# COMPARISON OF EOLIAN DUST COMPOSITION AT GALE AND JEZERO

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**Introduction:** On February 18th 2021, the NASA Perseverance rover landed at Jezero crater, Mars, a 50 km Noachian-aged lake system located on the western side of the Isidis impact structure. The geomorphology of the crater indicates the past presence of a fluvial delta with associated inlet and outlet valleys and infrared observations from orbit have detected the presence of carbonates, mafic and hydrated minerals [1]. Since its arrival at the Octavia E. Butler landing site, the rover has explored about 7 km away from its initial landing position and has analyzed the local bedrocks [2] and soils [3, 4] surrounding it.

**Instruments:** Located on the top of the mast of the Perseverance rover is SuperCam, a multi-techniques remote sensing instrument able to acquire high resolution color images, passive visible/near-infrared, laser-induced breakdown spectroscopy (LIBS) and Raman spectra, and including also a microphone [5, 6]. The LIBS technique is similar to the one used by ChemCam onboard the Curiosity rover, which has been exploring Gale crater since 2012: a series of 30 powerful laser pulses at 1064 nm ablates targets at a distance of few meters, inducing a plasma spark, the light of which is analyzed by spectroscopy to determine its elemental composition (e.g. [7]).

During such an analysis, the spectra obtained from the first five laser shots at each location are contaminated by dust deposited on the surface of the rock targets [8] and these spectra are usually removed from further analysis [9]. These spectra present a very homogeneous composition that is different from those of the underlying targets and from those of the surface of 'fresh' targets such as abraded patches or drill hole walls. As such, they have been interpreted to represent an analysis of eolian dust deposited over time on the surface of Mars [10].

In this study, we compare the spectral results obtained with the SuperCam first shots on the targets analyzed at Jezero crater with the average first shot spectra obtained by ChemCam on the rock targets at Gale Crater to determine to which extent the spectra correspond to a global eolian dust cover or to local material contributions.

**Method:** We have used all the LIBS first shot spectra acquired since the landing of Perseverance over the first 300 sols of the mission on targets that were not disturbed by the rover operations. Therefore, abraded targets, drill holes and calibration targets have been removed from the analysis. This corresponds to ~1300 different spectra processed by denoising, background removal, wavelength calibration, and correction for instrument response [9]. The average spectrum obtained from these data can then be appropriately compared with the average first shot spectrum obtained by ChemCam at Gale crater, which was built over 1500 sols (~ 8500 spectra) [10].

There is about an order of magnitude difference between the number of first shots spectra acquired by SuperCam and ChemCam at this time, so we can expect the SuperCam results to be less representative than the ChemCam ones, but averaging more than 1000 spectra should already give reasonable statistics for each instrument.

**Results:** After normalizing the spectra to their total intensity, it is possible to superpose them as shown in Figure 1. The first shots average LIBS spectra superposition indicates strong similarities in major element compositions The only disparity comes from stronger Mg and Ca lines in the SuperCam signal, which are possibly due to a contribution from local rocks and soils, as Ca-rich pyroxene and olivine have been detected amongst the local rocks minerals [2, 11, 12]. The alkali do not present very strong differences. The minor elements, such as H (highlighted in Figure 1), Li, Mn, Cr, also present peaks with intensities similar to the ones detected on the ChemCam spectra, indicating a similar level of hydration and minor elements contents of the dust fraction at Jezero and at Gale. The H content also appears related with the presence of alteration coatings on the surface of rocks at Jezero [13].

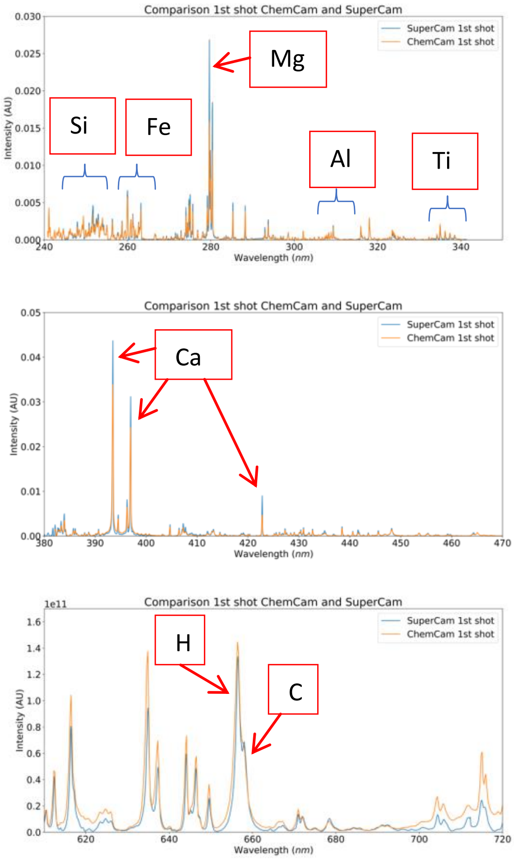


**Figure 1:** Comparison of average first shots LIBS spectra of ChemCam at Gale Crater ([10] in red) and average first shots LIBS spectra of SuperCam at Jezero Crater (in blue). A) UV range, B) blue-violet range, C) Orange range with H emission line comparison.

While the rocks analyzed by SuperCam at Jezero crater appear visually to be less covered by dust than the ones seen at Gale crater, our analysis indicates that the rocks studied at Jezero remain covered by a thin layer of homogeneous material similar in composition to the eolian deposited dust. This result is consistent with a global mixing of the eolian dust cover on Mars, or possibly a single origin for the eolian dust on Mars as proposed in previous studies (e.g. [14, 15]).

**Relationship with local soils at Jezero:** Comparison between the spectra of Jezero soils and eolian dust indicates a composition close to the fine-grained soils (grain size < 1 mm, e.g. Sei sol 84, Fig. 2 top) but significantly different than the coarse-grained soils (grain size > 1 mm, e.g. A_Koo sol 72, Fig. 2 bottom) with an elevated content in Ti for the fine-grained soils and dust and an increase in Fe and Mg content in the coarse-grained soils (also shown in [3]) that could be linked to the local contribution by comminution of local rocks. H content is more elevated in the fine-grained soils, at the same level as seen for the eolian dust.

**Conclusions:** The average of the first LIBS shot spectra acquired by SuperCam at Jezero crater compare very well with the average spectrum of ChemCam's first shots at Gale crater. The intensity and ratios of the emission lines in the two average spectra are very similar confirming the probable global mixing of the eolian dust deposited all over the surface of Mars. Some differences in Fe, Mg and Ca content could be due to local contributions by high Ca-pyroxene and olivine detected at Jezero.

Additional constraints might be obtained using passive infrared spectra acquired before the LIBS shots. Further analysis of this global extremely fine material will be available in the laboratory since any sample collected by the mission and returned to Earth will provide some amount of eolian dust cover on the surface of the bedrocks and since regolith samples will also be acquired. This will enable critical additional information about this global dust phase, and its implications for past climate, surface processes, and future exploration

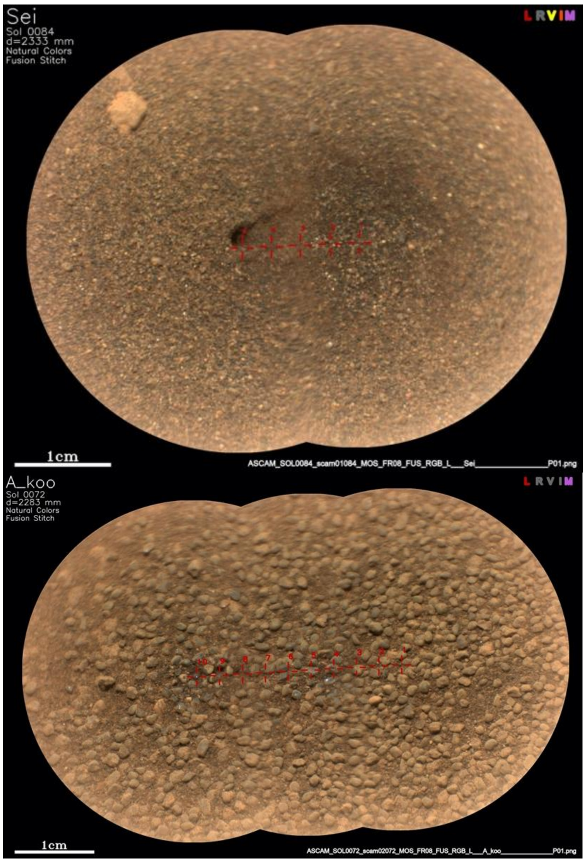


**Figure 2:** RMI mosaic of fine-grained soil Sei (sol 84) and coarse-grained soil A_Koo (sol 72).

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