Magnetism, Iron Minerals and Life on Mars

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We have recently shown (Chevrier et al., 2004) that the reduced iron phases most easy
to oxidized in the Martian atmosphere (CO2+H2O) are metal and sulfide. These
phases are transformed exothermically into oxihydroxides (e.g. goethite) and sulfates
(e.g. jarosite), readily observed by the MER instruments. Assuming that these
reactions have been mediated by putative martian microorganisms (like on Earth:
Kappler and Newmann (2004) and Dinh et al. (2004), we propose to increase the
probability of detection of active or recently fossilized microorganisms, by locating
metal and sulfide bearing rocks, under the oxidized coating, ubiquitous on the Martian
surface. An instrument sensitive to iron oxidation state and penetrative (at the cm
scale) is necessary. Contact magnetic susceptibility probe (COMASP) fulfill these
requirements (Gattacceca et al., 2004) and have been proposed for robotic
exploration of Mars (Rochette et al., 2004).

The chemical reactions involved can be summarized for metal as: Fe0 + 2H+ +
CO32- = > FeIICO3 + H2, and then 2FeIICO3 + 2H2O = > 2FeIIIO(OH) + 2CO2 +
H2
and for FeS as (although numerous other species are involved): FeIIS + 2 H2O
= > FeIIIO(OH) + S + 3/2 H2
The first target that COMASP can identify are meteorites laying on the martian regolith (Bland and Smith, 2004). Meteorites have metal and sulfide as major components (usually 10-20 w.%) and show a magnetic susceptibility one or two orders of magnitude larger than the one of Martian rock and soils. Test of COMASP in Antarctic meteorite concentrations have validated this concept. Recently fallen meteorites could provide the only accessible source for highly concentrated substrate (including organic carbon) and may thus be the only target for detectable level of microorganisms’ content.

Being able to detect the presence of a weathering rind around a sulfide bearing rock on Mars before any grinding or coring, as well as estimating its thickness and K contrast with respect to fresh rock, can be used as a guide to select where to look for an hypothetical microorganisms mediated weathering interface, for further more time consuming robotic investigations. We will show, using terrestrial analogs, that a magnetic susceptibility contrast is generated by this weathering and can be detected using the susceptibility profiles determined by inversion of COMASP data versus distance to rock surface.

References
and design of magnetic properties measurements on planetary and asteroidal landers. 
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