



Goethite identified by MER Spirit's Mössbauer spectrometer in the Columbia Hills, Gusev Crater, Mars

C. Schröder (1), G. Klingelhöfer (1), P.A. de Souza Jr. (1,2), D.W. Ming (3), R.V. Morris (3), D.S. Rodionov (1,4), A.S. Yen (5) and the Athena Science Team

(1) Institut für Anorganische und Analytische Chemie, Johannes Gutenberg-Universität, Staudinger Weg 9, 55128 Mainz, Germany, (2) CVRD Group, Vitoria, Brazil, (3) NASA Johnson Space Center, Houston, TX, USA, (4) Space Research Institute IKI, Moscow, Russia, (5) JPL, California Institute of Technology, Pasadena, CA, USA.

Rocks on the ejecta blanket of Bonneville crater and along Spirit's traverse over the Gusev plains towards the Columbia Hills are angular and strewn across the surface. They have a basaltic composition [1,2], and their Mössbauer spectra are dominated by an olivine doublet [1]. The ubiquitous presence of abundant olivine in rocks and in surrounding soil suggests that physical rather than chemical weathering processes currently dominate the plains at Gusev crater [1]. However, MB spectra of rocks and outcrops in the Columbia Hills suggest more aggressive alteration processes have occurred. At the foot of the Columbia Hills, Spirit encountered outcrop and rocks exhibiting layered structures. Some scattered rocks at the foot of the Columbia Hills appeared "rotten" or highly altered by physical and/or chemical processes. Mössbauer spectra of these rocks show a decrease in olivine accompanied by an increase in the Fe-oxides magnetite, hematite, and nanophase Fe(3+) -oxides, suggesting that chemical weathering processes in the presence of water have altered these rocks and outcrops. Ascending further into the Columbia Hills, Spirit encountered a rocky outcrop named Clovis. The Fe-oxyhydroxide goethite (FeOOH) is clearly identified in Mössbauer spectra of Clovis obtained from the unaltered rock surface and from interior rock exposed by grinding. Mössbauer spectra of surrounding outcrop rocks also show evidence of Goethite. The identification of the mineral goethite provides the first direct evidence of water interaction at the surface inside Gusev crater.

[1] Morris R. V. et al. (2004) *Science*, 305, 833-836. [2] Gellert R. et al. (2004) *Science*, 305, 829-832.