

MINERAL DIVERSITY OF LIGHT-TONED FLOAT ROCKS IN JEZERO CRATER AS SEEN BY SUPER-CAM. C. Royer^{1,*}, C. C. Bedford², R. C. Wiens², J. R. Johnson³, B. H. Horgan², A. Broz², O. Forni⁴, S. Connell², L. Mandon⁵, J. M. Madariaga⁶, E. Dehouck⁷, R. B. Anderson⁸, P. Beck⁵, É. Clavé⁹, E. Cloutis¹⁰, T. Fouchet¹¹, T. S. J. Gabriel⁸, A. Klidas², H. T. Manelski², A. M. Ollila¹², S. Schröder⁹, U. Wolf¹², A. Cousin⁴ and S. Maurice⁴, ¹IAS, Orsay, France, ²EAPS, Purdue Univ., West Lafayette, IN, USA, ³JHUAPL, Laurel, MD, USA, ⁴IRAP, Toulouse, France, ⁵IPAG, Grenoble, France, ⁶Univ. of Basque Country, Leioa, Spain, ⁷Univ. de Lyon, Lyon, France, ⁸USGS, Flagstaff, AZ, USA, ⁹DLR, Berlin, Germany, ¹⁰Univ. of Winnipeg, Winnipeg, MA, Canada, ¹¹LESIA, Meudon, France, ¹²LANL, Los Alamos, NM, USA, *clement.royer@universite-paris-saclay.fr.

Introduction: During its traverse across Jezero Crater, from the floor up to the rim, the *Perseverance* rover encountered > 4000 light-toned float (LTF) rocks – of variable size (up to ~ 50 cm) scattered on the ground without apparent connection to the surrounding stratigraphy [1]. Analysis performed using the SuperCam instrument's [2–4] Laser Induced Breakdown Spectroscopy (LIBS) revealed a high concentration of Al, Cr, Ti and Ni [5, 6], and very low of Fe, Mg, Ca and Na [5, 7]. SuperCam's infrared reflectance spectroscopy (IRS, between 1.3 and 2.6 μm) showed the presence of Al-rich aqueous alteration minerals (characteristic absorption bands of kaolinite and Al-smectites at 1.4 and 2.2 μm) as well as some (likely Cr-) spinels, identified through their broad asymmetric 2 μm band, responsible for the concavity of IR spectra. Here, we present the results of analyzing 26 light-toned float rocks, up to Sol 1323. In total, 30 LTFs have been observed by SuperCam but 4 are ignored in this study: Lake Clark and Ikatan Bay because of their heavy coating making the comparison with other LTFs harder, and Atoko Point and Mallard Lake because, although light-toned, they are poorly altered and mainly felsic in composition.

Method: In this study, we use the LIBS and IR spectroscopy data returned by SuperCam to take advantage of the synergy offered by these two techniques. The data were calibrated in elemental abundances [8] and reflectance [9], respectively. In the IR, the characteristic absorption bands of minerals at 1.4 μm (OH), 1.9 (H_2O) and 2.2 μm (Al/Si-OH) are modeled using a sum of Gaussians on spectra from which the continuum has been subtracted. This method allows for precise determination of the position and depth of the band, as well as the band depth-to-noise ratio (BDNR) quantifying the measurement quality.

Results: The LTFs studied exhibit significant compositional and spectral diversity, and can be divided into three main categories: 1) rocks rich in SiO_2 and poor in Al_2O_3 (shown in pink in Fig. 1), whose IR spectrum is consistent with the presence of weakly hydrated silica in varying proportions: high in AEGIS 910A (see [10, 11]), lower and mixed with Fe/Mg-rich phyllosilicates in the others (Fig. 1E, F). 2) Rocks rich

in Al_2O_3 and SiO_2 , particularly depleted in other elements, displaying deep absorption bands at 1.4 and 2.2 μm (in blue and green). Among these, some stand out due to the presence of absorption doublets at 1.4 and/or 2.2 μm , making them particularly interesting candidates for the presence of kaolinite (in blue: Chignik, Buffalo Creek, Pearl Falls, and Flett Glacier). Finally, 3) rocks rich in Al_2O_3 and SiO_2 but weakly hydrated (in orange and red). The IR spectra of these rocks show a negative slope and slight concavity, compatible with the presence of spinel (most pronounced in Dolgoi Island), a mineral formed at high temperatures and resistant to aqueous alteration. The spectral modeling of the LTFs, described in [1], shows that their mineral assemblage is composed of a mixture of aqueous alteration phases rich in aluminum (kaolinite, montmorillonite) but also hydrated silica, spinel, and a fraction of sulfates.

Discussion: The modeling of IR spectra of targets with high Al_2O_3 reveals the presence of a wide range of alteration phases associated with high Al-enrichment, but it does not account for the existence of other minerals that do not show signatures in the near-IR, such as glass, anhydrous silicates and aluminosilicates. As such, we cannot rule out their presence. The significant presence of spinel in all observations results from the overall concavity of the spectra, which cannot be explained by alteration minerals like clays and hydroxides. However, this mineral forms at high temperature, and its coexistence with hydrated minerals, stable at low temperature, may appear contradictory. Its presence might indicate a complex formation and evolution process, such as non-uniform heating and partial melting of rocks or alteration of crystalline rocks. Multiple scenarios of formation, alteration, and dispersion within Jezero crater could account for such compositions [1]. The scenario we have considered is divided into three main stages: 1) A primary parent rock (basaltic or felsic) would have undergone intense surface aqueous leaching, progressively removing the most soluble ions (Fe, Mg, Ca, Na, K) and transforming primary minerals into phyllosilicates until forming a kaolinite-rich horizon. 2) An intense thermal episode would have occurred after the alteration profile formation (magmatic intrusion, thick lava flow, impact),

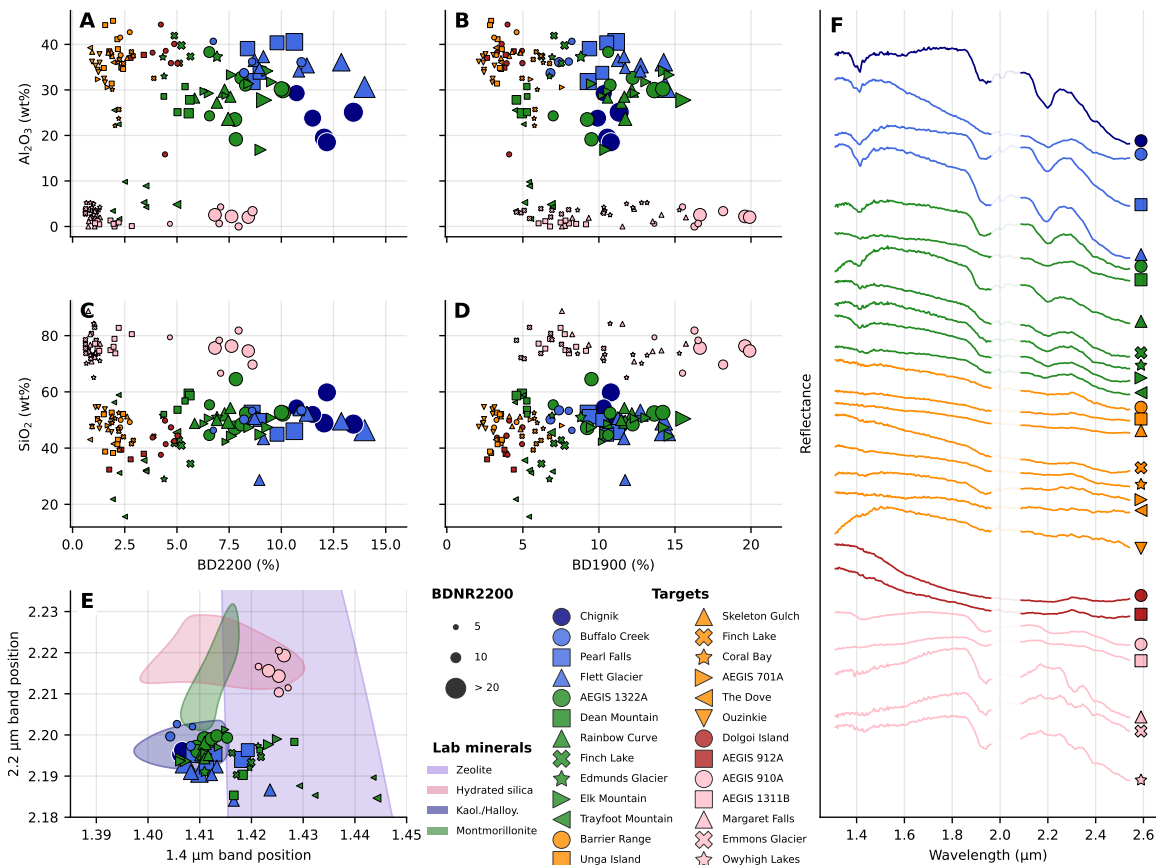


Figure 1 – A-D: LIBS Al_2O_3 and SiO_2 concentrations as a function of 2.2 and 1.9 μm band depth. Points size corresponds to the band depth-to-noise ratio (BDNR) of the 2.2 μm band, a metrics quantifying the quality of its detection. **E:** Band position comparison. Background patches correspond to areas occupied by lab minerals. **F:** Reflectance spectra of studied LTFs. The grayed portion corresponds to atmospheric CO_2 residuals. The marker at the end of each spectrum matches with the other panels.

heating the rocks and leading to their partial dehydration. 3) Finally, erosion or impacts would have fragmented the outcrop, dispersing rock fragments within Jezero, potentially briefly transported by flowing water or ice. In the watershed, several impact craters are associated with kaolinite weathering horizons [12], and light-toned linear features with fractured margins [13] may be potential parent outcrops for these float rocks. The LTFs might also be originated from Jezero crater rim, formed by impact, as supported by the observed accumulation of these rocks in the rim.

Conclusion: These light-toned float rocks stand out among the other rocks and soils comprising Jezero crater. Their exceptionally high Al content marks them as some of the most aqueously altered rocks ever observed *in situ* on Mars, and the evidence of spinel along with indices of dehydration provide insights into a potential complex post-formation evolution, involving heating and impact.

References: [1] Royer C. et al. (2024) *Communications Earth & Environment*, 5(1):1–13. [2] Wiens R. C. et al. (2021) *LPI Contributions*, 52(2548):2. [3] Maurice S. et al. (2021) *Space Science Reviews*, 217(3):47. [4] Fouchet T. et al. (2022) *Icarus*, 373:114773. [5] Forni O. et al. (2024) *Tenth International Conference on Mars, held 22-25 July, 2024 in Pasadena, California and Virtually. LPI Contribution No. 3007, 2024, id.3131, 3007:3131*. [6] Manelski H. (2025) *this meeting*. [7] Bedford C. C. et al. (2024) *55th Lunar and Planetary Science Conference, held 11-15 March, 2024 at The Woodlands, Texas/Virtual. LPI Contribution No. 3040, id.2221, 3040:2221*. [8] Anderson R. B. et al. (2022) *Spectrochimica Acta Part B: Atomic Spectroscopy*, 188:106347. [9] Royer C. et al. (2023) *Journal of Geophysical Research: Planets*, 128(1). [10] Beck P. et al. (2024), 3040:1304. [11] Beck P. (2025) *this meeting*. [12] Carter J. et al. (2015) *Icarus*, 248:373–382. [13] Bramble M. S. et al. (2017) *Icarus*, 293:66–93.