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Magnetism, Iron Minerals and Life on Mars

P.Rochette (1), J. Gattacceca(1), V. Chevrier, (1), P.E. Mathé (1) and M. Menvielle (2)
(1) CEREGE BP80 13545 Aix en Provence cdx 4, France (rochette@cerege.fr), (2) CETP St-Maur, France

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

Bland, P.A., Smith, T.B., 2000. Meteorite accumulation on Mars. Icarus 144, 21-26.

Chevrier, V., Rochette, P., Mathé, P.-E, Grauby, O., 2004. Weathering of iron rich phases in simulated Martian atmospheres. Geology, 32, 1033-1036.

Dinh, HT, Kuever, J, Mussmann, et al., 2004. Iron corrosion by novel anaerobic microorganisms. Nature 427, 829-832.

Gattacceca, J., Eisenlohr, P., Rochette, P. , 2004. Calibration of in situ magnetic susceptibility measurements. Geophys. J. Inter., 158, 42-49.

Kappler, A., Newman, D.K., 2004. formation of Fe(III)-minerals by Fe(II) oxidizing photoautotrophic bacteria. Geochem. Cosmochem. Acta 68, 1217-1226.

Rochette, P. Gattacceca, J., Menvielle, M., Eisenlohr, P., Chevrier, V., 2004a. Interest

and design of magnetic properties measurements on planetary and asteroidal landers. Planet. Space Sc. 52, 987-995.