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Along the traverses of Mars Exploration Rovers Spirit and Opportunity: Chemical compositions derived by the Alpha Particle X-Ray Spectrometer

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For more than two years, the Mars Exploration Rovers have been working on the surface of Mars to explore the geochemistry along their traverse. Attached to the rover's arm, there are three instruments and one sample preparation tool: Alpha Particle X-Ray Spectrometer (APXS) for chemistry [1], Mössbauer Spectrometer (MB) for iron mineralogy, Microscopic Imager (MI) for texture, and Rock Abrasion Tool (RAT) for brushing and grinding. Chemical compositions of surface soils are very similar along both rover traverses supporting the hypothesis of a global dust mixing model [2]. However, at Gusev a large dune field visible from orbit, called 'El Dorado', was recently investigated. Its chemical composition was found to be different than other soils. It might indicate a local input of surrounding rocks. While all float rocks on the Gusev plains are primitive basalts [2] the chemistry in the Columbia hills shows a remarkable diversity. Rocks and outcrops at West Spur showed enrichments of Mg, S, Cl, and Br indicating aqueous alteration [3]. Higher up in the hills, rocks revealed high abundance of Ca-phosphates by good correlation between Ca and P. Outcrops, dubbed 'Peace', exhibited high Mg sulfate content coexisting with olivine and magnetite identified by MB. This indicated cemented basaltic fragments [4]. Further along the traverse, outcrops with even more different compositions were discovered. The Meridiani samples can be divided into several distinct groups that differ significantly in chemical composition: basaltic soils, iron-rich spherules, and sulfur-rich outcrops [5]. The undisturbed soils, inside and outside of craters, resemble compositions found at Gusev crater. Spherules that have high iron contents mainly in form of hematite as determined by APXS and MB measurements are admixed to the soils. The spherules were found to stem from the sulfate rich outcrops and are released by erosion processes.

The formation of hematite is typically, but not exclusively, an indicator for aqueous activities. When the rover Opportunity climbed into Endurance crater, a stratigraphic sequence of salt-rich silicic sediments was measured with all instruments. Layers of enrichments of a factor of 3 in Cl and a depletion of Mg-sulfates were encountered by the APXS. These findings suggest a formation of the outcrops by the reaction of siliciclastic material with salt-rich brines. Successive evaporation and reworking of the material by aeolian and also ground water processes are indicated. The broad lateral continuity could be verified over several kilometers along the rover traverse [1] Rieder R. et al. (2003) JGR, 108(E12), 8066. [2] Gellert R. et al. (2004) Science, 305, 829. [3] Gellert R. et al. (2006), JGR., 111, in press. [4] Ming D. W. et al. (2006), JGR, in press. [5] Rieder R. et al. (2004) Science, 306, 1746.