RE-INTERPRETATION OF GRAIN FEATURES IMAGED BY THE PHOENIX MARS LANDER'S OPTICAL MICROSCOPE.

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Introduction: The Phoenix Mars Lander landed in Vastitas Borealis, near Mars' northern polar cap, on May 25 2008, and operated until November 2, 2008 [1]. Among its instruments was an Optical Microscope (OM) with a fixed focus, fixed magnification, and a spatial image resolution at 4 μm/pixel [2].

Previous studies used OM images to determine grain types, grain form, and particle sizes and distributions at the Phoenix landing site [3-7]. Subsequent comparisons with various terrestrial analogs revealed no differences in grain form [8,9].

This presentation interprets the environmental significance of the coarsest grains imaged using the Phoenix OM by comparison with similar grains from well-studied terrestrial (basaltic) analogs.

Materials and Methods: Three Mars regolith ("soil") analogs were examined; NASA JSC Mars-1 [10], HWMK600 [11,12], and MMS [13]. All contain the primary rock-forming mineral plagioclase [10,12-14], along with other primary and secondary phases.

Grains from each analog were imaged using scanning electron microscopy in secondary electron imaging mode. Context images were acquired at the same resolution as the OM, and 150 grains from each analog were imaged close-up at one grain per frame (3 analogs × 150 grains = 450 total grains). Grain-surface textures were classified from high-magnification images of individual grains, and proportions of grains with each surface texture were tabulated.

Results: *JSC Mars-1:* More than 30% of the grains have vesicles ranging in size up to lengths comparable to grain dimensions. Approximately 10% of the grains have fine particulate debris resolvable in whole-frame images of individual grains. Networks of intersecting and randomly oriented shallow cracks occur on more than half of the grains.

HWMK600: Approximately 25% of the grains have vesicles ranging in size up to lengths comparable to grain dimensions. All grains have fine particles resolvable in whole-frame images of individual grains. Cracks occur on less than 20% of the grains. Cracks confined to grain surfaces are more abundant than cracks that go deeper into the grain.

MMS: Over 30% of grains exhibit some planar surfaces consistent with cleavage of plagioclase, known to occur in MMS source materials [14]. Fine particulate debris is the dominant grain-surface texture on more than 50% of the grains.

Discussion: The vesicles in JSC Mars-1 and HWMK600 indicate volatile-bearing magma. The persistence of primary rock-forming minerals and absence of common chemical-weathering textures [15-18] in all analogs both suggest limited duration and/or intensity of water-driven chemical weathering.

Different moisture and temperature regimes with elevation may have produced different proportions of hydrous, weathered, crack-prone grain surfaces. Differences in the proportions of cracked grain surfaces between JSC Mars-1 and HWMK600 (sampled on Mauna Kea volcano at 1850 and 3730 m elevation AMSL, respectively [19-20]) are consistent with climate control, with the JSC Mars-1 site being lower, "wetter", and warmer than the HWMK600 site.

Conclusion: While vesicles in the Mauna Kea analogs are typically large enough to been resolved by the Phoenix OM, common aqueous-corrosion features of the dominant rock-forming minerals at Mars' surface (pyroxene, olivine [15-18]), and the apparent dehydration cracks on grain surfaces from analog materials, are not resolvable by the OM. Consequently, the significance of the OM imagery for assessing habitability remains under-constrained.

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