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Mars dust mineralogy and structure obtained by a simple Mars rover instrumentation development – suggestions for future missions.

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Selective spectroscopic observations of the dust on the surface of Mars have neither been possible from Earth nor from orbiters as ESA, Mars Express or NASA, MRO. Even in surface soil sampling detailed chemical or mineralogical information about Martian dust cannot be separated from the soil. Remote spectroscopic data contain a mixture of mineralogical components which do not provide any specific information on the dust. Information about chemical composition and mineralogy of the Martian airborne dust was derived from APXS and Mössbauer data from the MER rovers by Goetz et al. (2005). This paper concluded that magnetite and not maghemite is the magnetic phase of the dust, and also that the presence of olivine indicates that liquid water did not play a dominant role in the formation of atmospheric dust. The dust is most likely formed by mechanical comminution comparable to the fine fractions of dust in dune sand on Earth (Nørnberg, P. 2002).
Our Mars dust model operates with particles (2-3 μm) that inside consists of primary minerals which are either oxidized down to tenths of nm below the surface or have captured electrically charged nanoparticles of hematite on the surface giving the dust its red colour. Experiments done by Merrison, J.P. et al. (2010) showed that mechanical tumbling (abrasion)of a mixture of 10g quartz and 1 g magnetite in a dry process in a Martian atmosphere transformed magnetite to hematite. This experiment supports the dry comminution process indicated by Goetz et al (2005).
The XRD analyses on the NASA, MSL are done on a mixture of soil material in which the dust accounts for only a minor part. However, if dust could have been captured separately from the atmosphere e.g. by magnets on the MSL and taken off by e.g. tape or another mechanism that could be transferred into the target holder of the XRD diffractometer on the rover, it could by Rietveld analyses have provided valuable quantitative information on the mineral content of the dust.
So we still do not know whether the dust particles consist of primary minerals that are oxidized down to a certain depth in a dry oxidation process, or if the oxidation has taken place under influence of UV radiation. A third possibility is that the primary particles due to electrification of the dust have captured a coating of nano particles of hematite. We could come closer to a solution to these central questions by relatively simple modifications of future rover instrumentation.
Goetz, W. et al. 2005 Nature, 436/7, 10.1038.
Nørnberg, P. 2002 17th WCSS, Bangkok. Symp. 25, 1124.
Merrison, J.P. et al. 2010 Icarus 205, 716-718.