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# Hydrogen in soils and dust as observed in ChemCam spectra at Gale Crater, Mars.

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The NASA Mars Science Laboratory (MSL) rover Curiosity includes the ChemCam instrument to provide elemental analysis of soils and rocks, with the first Laser-Induced Breakdown Spectroscopy (LIBS) instrument ever used on a planetary mission. It is combined with a Remote Micro-Imager (RMI), enabling pre- and post-LIBS context images of the target. For LIBS, radiation from a high power laser (Nd:KGW with 1067 nm, 8 - 14 mJ on the target) is focused onto the sample where material is ablated and a luminous plasma is produced. Information on the elemental composition is obtained from relaxation of excited atoms and ions due to specific transitions coming along with characteristic spectral lines. Moreover, bremsstrahlung and recombination from unbound states result in a continuous spectrum superimposed upon the characteristic emission. At the edge of the visible to NIR wavelength range, where the most intense hydrogen peak (H$\alpha$ at 656.5 nm) is found, this continuous emission can prevent the detection of less intense emission lines and has to be carefully taken into account. In ChemCam data, the H emission feature is usually overlapped by a C peak at 658.0 nm that is present with almost constant intensity in all the LIBS data due to the $CO_2$-dominated atmosphere on Mars. To investigate variations of the H signal, univariate analysis was used to compare the abundance of each element to the area of these peaks.

In this study, the H emission signal in LIBS spectra of martian soils and dust on rocks is investigated. The focus will be on ChemCam data taken on Sol 74 of a fine-grained soil named Crestaurum, where spectra were obtained as usual during day and for comparison additionally during early martian day before dawn. Intense H lines were observed in the spectra, slightly decreasing in intensity with shot number and featuring enhanced values for some single shot spectra The H signal remains more intense than the nonvarying C peak for the daytime data as well as for the pre-dawn data. In comparison, H emission strongly decreases after the first shots in ChemCam spectra obtained from rocks, likely due to a signal from the overlaying dust layer. No significant difference in H peak intensity was found in the ChemCam spectra measured during the day compared to those measured before dawn.

ChemCam is capable of detecting H in martian targets, which could be either due to bound or adsorbed water. So far only qualitative trends in intensity of the H signal when drilling into a target can be obtained. Further work will focus on laboratory calibration of the H peak, enhanced databases with additional samples, and comparison to multivariate approaches such as independent component analysis.