POSSIBLE ALTERATION OF ROCKS OBSERVED BY CHEMCAM ALONG THE TRAVERSE TO GLENELG IN GALE CRATER ON MARS

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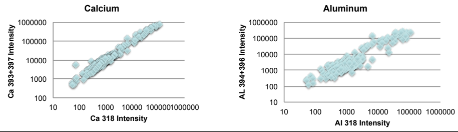
Introduction:

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.

Method: 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.

Choice of the line: example

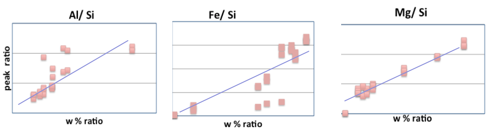


Bulk chemistry:

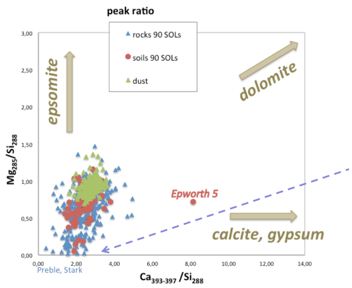
Alkaline earth elements have sporadic values radically enriched in Ca suggesting the presence of a non silicate Ca-phase and the rocks enriched in alkali elements are depleted in Ca and Mg.

Alkali elements in rocks and soils display a trend towards enriched compositions consistent with the alkali feature of rocks such as Jake Matijevic [3], unusual for Martian basalts, but confirmed by APXS analyses [4].

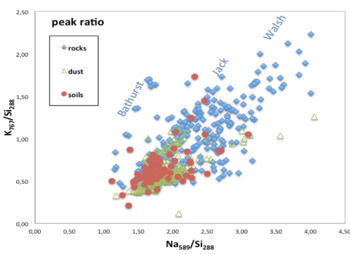
On-board calibration



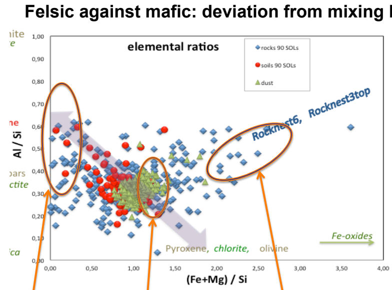
Peak ratios ($Al_{494+496}/Si_{288}$ and $(Fe_{438}+Mg_{285})/Si_{288}$) have been converted to approximate element ratios



No leaching of labile elements

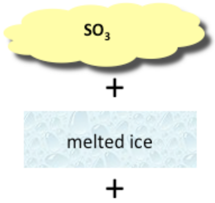


Felsic against mafic: deviation from mixing line

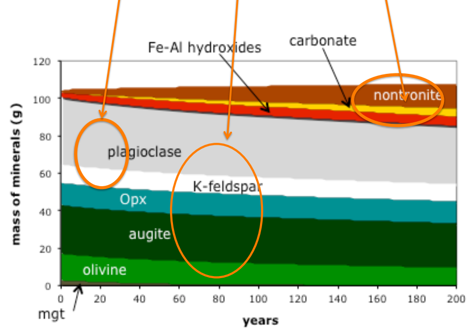


Modeling:

Here we modeled a short-term alteration at low temperature of a mineral mixture representative of the composition encountered at Gale, using the JChess simulator [6] with realistic kinetic constraints. We tested acid brines [8] (H_2SO_4 brines, in the continuation of [9], assuming a SO_2-rich atmosphere [10]) to near-neutral solutions. The best fit is obtained with weakly acid solutions: olivine and magnetite feed the precipitation of a mixture of Fe,Al-oxyhydroxides and nontronite, the composition of which corresponds to the observed trend in rocks.



Olivine (Fo_{50}):	13 %
andesine:	34 %
augite (diop.-hedenb.):	25 %
Opx (enst.-ferrosil.):	11 %
Magnetite:	6 %
K-felspar:	10 %



Interpretation:

- These results, compared to the absence of clays, sulfate or other hydrated alteration phases in the scooped soil analyzed by CheMin, suggest that the Ca-rich spots observed in several soils, as well as the silica rich compositions encountered [7] at Rocknest, may result instead from the sporadic evaporation of a Ca-enriched fluid and not from an intensive alteration of the soils as suspected elsewhere on Mars [11].
- For rocks, the slight alteration of the mafic rock constituents into oxides and nontronite remains perhaps possible, as modeled here, although no sign of alteration is detected in the neighboring soils. Given the likely volcanic context for some of the analyzed rocks [12], such a partial alteration of the mafic constituents may suggest an early, local and ephemeral alteration during or just after their formation, as suggested by [13], 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] Cousin A. et al. (2013) this meeting. [4] Stopler. E. et al. (2013) this meeting. [5] Blake D. et al. (2013) this meeting. [6] Van der Lee J. and De Windt L. (2002) Ecole des Mines de Paris, France. [7] Clegg S. et al. (2013) this meeting. [8] Hurowitz J. A. et al. (2006) *J.G.R.*, doi:10.1029 /2005JE002515. [9] Berger G. et al. (2009) *Amer. Min.*, *94*, 1279-1282. [10] Halevy I. et al. (2007) *Science*, doi: 10.1126/science.1147039. [11] Ehlmann B. L. et al. (2012) *Space Sci. rev.*, doi: 10.1007/s11214-012-9930-0. [12] Sauter V. et al. (2013) this meeting. [13] Meunier A. et al. (2012) *Nature Geoscience*, doi: 10.1038/NGEO1572.