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Soil crusts observed and investigated at the MER landing sites

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Observations by the two Mars Exploration Rovers (MERs) Spirit and Opportunity have revealed evidence for soil crusts. In the case of the Gusev crater site of Spirit, imaging at both the macro scale and the micro scale of disturbed soil-like materials suggests that soil crusts are rather ubiquitous in that surface soils in many instances - as well as some of the aeolian bedforms - appear indurated in a surficial sheet of several mm thickness. The crust is easily disrupted by shear from the rover wheels, revealing relatively darker subsurface soil. Microscopic imaging of fractured crust consistently shows crust clods to be brighter than the subjacent soils, indicating a difference in composition and/or modification history. Undisturbed crusts do not show desiccation cracks, suggesting an insignificant role of volume-changing processes in their formation. Hypotheses for crusts at Gusev include the model that they represent a layer of airfall dust cemented by precipitating salts upon evaporation of films of moisture (supplied from the atmosphere) with dissolved salts. The chemical and mineralogical composition of the actual crust thus far has been difficult to isolate with the MER Athena instruments due to the presence of a microns-thick, unconsolidated dust veneer deposited on top of the crust in most instances. At the Meridiani Planum site, soil crusts are much less apparent than at Gusev, in that the sheet of fine sand covering the plains surface only locally appears indurated as judged from observations of materials disturbed by the rover. Due to the observed scarcity of airfall dust at this site, Meridiani crusts probably are patches of the fine surface sand which have been indurated by apparently very small amounts of unresolved cements, possibly carried by airfall dust.

Besides discussing available soil crusts observations from MER, we will present results of laboratory experiments at simulated Martian conditions to constrain crusts

formation mechanisms. Accordingly, these experiments demonstrate that soil crusts morphologically similar to the ones seen by the MERs can be made at Mars surface pressure and temperature with mineralogical Mars soil simulants enriched with less than 10 wt-% of Mg sulfates if moisture is added to the samples in the liquid phase. With water supplied in the gaseous phase and the simulated Martian atmosphere forced into saturation, soil crust formation is observed to take significantly longer and may not lead to crusts to the extent observed on Mars at all. The implications for the environmental conditions required at time of crusts formation will be discussed.