SEARCHING FOR THE METEORITIC CONTRIBUTION TO MARTIAN SOILS AND SEDIMENTS.

Benton C. Clark[1]. [1]Space Science Institute, Boulder, CO 80301, USA. bclark@spacescience.org

Introduction: The martian regolith and sediments derived therefrom contain a relic record of the history of accretion of meteoric material and IDPs. Although so-far elusive to in situ exploration, this component has important significance.

Relevance: It provides minerals not common in typical martian igneous compositions: native Fe and Ni which would be highly susceptible to aqueous alteration; organic compounds of a wide variety; and many reduced mineral species. Determination of the contribution of meteoritic material to soil would allow a more definitive estimate of the organic content before degradation by oxidative surface processes. Ablation products and pulverization during impact may contribute a component of the airborne dust. It also could constrain the depth/turnover of the global soil unit.

In situ Measurements: High precision element analysis by XRF has been performed on every landed Mars mission (except Phoenix). Major and minor rock-forming elements are readily determined, but these are not sufficiently diagnostic of meteoritic material. In addition to the discovery of several meteorite rocks by MER and MSL rovers, the Ni content of martian soil has been considered a possible tracer of meteoritic contributions [1]. However, large Ni variability in the MER and MEL data sets are evidence of high mobility for this element on Mars, confounding its use as a tracer. Elements such as Os and Ir can in principle be detected by all XRF-based systems that have been flown, but their concentrations in meteorites, although much higher than in SNC's, is at levels of a few ppm to sub-ppm, making the detection of their L lines difficult, especially relative to the K lines of Zn, Ge, Ga, and As. These and many other key diagnostic high-Z elements must await return of samples to Earth in some future decade.

Martian materials measured in situ are often enriched in Ge. Ge in SNC's is ~ <1 ppm [2], but is 10 ppm or more in most meteorites [3], and several 10's of ppm in carbonaceous meteorites. Some martian samples reach 100 ppm or more Ge [4] – could it be meteoritic in origin? Other trace elements that can and have been measured in one or more samples in situ by APXS include Cu, Ga, Co, As, Br, Y, Ba, and Pb. CCAM on MSL has detected Li and F.

Evolved gas analysis of RockNest soil by MSL included H_2S, the progenitor of which is probably an FeS_x [5]. Although some sulfide could be igneous in origin, the balance may be an important indicator of exogenous material.

Future Measurements:. The PIXL instrument on the 2020 Mars Rover will perform XRF micro-analysis (100 μm), and may detect minerals highly diagnostic of asteroidal and cometary materials, such as osbornite (TiN), oldhamite (CaS), and schreibersite ((Fe,Ni)P), even if somewhat altered by the chemical environment.

References: [1] Yen, A. et al. 2005. *Nature*.436: 49Y20. [2] Lodders, K. 1998. *Meteoritics & Planet. Sci.* 33: A183-A190. [3] Mason, B. 1971. Handbook of Elemental Abundances in Meteorites. Gordon and Breach, NY. [4] Gellert, R and Clark, B.C. 2015. *Elements* 11:39-44. [5] Ming, D.W. et al., 2014. *Science*, DOI:10.1126/science.1245267