EXPERIMENTAL EOLIAN EROSION OF SOFT SEDIMENTARY ROCKS WITH A VARIETY OF ABRASIVES – OBSERVED FEATURES AND POTENTIAL APPLICATIONS FOR MARS ROVER GEOLOGY  R. Wilson, J. Schieber, and T.V. Howald, Department of Geological Sciences, Indiana University, Bloomington, Indiana 47405, jschiebe@indiana.edu.

Introduction: Sedimentary rocks exposed on the surface of Mars are rather soft and appear to consist largely of a mixture of altered volcanic materials mixed with evaporite salts [1]. Given that abundant dust is produced and transported on the Martian surface, it is also quite likely that mudstones constitute part of the Martian rock record. On Earth erosion of evaporites and mudstones is typically accomplished by aqueous erosion, even in areas that receive very little rainfall. As a consequence it is very difficult to observe eolian erosion features associated with evaporites and mudstones in modern terrestrial deserts.

Liquid water has largely been absent from the Martian surface for several hundred million years, and much of what we see today is most likely a result of eolian abrasion over long time periods. Therefore, in order to get a better understanding of eolian erosion features that might be observed in mudstones and evaporites encountered in future Mars rover missions, we have conducted a series of erosion experiments on a collection of mudstone and evaporite samples.

Methodology: We use a circular abrasion chamber with a rotating propeller that allows wind speeds up to 40 km/hr. The abrasives we used were silt to fine sand size hematite dust, a 50/50 mixture of ground hematite and basalt, and fine to medium size quartz sand. A constant wind speed of ~ 30 km/h was applied. Twelve samples of cut mudstones and evaporites were anchored to the base of the wind chamber and subjected to abrasion for up to 3 months. Samples were weighed and measured before and after to determine the extent of erosion and rock varnish accumulation. Sample surfaces were photographed in detail before and after the experiment. Surface textures of samples were also examined by SEM, as were the changes in the character of the abrasive mixtures [2, 3].

Observations: Significant sample erosion occurred in all experiments, with systematic differences between clay vs silt dominated mudstones, sandstones, and indurated anhydrite samples. All samples had never been exposed to surface weathering. They were collected fresh from quarry operations and underground mines. Clay-rich mudstones experienced the strongest wear (average removal rates of up to 1 gram of material per day), followed by silt-dominated mudstones. Anhydrite samples experienced modest overall wear, and sandstone samples experienced the least abrasion. Abrasive performance was best for quartz sand, and worst for the hematite & basaltic sand mixture. In the latter case a large portion of the basalt grains disintegrated into dust over the course of the experiment.

In mudstone samples wind abrasion strongly accentuated fine lamina details (silty laminae being more resistant), and formed pedestals (Fig. 1) in places with resistant mineral grains (pyrite concretions). Hairline fractures were strongly enhanced by continued abrasion (Fig. 2), and in several instances served to undermine (focused excavation) the sample so much that entire pieces broke off.

![Figure 1](image1.png)  
Figure 1: Abrasion of shale sample, layers vertical. At right sample before experiment, at left 76 days later. Abrasion has accentuated internal bedding and formed pedestals underneath pyrite nodules (arrow).

![Figure 2](image2.png)  
Figure 2: Abrasion of shale sample, layers horizontal. At right sample before experiment, hairline fracture marked with arrows. At left sample after experiment, hairline fracture location marked with white arrows. Undermining along the fracture
removed the top of the sample. Green arrows point to accentuated laminae, small bumps are etched out concretions of pyrite.

The abraded dust that is produced in the course of these experiments tends to form sintered coatings (resembling rock varnish) on sample surfaces that, for reasons of placement within the chamber and airflow characteristics, do not experience as much abrasive flux. These coatings can be quite thick (several mm), may even be internally laminated, and can provide protection from further abrasion (Fig. 3).

Figure 3: Abrasion of a sample of anhydrite. At right sample before experiment. At left sample after experiment. The arrows mark a thick piece of sintered coating with internal laminae. The uncoated part of the sample shows pitting and some differential erosion.

**Implications:** Although evaporite rocks tend to be rather soft to scratch, their tightly interlocking crystals seem to make them more abrasion resistant. Their more uniform composition also seems to make them less prone to differential erosion when compared to mudstone and shale samples. In the latter, cemented silt laminae and concretionary bodies are much more resistant than the clay-dominated matrix and lead to very pronounced abrasive textures (Fig. 1).

Imaging devices (MAHLI) on the next Mars rover (MSL) do not have the resolution necessary to differentiate between silt-rich vs clay-rich rocks, and can also not differentiate between fine grained rocks composed of evaporite minerals and those that consist largely of fine grained silicates (clay and silt). Application of the observations from our experiments, calibrated with select XRD analyses (CHEMIN), should help us to make these distinctions on a routine basis (from images alone) once MSL surface operations have commenced.

The observed abrasion rates suggest that in fine grained and evaporitic sediments at least, many of the topographic features on today’s Martian surface could have resulted from eolian erosion alone. Rock coatings found on Martian outcrops above the basal zone of eolian sand transport (1 m or less) may have originated in a similar fashion as the sintered crusts in our experiments (Fig. 3).

In future experiments we will continuously remove fine dust from the experiment chamber in order to avoid crust formation. This approach should allow us to get more consistent data for eolian abrasion rates of soft sediments.