AN UPDATE ON MARTIAN DUST COVERAGE AND CONTRIBUTION TO APXS ELEMENTAL CONCENTRATION AND BEDROCK COMPOSITION FOR ROCK TARGETS IN GALE CRATER . T.L.J. Henley[1]. M.E. Schmidt[2], S.L. Bray[3], J.J. Zheng[4]. Earth Sci, Brock Univ, St. Catharines, ON L2S 3A1, Canada, th18is@brocku.ca

Introduction: Airfall dust (1.3-1.7 µm) is widespread on the Mars surface and hinders our ability to interpret the textural and geochemical properties of rock targets analyzed by the Mars Science Laboratory (MSL) Curiosity rover. The Alpha Particle X-ray spectrometer (APXS) measures elemental abundances in the outermost 2-200 µm of soil and rock surfaces [1] making it more susceptible to dust, particularly affected are the lighter elements (Na, Mg) and volatiles (S, Cl), which are enriched in the dust [2]. Rock surfaces observed in Gale may be brushed by the Dust Removal Tool (DRT), but it does not completely remove dust [3]. ChemCam utilizes Laser Induced Breakdown Spectroscopy (LIBS) to gradually ablate into target surfaces with a secondary effect of unevenly moving dust away from the laser point [4]. Yet, the dust is discontinuous and bedrock characteristics are always discernable, even for the dustiest rockfig targets.

To address the effect of dust on APXS, we use Mars Hand Lens Imager (MAHLI) images to estimate dust coverages and have found correlations with elemental concentrations [1]. We here present recent results up to sol 2471. We additionally estimate areal coverages of Ca-sulfate veins and their contributions to bedrock chemistry. We focus here on a comparison between the Sheepbed mudstone (Yellowknife Bay) and Blunts Point Member of the Murray formation (Vera Rubin Ridge).

Methodology: Adapted from methods detailed by [1], MAHLI images of APXS targets were used to analyze dust coverages, vein abundance, and bedrock composition. Focus merge images were opened in a free online photo-editor called BeFunky.com [5]. The image was sharpened and enhanced to greater enhance the visual contrast between dust and bedrock. If shadows were present in the image, such as the cast by the rover's arm, they were removed during the initial editing process. After editing, the *Replace Color* in Adobe Photoshop was used to gradually replace every colour value of dust with white and bedrock material with black. The same process was performed again to target vein material. ImageJ was next used to convert the image to 8-bit greyscale and the *Threshold* tool was used to target the now white dust pixels. The percent dust coverage were determined within a 1.7 cm-diameter circle centered on the MAHLI image to represent the APXS Field of View (FOV). APXS chemical abundances and dust coverage were then compared to estimate dust-free bedrock composition by mass balance. APXS placement, including horizontal position relative to the MAHLI image as well as vertical standoff distance contribute uncertainty [6].

Results: Analysis of 613 rock targets (to sol 2833) was performed to understand dust behaviour on the surface of Mars, as well as its influence on APXS data. Of the 613 targets, 341 are 'As Is' (i.e., not brushed by the DRT), 178 DRT, and 93 were targeted by the Chem-Cam prior to analysis (Fig. 1). As-Is targets ranged in dust coverage from 0.2% to 79.1% with a median value of 37.4%. DRT targets ranged from 1.2% to 60.9% with a median value of 24.0%. Chem-Cam targets had dust coverages that ranged from 1.3% to 67.9% with a median value of 31.4%. These results demonstrate how the Chem-Cam is not an effective dust-clearing tool.

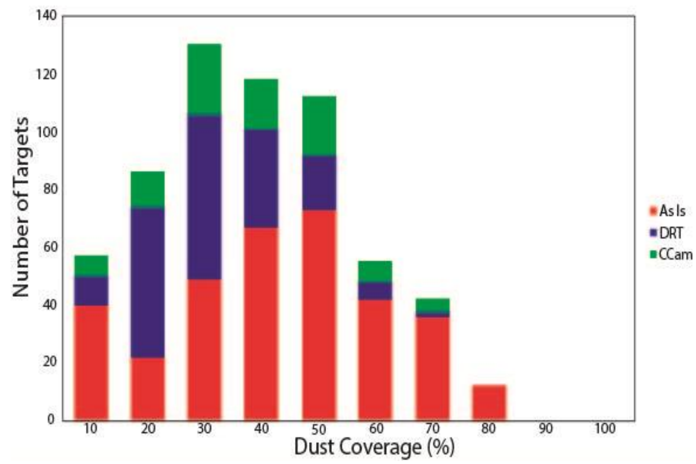

Fig. 1. Distribution of all analyzed rock targets, separated into 'As Is', DRT, and Chem-Cam targets.

Dust Coverage Abundance: The measured dust coverage abundances of 'As Is' targets throughout the Mars Curiosity Rover mission (Fig 2.) are found to be decreasing with time. From the analyzed rock targets, the 'As Is' targets from sols 0-999 had a median dust coverage of 48.1%. 'As Is' rock targets from sols 1000-1999 had a median dust coverage of 35.7% and 34.7% for rock targets between 2000-2833.

Comparison with APXS: The Sheepbed mudstone (sols 129-291) and the Blunts Point member of the Murray formation are compared by plotting determined dust coverages against the elemental concentrations of MgO and SO_3 (Fig. 3). Earlier work has demonstrated that the Sheepbed mudstone is relatively homogenous and exhibits clear correlations between the dust coverage and bed-rock compositions [4]. In contrast, MgO and SO_3 in Blunts Points rock do not correlate

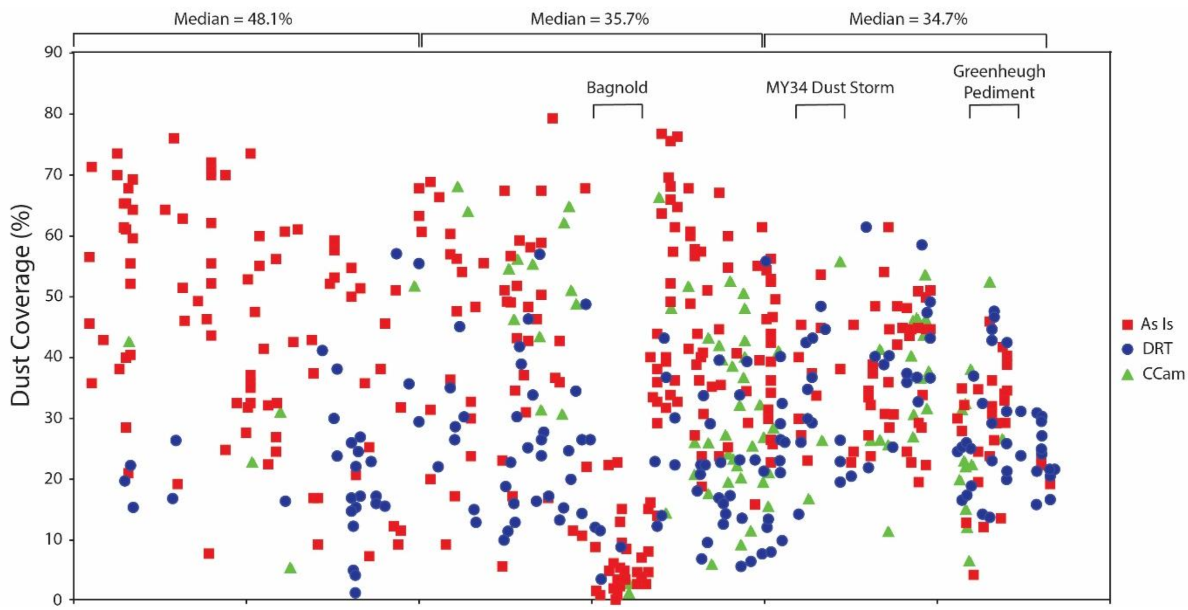

Fig. 2. Measured dust coverage (%) of all analyzed targets plotted against the target's corresponding sol. Median values for sols 0-999, 1000-1999 and 2000-2833 are labeled above their corresponding points. Targets of significantly lower dust coverages (Bagnold and Greenheugh Pediment targets) and the mars year 34 (MY34) dust storm [9] are also labeled.

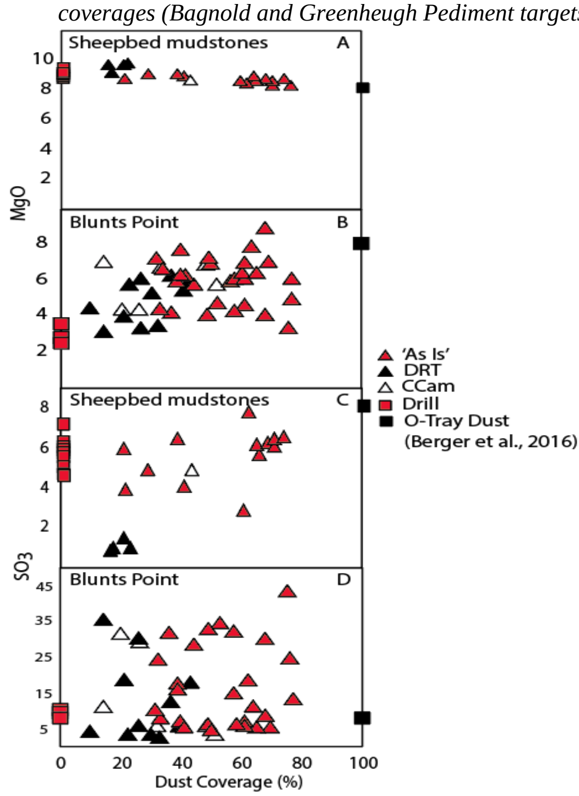

Fig 3. Measured dust coverage plotted against compositions as measured by APXS. A and C: Sheepbed mudstones MgO and SO_3 (wt%) vs. Dust Coverage %, B and D: Blunts Points Targets MgO and So_3 (wt%) vs Dust Coverage %.

with dust coverage, even when taking Ca-sulfate veins into account. The Blunts Points is much more varied in composition than Sheepbed and SO_3 occurs within the bedrock as either a primary precipitate, detrital grains, or as a later cement [7, 8].

Conclusions: Although rock target measurements of dust abundance are found to be declining, it is so abundant on the Mars surface. It is important that it be continually be taken into account when analyzing data collected by Curiosity and in the future with Perseverance. Dust noticeably impacted all APXS targets, including those that were cleared by the DRT and Chem-Cam.

While contributions from dust and veins are significant in APXS rock targets, we here demonstrate how this accounts for only some of the variability for some rock groups, including the Blunts Point member of the Murray formation. For other, more uniform groups, such as the Sheepbed mudstone, dust and veins may account for the majority of the compositional variability.

Acknowledgements: This work was supported by a Canadian Space Agency MSL Participating Scientist grant to Mariek Schmidt

References: [1] Schmidt, M.E. et al. (2018) JGR 123, 1649-1673. [2] Berger, J.A. et al. (2016) Geophys. Res. Lett. 43, 67–75. [3] Davis, K et al. (2012) Aerospace Mechanisms Symposium, 41 [4] Schmidt, M.E. et al. (2014) JGR 19, 1-18. [5] Befunky.com, https://www.befunky.com/features/photo-editor/ [6] Bray, S.L. et al., (2017) LPSC 1670. [7] Van Bommel S.J. et al., (2017) LPSC 1630. [8] Thompson et al. (2020) this meeting. [9] Guzewich et al. (2018) Geophs. Res. Lett. 46, 71-79.