A JOURNEY ACROSS THE TRANSITION BETWEEN THE IGNEOUS SÉÍTAH FLOOR UNIT AND THE DELTA WITH THE MARS2020 SUPERCAM INSTRUMENT AT JEZERO CRATER, MARS O. Beyssac[1], E. Clavé[2], E. Dehouck[3], O. Forni[4], A. Udry[5], P. Beck[6], A. Cousin[4], N. Mangold[7], C. Quantin Nataf[3], C. Royer[8], L. Mandon[9], J.R. Johnson[10], J.I. Simon[11], P.Y. Meslin[4], T. Fouchet[12], S. Le Mouelic[7], C. Pilorget[13], G. Caravaca[4], F. Poulet[13], J. Lasue[4], P. Pilleri[4], A.M. Ollila[14], S. Clegg[14], J.I., Nunez[10], S. Maurice[4], R.C. Wiens[8] [1]IMPMC, Paris, France (olivier.beyssac@upmc.fr) [2]CELIA Bordeaux, France [3]LGLTPE, Lyon, France [4]IRAP, Toulouse, France [5]UNLV, Las Vegas, USA [6]IPAG, Grenoble, France [7]LPG, Nantes, France [8]Purdue University, USA [9]CalTech, Pasadena, USA [10]JHUAPL, Laurel, USA [11]NASA [12]LESIA, Meudon, France [13]IAS, Orsay, France [14]LANL, Los Alamos, USA

Introduction: During the first scientific campaign, Perseverance explored the Jezero crater floor and found two main igneous formations: the basaltic Máaz unit, and Séítah, consisting of an olivine-rich cumulate. Then the rover did a rapid traverse towards the second campaign region, Jezero's delta. Just before reaching the lowest part of the delta, Perseverance encountered the Séítah formation again, with some variability in the degree of alteration. Here, we use the data obtained by the SuperCam instrument to document the structure and texture of rocks at the transition between Séítah and the delta front, its geochemistry and its primary and secondary mineralogy. Then, we discuss the similarities/differences between these rocks and discuss a geological scenario to account for these observations.

The SuperCam instrument: SuperCam analyzes elemental chemistry by LIBS remotely (up to 7 m) and mineralogy by VISIR and Raman spectroscopy of the target. It also provides high-resolution context images with a Remote Micro Imager (RMI). The SuperCam instrument is described by [1] and [2]. LIBS provides a quantitative estimate of major elements present in the fraction of rock ablated by the laser within a ~350 µm wide spot [3], as well as semi-quantitative information on many light and/or minor elements such as H or C. In some rocks, grains are larger than the LIBS spot size making possible single crystal analysis and stoichiometric analysis [4-6]. VISIR spectroscopy has a larger analytical footprint (in the mm range) and generally samples several grains.

Structure and texture: Figure 1 depicts the region of interest with areas investigated by SuperCam.

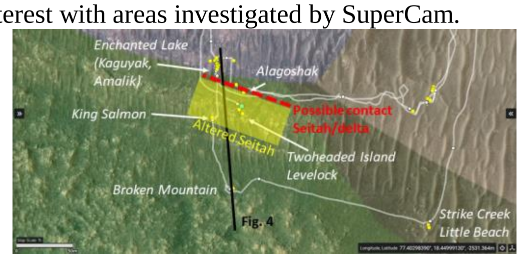

Fig. 1: Region of interest with main targets. Location of Fig. 4 is indicated. Scale bar is 50m.

Figure 2 depicts representative textures along the transect. The igneous Séítah unit outcrops to the south (sols 417-420) and is the lowest exposed crater floor formation visited by the rover. The rocks are massive and dispersed among the regolith ripples. They appear relatively flat although it is hard to define a clear bedding. Texturally, the rocks are granular (mm grains), bearing high similarity with the cumulate texture described for Séítah outcrops explored previously [4,6,7]. The King Salmon group is composed of flat rock exposures gently dipping (a few degrees) towards the north. At King Salmon (sol 421), texture is granular, similar to Séítah, while it is still granular but texturally altered to the north (TwoHeaded Island sol 642). Before reaching the delta sediments, the rover crossed an area filled by regolith with disperse exposures of small ridges forming outcrops: these ridges are composed of granular rocks with 1-2 mm rounded grains (Alagogshak sol 456). Upsection, the delta sediments appear as flat-lying outcrops with a completely different texture composed of fine-grained sandstones with thin planar mm to cm thick layers. Rocks are greyish on vertical faces and more reddish on horizontal faces suggesting the presence of coatings or dust crust.

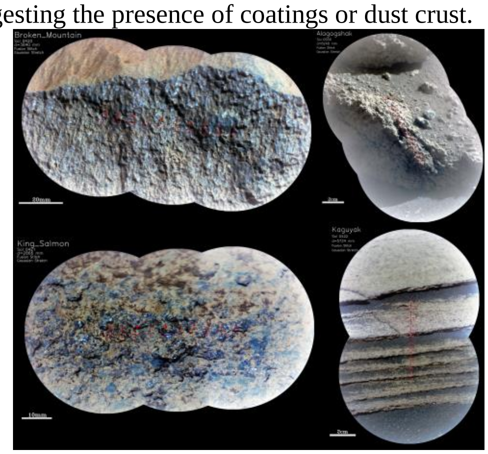

Fig. 2: RMI Gaussian stretched images for Séítah (Broken Mountain), King Salmon, Alagogshak and delta (Kaguyak).

Bulk geochemistry: The Séítah rocks have a bulk composition that is highly similar to the composition of non-altered Séítah at the Bastide and Brac localities (Beyssac et al. subm): high MgO and FeO and low CaO and Al_2O_3. A broadly similar composition is observed for King Salmon with subtle variability due to the presence of carbonates. The lower delta sediments are high in FeO, slightly lower in MgO and have slightly higher Al_2O_3 compared to Séítah and King Salmon.

Mineralogy: LIBS and VISIR suggest the presence of olivine grains in most Séítah rocks, and some LIBS points are very close to pyroxene compositions as analyzed elsewhere in Séítah. These rocks are overall pristine with only local evidence for alteration in LIBS and VISIR data. Olivine is also detected in the King Salmon rocks. Pyroxenes are detected in the King Salmon rocks as well as in the Alagogshak rock with composition consistent with Séítah pyroxenes (Fig. 3). In the lower delta, some LIBS points are consistent with mixtures dominated by olivine with Mg# similar to Séítah (Mg55-74). Some of these points have higher H score suggesting presence of hydrated phases, others not. Pyroxene is detected with a composition consistent with Séítah yet with slightly higher Mg#. In terms of secondary mineralogy, some Séítah rocks and overall the King Salmon rocks show the presence of carbonates with various compositions based on LIBS. In these rocks, VISIR shows locally a strong absorption band at ~2.3 um possibly reflecting the presence of carbonates and/or Mg-rich clays. At Enchanted Lake, the sediments of the Amalik interval depict an intense absorption band at 2.33 µm suggestive of serpentine as discussed by [8].

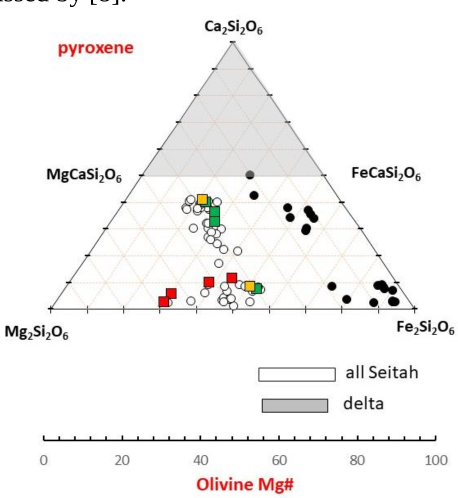

Fig. 3: Top: Pyroxene composition for Séítah (white, from [6]), Máaz (black, from [5]), delta sediments at Enchanted Lake (red), King Salmon rocks (green) and Alagogshak (orange). Bottom: olivine Mg# for all Séítah (data from [6] plus King Salmon) and for possible olivine in mixtures for the delta.

Geological interpretation: Figure 4 depicts a schematic cross-section along the transect. In Séítah, the structure is quite similar to the transect studied closer to the landing site [6]: well preserved primary mineral assemblages with weak alteration for deeper rocks and stronger alteration for the uppermost levels. At King Salmon, alteration seems more intense compared to the Issole region based on the texture of the rocks but also with more carbonates and clay minerals. These altered layers could derive from fluid-rock interactions that may have occurred when Séítah was exposed to the lake before the delta emplacement, which would imply that Séítah was not covered by Máaz in this area at the onset of the lacustrine phase. Alagogshak could be also an altered version of Séítah based on texture; its enrichment in pyroxenes is consistent with its position in the uppermost part of the cumulate series. Alternatively, its granular texture could be interpreted as fine-grained conglomerate (with likely source from Séítah-like material based on bulk rock and pyroxene compositions). The delta sediments at Enchanted Lake have a bulk elemental composition bearing some similarity with Séítah; they also contain minerals (olivine, pyroxenes) similar to those observed in Séítah. These sediments could derive from a local reworking of Séítah, either from topographically high areas of the crater floor or from elsewhere in the Neretva Vallis watershed where the regional Nili Fossae olivine-rich unit outcrops [9]. Importantly, the contact between the crater floor (Séítah) and the delta would occur in the area covered by regolith (Figs. 1 and 4) between Alagogshak and Enchanted Lake.

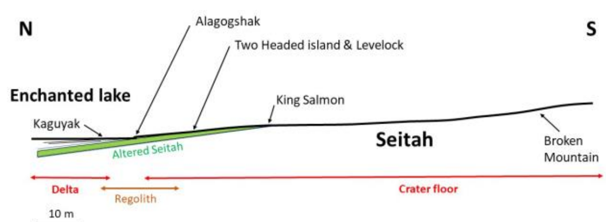

Fig. 4: Schematic section illustrating the transition from Séítah to the delta. Location shown on Fig. 1.

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References: [1] Wiens et al., SSR, 2021; [2] Maurice et al., SSR, 2021; [3] Anderson et al., SAB 2022; [4] Wiens et al., Sci. Adv.; [5] Udry et al., JGR; [6] Beyssac et al., JGR subm.; [7] Liu et al., Science 2022; [8] Dehouck et al., this meeting; [9] Mandon et al. Icarus 2020.