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Possible alteration of rocks observed by Chemcam along the traverse to Glenelg in Gale crater on Mars.

Gilles Berger (1), Diana Blaney (2), John Bridges (3), Agnès Cousin (1), Olivier Forni (1), Olivier Gasnault (1), Jérémie Lasue (1), Nicolas Mangold (4), Sylvestre Maurice (1), Pierre-Yves Meslin (1), Patrick Pinet (1), Claude d'Uston (1), Roger C. Wiens (5), and The MSL ScienceTeam (2)

(1) CNRS, IRAP, Observatoire Midi Pyrénées, Toulouse, France (gilles.berger@irap.omp.eu), (2) JPL, CalTech, Pasadena, USA, (3) University of Leicester, LE1 7RH, UK, (4) Lab. de Planétologie et Géodynamique de Nantes, France, (5) LANL, Los Alamos, NM 87545 USA

The possibility that the rocks and soils along the traverse during the 90 first SOLs have been altered is evaluated through the large number of ChemCam observations and through theoretical considerations on water-rock interactions. ChemCam [1,2] uses laser-induced breakdown spectroscopy (LIBS) to produce atomic emission spectra of small (350-550 μm) observation points on rocks and soils within 7 m of the rover. In the first 90 sols, 359 such observations were made on Mars targets.

LIBS peak ratios, normalized to silica, have been used as a first level quantification tool for the assessment of chemical input or output fluxes. The dust (1st laser shot on 30 to 50 per observation), and the soils and rocks (average of all shots excluding the first five) are evaluated separately. Alkali elements in rocks and soils display a trend towards enriched compositions, and the data do not suggest any sign of leaching of these labile elements. Alkaline earth elements have sporadic high Ca values, but are significantly depleted in rocks enriched in alkali elements.
The peak ratios Al494+496/Si288 and (Fe438+Mg285)/Si288 have been converted to approximate element ratios and highlights the distinction between felsic and mafic mineral constituents. A felsic end-member having the composition of andesine has been identified. Rocks also display incursions towards either a silica-rich composition or a trend showing Fe+Mg enrichment, the latter may indicate a contribution of oxide phases.

We also modeled the alteration of a mixture of olivine, andesine and pyroxene, with the addition of 10% K-feldspar as suggested by the K content encountered at Gale, by a numerical simulator with realistic kinetic constraints [3]. The alteration is assumed to be driven by fluids from acidic composition assuming a SO_3-rich atmosphere.

The results suggest sporadic evaporations of a Ca-enriched fluid in the soils, not an intensive alteration of the soils as suspected elsewhere on Mars [5]. For rocks, the few silica-rich spots are more problematic and local Ca-rich salt contamination may also be envisaged rather than a strong leaching which is not reflected in the alkali content of rocks. However, the slight alteration of the mafic constituents into oxides and nontronite remains perhaps possible in rocks, although no sign of alteration is detected in the neighboring soils. Given the likely volcanic context, such a partial alteration of the mafic constituents and the precipitation of Si- and Ca-rich phase may be consistent with an early, local and ephemeral alteration stage by the degassing volatiles affected these rocks during or just after their formation, as suggested by [6], making the alteration history of the local rocks different from the soils.

Reference: [1] Wiens R. C. et al. (2012) Spa. Sci. Rev., doi:10.1007/S11214-012-9902-4. [2] Maurice S. et al. (2012) Spa. Sci. Rev., doi:10.1007/s11214-012-9912-2. [3] Berger G. et al. (2009) Amer. Min., 94, 1279-1282. [4] Hurowitz J. A. et al. (2006) J.G.R., doi:10.1029 /2005JE002515. [4] Ehlmann B. L. et al. (2012) Space Sci. rev., doi: 10.1007/s11214-012-9930-0. [5] Meunier A. et al. (2010) Nature Geoscience, doi: 10.1038/NGEO1572.