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Introduction: The ChemCam instrument on the Mars Science Laboratory (MSL) Rover *Curiosity* contains an integrated remote laser-induced breakdown spectrometer (LIBS) and a remote micro-imager (RMI).[1, 2] The LIBS instrument is fundamentally an elemental analysis tool that probes samples up to 7 m from the rover mast. Through the first 360 sols, the ChemCam instrument has recorded <100,000 individual LIBS spectra of Martian rocks and soils. These ChemCam observations have quantitatively documented a broad distribution of geologic materials including felsic rocks, mafic soils [3], magnesium rich ridges [4], calcium sulfate veins [5], and fluorite and fluorapatite [6].

Consequently, the ChemCam team completed an extensive expansion of the calibration database. The ChemCam flight model was originally calibrated with 66 geochemical standards prior to rover integration. A replica of the ChemCam flight model in the Los Alamos National Laboratory (LANL) LIBS User Facility was used to collect spectra from a diverse set of 482 geochemical standards. These new spectra have been used to generate new calibration models that more accurately represent the geochemical diversity observed on Mars.

Experimental: The ChemCam instrument focuses a 1067 nm Nd:KGW laser to ablate material from the surface of the Martian rocks and soils. The investigations on Mars used between 9 mJ/pulse (< 3 m) and 14 mJ/pulse (>3 m) on target to generate the plasma from which the elemental compositions are extracted. These spectra are pre-processed as described by Wiens et al [7] including background subtraction, denoising, continuum removal, spectral recalibration, and normalization to produce spectra represented in Figure 1.

The ChemCam team carefully characterized the LANL testbed such that these spectra could be used to generate new elemental calibration models. These experiments were conducted with 14 mJ/pulse focused to a 250 µm spot size on samples 1.5 m away in 7 Torr CO_2 to simulate the Martian surface pressure.

Quantitative elemental compositions are extracted from ChemCam LIBS spectra using either a Partial Least Squares (PLS1) multivariate analysis [7, 8] or by univariate analysis [9]. The elemental compositions of the 482 standards will be integrated into an individual PLS1 model for each element detected by ChemCam. The new standards included in this database were pro-

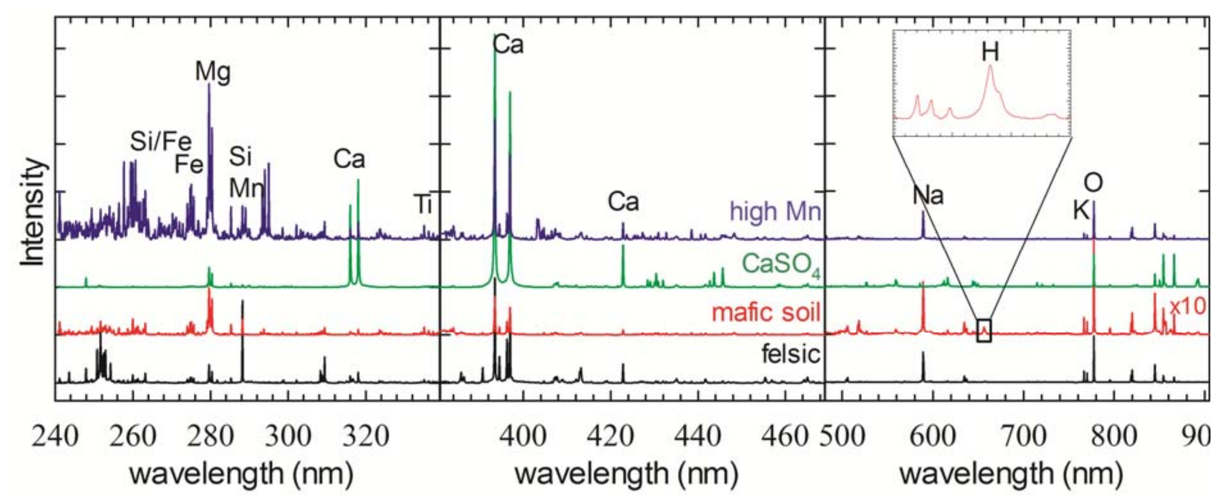

Figure 1: ChemCam spectra representing some of the observed geologic diversity. The high Mn spectrum was observed from Caribou (ccam1342, blue). The $CaSO_4$ rich spectrum was from one of the Rapitan veins (ccam1135, green). Epworth (ccam2072, red) was a soil in the Rocknest region that produced a persistent H signature. Link (ccam2027, black) was a felsic rock.

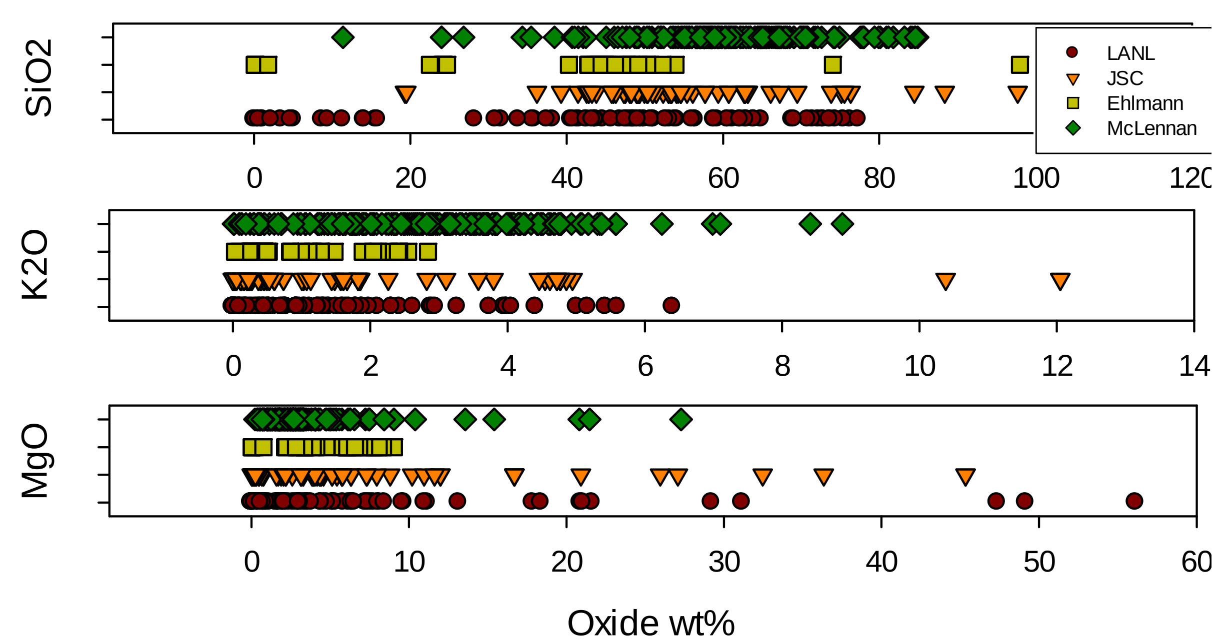

Figure 2: The distribution of elemental compositions for three of the major elements. The LANL data (red circles) represent the standards in the original database. The standards from Morris (JSC, orange triangles), Ehlmann (CIT, yellow squares) and McLennan (SBU, green diamonds) are new contributions to the database.

vided by many of the coauthors including Dyar (igneous samples), Morris (samples used to cross calibrate Pathfinder and MER instruments), Ehlmann (alkali-rich and aqueously altered igneous rocks, basalt+salt/oxides mixtures) [10], and McLennan (sedimentary).

Discussion: The ChemCam instrument was used to routinely probe samples along the traverse from the Bradbury Rise (BR) landing site into Yellowknife Bay (YKB). Analyses around BR were generally igneous and the original calibration database was sufficient for most observations. In contrast, the samples observed in YKB were sedimentary and the original ChemCam calibration database included only a limited number of sedimentary samples.[11] This new ChemCam database was created in order to better represent the types of samples observed in YKB as well as the types of samples *Curiosity* is likely to encounter on Mount Sharp.

ChemCam and APXS analyzed alkali-rich targets such as *Jake M* where the Na_2O and K_2O concentrations were larger than the range included in the original database.[12] New samples were added to extend the Na_2O and K_2O compositional range as depicted in Figure 2 to better match these ChemCam observations. ChemCam has also observed many silica-rich and alkali-rich feldspars on the traverse.[3] Many of the new database samples extend the SiO_2 composition range (Fig. 2) to more accurately represent these feldspar observations. The sedimentary samples provided by McLennan have been incorporated into the model to provide samples that are representative of the YKB sedimentary observations including the MgO-rich ridges.[4] Finally, the Morris samples were included in the model as they were characterized and analyzed by Pathfinder and MER instruments.

Conclusion:

This new ChemCam database was designed to better represent the diverse geochemical observations made in the first 360 sols and improve the geochemical uncertainties. The initial implementation of this new database would use all of the samples in a single *universal* model. However, independent igneous and sedimentary models will also be generated as we enter regions such as YKB where a specific geochemical model would be most applicable.

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