Towards an Origin of the Séítah Formation in Jezero Crater, Mars: Combination of Rover and Orbital Observations T. J. Anderson¹ and V. Payré¹, ¹Department of Earth and Environmental Sciences, University of Iowa, IA, USA (thomanderson@uiowa.edu).

Introduction: The Mars2020 Perseverance rover touched down on Feb. 18, 2021, at the Ursula K. Le Guin Landing Site within the ~45 km diameter Jezero impact crater located at 18.4°N, 77.7°E in the Nili Fossae region of Mars. The current morphology of Jezero is the result of a historical intermingling of igneous, aqueous, and aeolian processes since its initial formation dated to 4.3 Ga. An initial traverse identified three mineralogically and texturally distinct lithological units on the floor of the crater, the Máaz formation, the Sétah formation, and the Artuby Ridge formation. The Máaz formation overlies the Sétah formation without a clear contact observed, and Artuby protrudes above Sétah and below Máaz along the SW rim of Sétah only [1]. Analyses of Máaz rocks have been determined to be consistent with the textures and composition of a series of lava flows and possibly pyroclastic flows [4], while the Sétah characteristics are most consistent with an olivine-dominated cumulate likely originating in a thick magma body or lava lake that once filled the crater floor [2,3]. While appearing to be the lowest stratigraphical unit exposed on the crater floor, the Sétah formation displays a notable topographic high at its center along the rover traverse relative to both Máaz and Artuby, causing debate as to the mechanism of uplift or emplacement [2,5].

This study is the continuity of [4] and is undertaken with the goal of fully constraining the origin of the Sétah formation and determining the interconnectedness of its petrogenesis and geological history to that of the Máaz and Artuby formations by using major-oxide compositions measured by the SuperCam instrument onboard Perseverance paired with thermal-based spectral imagery captured from orbit.

The Sétah Formation: The Perseverance rover crossed from the Máaz formation into the Sétah formation on sol 201 of its traverse. Texturally, Sétah rocks are distinctively holocrystalline, with angular and euhedral grains [3]. Máaz rocks exhibit various textures with Fe-rich augite and plagioclase [4]. The Artuby ridge is texturally and mineralogically distinct from Máaz with heterogeneous grain sizes and a higher augite content. The ground-penetrating radar RIMFAX onboard the rover detected well-developed centimetric layering in sub-surface within Máaz up to the contact with the Sétah formation, dipping downward up to 15° SSW. This suggests that Sétah is stratigraphically below Máaz and Artuby [5]. Dip on the distal side of Sétah is parallel that of Artuby; however, some layers farther into the interior of Sétah are flatter [2]. Analysis of target rocks was conducted using the SuperCam (SCAM) suite of instruments that includes a laser-induced breakdown spectrometer (LIBS) to investigate the major and minor element chemistry of materials. Initial data was sourced from [2], which reported LIBS results up until sol 286. The Máaz formation is divided into a lower and upper member, as well as the Content member overlying Sétah following [4].

**Figure 1: Averaged (per rock) Na₂O+K₂O wt% plotted against SiO₂ wt% normalized to 100 wt.% for Sétah (green), upper Máaz (red), lower Máaz (blue), Artuby (purple), and Content members (yellow).**

**Figure 2: Averaged Al/Si plotted against Mg+Fe/Si ratio for Sétah (green), upper Máaz (red), lower Máaz (blue), Artuby (purple), and Content members (yellow).**
showed no positively identifiable grains within Séítah or Artuby, but 22 grains of Ors-34Ab44-61An15-45 composition appeared in a few Máaz targets. The Séítah formation shows a basaltic to picrobasaltic composition (Fig. 1), while Máaz and Content display a more evolved (SiO₂>52 wt.%) composition along the alkaline/sub-alkaline line. Artuby rock compositions are intermediate between Máaz and Séítah (Fig. 1), with chemical trends continuous with Máaz rocks. Bulk rock compositions of Séítah are highly enriched in Mg relative to the other members supporting the presence of abundant olivine, while Máaz rocks are significantly higher in Al content at low Mg, which reinforces the occurrence of plagioclase (Fig. 2). Artuby composition is intermediate between that of Séítah and Máaz rocks (Fig. 2), supporting a mixture of plagioclase and pyroxene/olivine. While textural and chemical analysis using LIBS data provides valuable insight on the extent of the Séítah formation is essential to decipher its relationship with other members.

**Thermal Imagery:** Pivoting from rover ground measurements to orbital analyses of Séítah, thermal data from the Thermal Emission Imaging System (THEMIS) onboard the Mars Odyssey spacecraft are used to assess the extent of the Séítah formation in Jezero crater and its vicinity and identify the geometry of the formations as well as their spectral signals. Using the JMARS geographic information system and by comparing thermal observations of Séítah with other non-crater related formations, three areas (ROI) of potential spectral correspondence were identified to the south and east of Jezero (Fig. 3). Attempts to observe these regions with high resolution images have been held back by the lack of HiRISE imagery taken for the area of interest. Using lower resolution images with the Context Camera (CTX), it is yet possible to discern certain common elements to these features, including the elongated thin lobate geometry of the outcrops and their apparently rocky surface textures. Higher elevations of these ROI relative to the surrounding land surface are also observed based on CTX Digital Elevation Model (DEM) measurements. These textural and spectral similarities suggest a potential relationship with the Séítah formation that needs to be further explored.

**Discussion:** A full survey of the nature of the Séítah formation is key to uncovering the geological history of Jezero crater and understanding the interactions between aeolian, alluvial, and igneous processes as they occur on Mars. Our findings suggest there is a magmatic evolution relating the igneous formations on the crater floor. Based on chemical and mineralogical data, the Artuby formation and the Content, lower Máaz, and upper Máaz members likely originated from the same parental magma [4], which might have undergone different differentiation history based on their distinct FeO²⁻ contents. Séítah, could be related to the same parental magma based upon the oxide continuous trends with other members, as well as Fe-rich olivine (Fo59-72) echoing the elevated FeO²⁻ content in the lower Máaz augite grains [6] that indicate high differentiation degrees. In this scenario, the cause of uplift of Séítah and tilting of Artuby remains unexplained. Confirming whether or not the lateral extent of Séítah extends outside of Jezero as potentially identified in Fig. 3 and if these units displaying textures and thermal signatures similar to Séítah are part of the same unit will help in understanding whether Séítah is a localized magmatic body within Jezero or a larger, widespread occurrence within the Nili Fossae region of Mars. Further spectral analyses using THEMIS and CTX DEM will enable us to decipher the relationship between the identified units and the Séítah formation.

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**References:**


