WHAT MARS IS MADE OF: RECONCILING ORBITAL DATASETS WITH CLUES FROM THE SPECTRUM OF NORTHWEST AFRICA 7034

K. M. Cannon[1], J. F. Mustard[1], and C. B. Agee[2]. [1]Brown University, Department of Earth, Environmental, and Planetary Sciences, Providence RI. Email: kevin_cannon@brown.edu. [2]Institute of Meteoritics, University of New Mexico, Albuquerque NM.

Introduction: Mars is mostly covered by sand-sized grains of regional basaltic provenance [1], iced with a veneer of globally distributed dust. The mineralogy of the non-dust component has been assessed by two orbital datasets: Visible/near-infrared (VNIR) reflectance spectroscopy [2] and thermal emission spectroscopy [1]. These datasets are interpreted by "unmixing" spectra into pure mineral endmember components. However, this technique requires up to 50% of ad hoc darkening agents and "spectrally neutral components" because actual spectra from the martian surface are too dark and spectrally featureless to be explained by ground-up basalt. Here we suggest that the unique spectral properties of Northwest Africa (NWA) 7034, the first meteorite breccia from Mars [3], offer a plausible solution to these shortcomings and that eroded fine-grained breccias are a significant component of the martian regolith.

Approach: We measured the reflectance spectrum of a solid chip of NWA 7034 at the NASA/Keck RELAB facility at Brown University [4], and with spatially resolved hyperspectral imaging [5]. Hyperspectral imaging covered the wavelength region from 0.4-2.6 µm, while RELAB point measurements covered 0.3-25 µm with a greater signal to noise ratio but no spatial information.

Results and Discussion: Pyroxene, andesine, and lithic clasts [3] in NWA 7034 are resolvable through hyperspectral imaging, but their spectral signatures are muted by the surrounding matrix such that the average spectrum of NWA 7034 is very dark with low spectral contrast and no observable absorption features in the near-infrared. [3]. This is in contrast to spectra of all other SNC meteorite chips measured previously. SNC meteorite spectra are much brighter and are dominated by strong crystal field absorptions from pyroxene and olivine. We attribute the unique spectral properties of NWA 7034 to textural effects from its very fine-grained matrix [6], with grain sizes on the order of VNIR wavelengths of light [7].

Mars has nearly four hundred thousand craters greater than 1 km in diameter [8] so it is reasonable to assume that very fine-grained breccias like NWA 7034 are not uncommon on the surface. When physically eroded into sand-sized grains these breccias likely retain their spectral properties. Mixing sand-sized particles of fine-grained breccia with ground up basalt will cause greatly reduced albedo and spectral contrast of the resulting mixture, consistent with actual spectra from the martian surface [9].

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