90-120 deg for Moama eucrite. Eucrites and diogenites show maximum shift in Band II center with increase in temperature. The equations will correct the spectral parameters to standard geometry (0 deg) for phase angle data and room temperature (300K).

References: [1] Sierks et al., 2011, Space Science Reviews [2] Gaffey, 1997, Icarus 127 [3] Hinrichs et al., 2002, Icarus 155 [4] Schade and Wäsch, 1999, MAPS 34 [5] Reddy, 2009, Ph.D. dissertation, UND.