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Chemical diversity of diagenetic features analyzed by ChemCam at Gale crater, Mars

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The Curiosity rover has covered 18 km of the surface of Mars in >1900 sols (Martian days) since its landing in Gale crater. Since sol 750, the rover has been observing mudstones and fine-grained sandstones of the Murray formation, marking the base of the Mt. Sharp (also known as Aeolis Mons) and interpreted to be predominantly lacustrine deposits. A diversity of diagenetic features have been observed in these mudstones using the ChemCam instrument, which consists of of a Laser-Induced Breakdown Spectrometer (LIBS) providing elemental chemistry at a scale of ∼0.5 mm coupled with a Remote Micro-Imager (RMI). Diagenetic features analyzed include Ca-sulfates veins with local enrichment in Cl on their shoulders, dark veins enriched in fluorine and manganese, Mg- or Fe-sulfate concretions, Si-rich halos, and Mg-P-Fe rich dark concretions and fillings. Among those features, diagenetic Ca-sulfate veins are the most ubiquitous. These veins have been consistently observed in all geological units crossed by the rover, and represent a regional late-stage episode of fluid circulation. They consist of light-toned veins crossing mudstones and overlying sandstones orthogonally to the laminations, with some occurrence of subhorizontal fillings. They are formed as bassanite predominantly, as suggested by their hydrogen signal. These veins display local variations in chemistry. Local Fe enrichments were reported near the Naukluft Plateau (sol ∼1200-1400) suggest oxidizing and potentially acidic fluid conditions while dark-toned inclusions in veins near the Old Soaker outcrop (sol ∼1500-1600), enriched in Fe, Mn and P, hinted at a more reduced environment of formation. On sol 1800, the rover reached a local topographic high known as Vera Rubin Ridge (VRR) is characterized by a hematite signature in orbital spectra. Recent observations from ChemCam did not show an increase in bulk FeO abundance in the host rock, but instead highlighted sporadic, anomalously high Fe detections (>30 wt.% FeOT) often linked to grey patches within large veins, thus likely of diagenetic origin. ChemCam passive reflectance spectra do not (or only weakly) show ferric absorptions associated with these features (535 nm band, downturn after 750 nm), contrasting with typical spectra associated with VRR host rocks. Overall, these observations highlight the role played by ground water circulation and variation in diagenetic processes in the sedimentary rocks studied. Variations in Fe-abundance also highlight the mobility and distribution of this redox sensitive element helping to understand the redox conditions that prevailed within these lacustrine sediments.