EOLIAN ADHESION CRUSTS PRODUCED DURING EXPERIMENTAL ABRASION OF SEDIMENTARY ROCK – AN ALTERNATIVE PROCESS FOR MARTIAN ROCK VARNISH FORMATION? K.H. O'Donnell[1], T.V. Howald[2], and J. Schieber[1], [1]Department of Geological Sciences, Indiana University, Bloomington, IN 47405, kenodonn@indiana.edu, jschiebe@indiana.edu, [2]Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, NM, 87801, thowald@nmt.edu.

Introduction: The MER rover Spirit has observed many rocks with iron-rich crusts on the Martian surface. In MI images these crusts resemble rock varnish known from arid environments on Earth. Terrestrial examples have environmental implications [1], and various attempts have been made to evaluate it as a bio-signature. Implications for microbial and/or water-related activity [2] have stirred considerable debate whether analogous processes produce terrestrial and Martian rock varnish.

In experimental work, designed to study eolian abrasion of soft sedimentary rocks [3], we inadvertently produced a firm mineral coating on exposed rock surfaces (Fig. 1). This study describes the likely origin of this coating and compares it with extant rock varnish. (Fig. 1) [3].

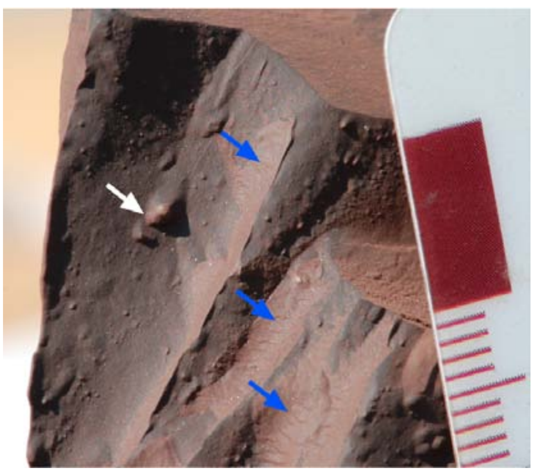

Fig. 1. Mudstone with adhesion crust (blue arrows). Two months of eolian erosion with fine basalt sand produced the observed surface topography where pyrite forms resistant protrusions (white arrow). Scale = 1 cm.

Methodology: Our abrasive was a 50/50 mixture of ground hematite and basalt, with grain sizes comparable to Martian surface sediments (< 125 microns). A constant wind speed of approximately 30 km/h was applied. Eleven samples of cut mudstones and evaporites were anchored to the base of the wind chamber and subjected to abrasion for 28 days. Samples were weighed and measured before and after to determine extent of sample erosion and rock varnish accumulation. Grain surface features, grain size, and compositions were observed by SEM on the initial sediment mixture and the material present in the chamber after 28 days.

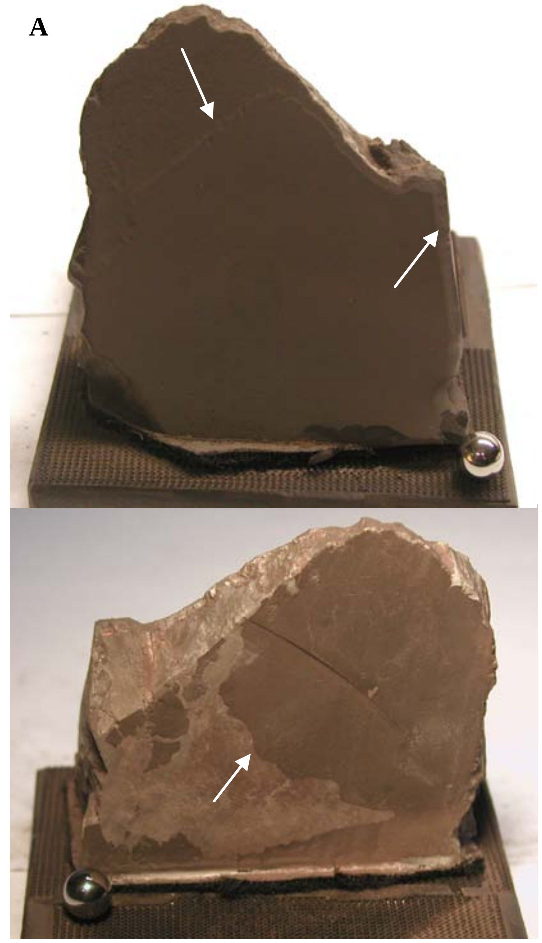

Figure 2. A) Adhesion crust formation occurs mostly on windward rockface. Note eroded edges (white arrows). **B)** Accumulation was also observed on downwind side (white arrow). Ball bearing for scale (0.9 cm).

Observations: All samples show a smooth veneer of rock varnish of varying thicknesses. Accumulation occurred primarily on the upwind-facing side (Fig. 2a), with less accumulation on the downwind side (Fig. 2b).

Ten samples exhibit a net mass loss (< 1 g in each instance) after varnish removal, indicating that some actual erosion of the starting material occurred in addition to adhesion crust buildup. Unlike in earlier experiments (Fig. 1), no significant erosive features developed in the course of the current experiment.

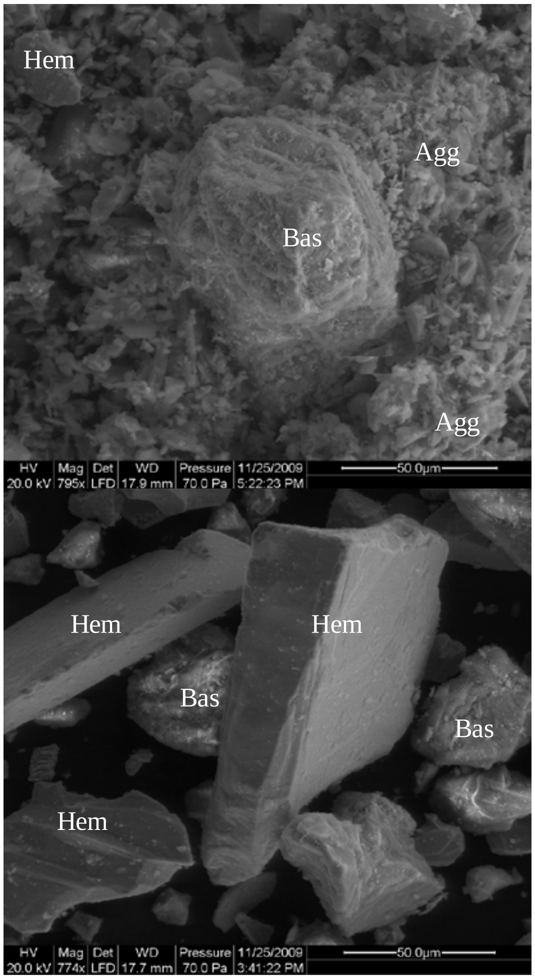

Figure 3. Windblown dust after 28 days. Basalt (top) shows rounding, pitting, and chipping. Hematite (bottom) shows some rounding and fracturing. All particles observed are < 100 microns. Bas=basalt; Hem=hematite; Agg=aggregate.

The hematite and basalt abrasive showed noticeable wear after 28 days, indicated by weathering features associated with windblown sediments, including rounded corners, pitting, fining of grain size, and production of micron-size dust that tends to form larger aggregates. Rounding and grain diminution are much more pronounced for the basaltic sand grains (Fig. 3). Heavier minerals (e.g., hematite, amphibole) dominate the coarser fraction of the loose sediments. The adhesion crust consists of sub-micron- to micron-sized silicate and hematite grains, and may exhibit faint lamination (Fig. 4). No filaments or organic matter were observed.

Conclusions: The absence of organic matter indicates an inorganic origin for adhesion crusts. Ambient humidity is likely responsible for initial adhesion of windblown fines. High-speed grain impacts, forcing close contact of grains with

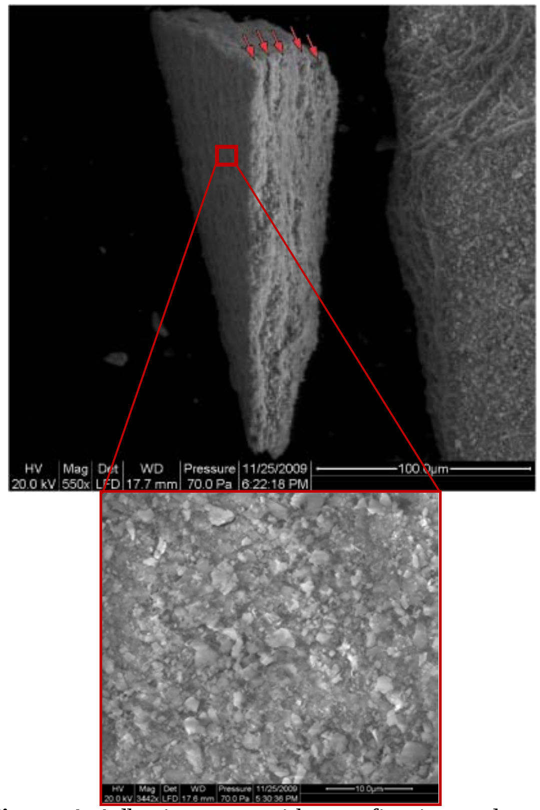

Figure 4. Adhesion crust with very fine internal laminae (red arrows). Laminae are composed of sub-micron- and micron-sized basalt and hematite particles.

abundant surface charges, may have led to a "sintering" effect and allowed further accretion. On the Martian surface, daily humidity fluctuations (high relative humidity at night time) may analogously allow initial dust coatings to stick [4-5], laying the foundation for further buildup by wind impact of small grains. Dust storms that entrain abundant fine-grained material may produce mm-thick adhesion crusts within a few weeks, within the duration bandwidth of typical Martian dust storms [6].

References: [1] Perry, R. S. and Sephton, M. A. (2006) *Astron. Geophys., 47*, 4.34-4.35. [2] Probst, L. W. et al (2002) *LPS XXXIII*, Abstract #1764. [3] Howald, T. V. and Schieber, J. (2009) *LPS 40*, Abstract #2052. [4] Fanale, F. P. et al (1986) *Icarus, 67*, 1-18. [5] Hudson, T. L. et al (2007) *JGR, 112*, E05016, doi:10.1029/2006JE002815. [6] Stanzel, C. et al. (2008), *Icarus, 197*, 39-51.