DETERMINING MARTIAN AQUEOUS MINERALOGY THROUGH ANALYSES OF ORBITAL REMOTE SENSING & MARTIAN METEORITE GEOCHEMISTRY.

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Introduction: Investigating similarities and differences in the mineralogy of Mars determined from meteorites and the surface may provide insights into Mars' geologic history. Many of the same phyllosilicate, carbonate and sulfate minerals have been identified through orbital remote sensing and the meteorite record [1]. We consider here the age of aqueous outcrops on Mars characterized through orbital remote sensing in comparison with the composition of Martian meteorites and their ages.

Orbital Evidence for Aqueous Alteration: Fe/Mg-smectite-bearing sequences are generally the oldest phyllosilicate units on Mars and appear in many Noachian-aged terrains [2, 3]. This unit formed ~3.9-4.1 Ga at Mawrth Vallis [4] where the largest Fe/Mg-smectite outcrop is observed. Al/Si-OH-rich species formed subsequently at Mawrth Vallis [5] and elsewhere [6], presumably about 3.9 Ga. Isolated regions of hydrothermal activity such as at Toro Crater formed high-temperature phyllosilicates [7]. More recent hydrothermal, fluvial and/or evaporative processes in the greater Valles Marineris region have produced multiple alteration phases [e.g. 8, 9].

Aqueous Mineralogy in Martian Meteorites: A variety of phyllosilicates, carbonates and sulfates have been identified in the nakhlites and chassignites [e.g. 10, 11] estimated at 1.3-1.4 Ga [12], while only carbonates have been found in the ancient Martian orthopyroxenite ALH 84001 [13]. This meteorite likely formed ~4.1-4.5 Ga [14], which is prior to the presumed date of phyllosilicate formation on Mars. Variable water-rock ratios are proposed to explain the subtle differences in phyllosilicate, carbonate and sulfate mineralogy observed among nakhlites [15].

Interpretations: Evaluation of Martian mineralogy determined through orbital remote sensing and meteorite analyses is consistent with multiple aqueous events forming phyllosilicates, carbonates and sulfates. Carbonate-bearing rocks at the ALH 84001 source region may signal ancient aqueous processes that took place before the warm and wet smectite-forming epoch ~4 Ga ago. Variations in mantle temperature over time on Mars [16], together with impacts and volcanism likely triggered changes in the aqueous environment in localized regions. We are investigating relationships between aqueous mineralogy in meteorites and possible surface processes.

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