INVESTIGATION OF SUBSURFACE CONTACT BETWEEN MAAZ AND SIETAH FORMATIONS WITHIN JEZERO CRATER FLOOR: EVIDENCE FROM ADZIILII CRATER.

O. A. Ciancolo[1], L. C. Kah[1], others [1]Department of Earth and Planetary Sciences, University of Tennessee, Knoxville TN 37996

Introduction: Prior to the February 2021 landing of the Perseverance rover, photogeologic mapping efforts of the Jezero crater landing site (Figure 1) defined two primary crater floor units: Cf-f (fractured) and Cf-fr (fractured rough) [1]. Each of these units is variably mantled by surficial sand, and the CF-Fr unit is additionally characterized by broad regions of regolith referred to as Us (undifferentiated smooth) [1].

During the investigation of crater floor units by the Perseverance rover team, the Cf-f and Cf-fr units were renamed the Séítah and Máaz formations, respectively, and were interpreted to represent an olivine cumulate phase (Séítah formation) and a series of volcanic flows (Máaz formation) [2].

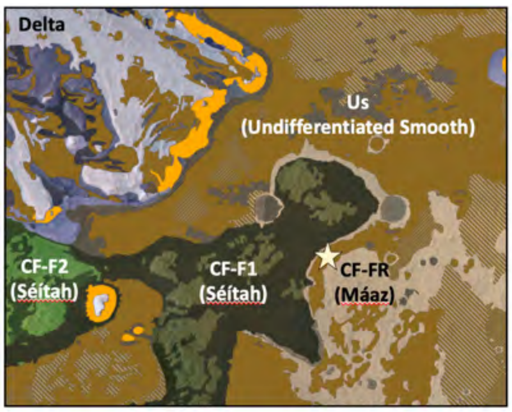

Figure 1. Map of the Jezero crater floor in the region of the Perseverance rover landing site (star). Primary crater floor units include Cf-f and Cf-fr, which since landing have been renamed as the Séítah and Máaz formations, respectively.

The interpretation of Jezero crater floor units as predominantly igneous in origin was, in part, consistent with earlier interpretations [3], but at odds with the interpretation of Jezero crater as having housed potentially long-standing lacustrine environments associated with deposition of the northern and western deltas [4]. This potential conundrum highlights the importance of understanding the temporal relationships between large-scale stratigraphic units within Jezero crater, in order to (1) better understand the long-term history of Jezero crater, and (2) to provide an accurate framework for the interpretation of deltaic and crater floor materials – particularly for sample return and the potential radiometric dating of these units. Whereas radiometric dating of minerals within potentially igneous lithologies may provide an absolute age associated with emplacement, radiometric dating of detrital minerals provide insight into the absolute age of the parent material, but only the maximum are of sedimentary emplacement. Regional mapping of Jezero crater also indicated the potential presence of numerous unconformities between crater floor units and the western Delta. Understanding the relative age of Jezero crater units is therefore critical to constrain the time over which liquid water may have persisted within Jezero crater.

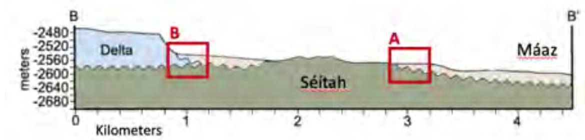

Figure 1. Possible cross-section of the Jezero crater floor [modified from 1]. A) Understanding the subsurface relationship of the Séítah-Máaz contact is critical to testing hypotheses of emplacement and relative age; also B) Determining the relationship between the Máaz formation, regolith of Us, and the delta is critical to understanding potential age relationships of delta growth.

Importance of crater floor units: Lithologic units on the floor of Jezero crater are key to understanding the long-term history and potential habitability of Jezero crater. Pre-landing mapping efforts showed the potential presence of numerous unconformities between crater floor units and the western Delta [1]. The Máaz formation, in particular, is critical to this understanding (Figure 2). For example, rocks of the Séítah formation stratigraphically underlie those of the Máaz formation, yet in places are topographically elevated relative to the Máaz formation, which appears to dip away from elevated regions [5]. Understanding the regional thickness of the Máaz formation and the shape of the Séítah-Máaz unconformity is critical for understanding emplacement mechanisms. In additional examples, it is critical to understand whether the Máaz formation underlies regional undifferentiated smooth (Us) regolith and the relationship of these units to rocks of the Delta front, in order to constrain the relative timing of fluvial-lacustrine sedimentation in Jezero.

Investigation of Adziilii crater: Here we explore the first of these examples—the character of the Séítah-Máaz unconformity. Specifically, we use Adziilii crater as a window into the subsurface of the Jezero crater floor and explore the nature of ejecta excavated during the Adziilii impact event.

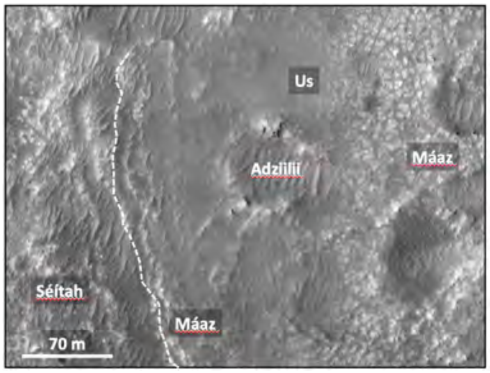

Figure 3. Adziilii crater. Locally, the Máaz-Séítah boundary region shows flat-topped rocks similar to the boundary near the landing ellipse.

Adziilii crater is a small, simple crater that sits south of the Perseverance landing site, approximately 80 m from a contact between the Máaz formation and the underlying Séítah formation, on the northern flank of the eastern "thumb" of the Séítah exposures. Here, we explore the possibility of Adziilii crater intersecting the Séítah-Máaz contact. We suggest that if excavation of the Adziilii impact crater intersected the Seitah-Maaz contact, we should find ejecta blocks within the crater rim and proximal ejecta blanket that are recognizable as Seitah formation. Conversely, if the crater does not intersect the Séítah-Máaz contact, then ejecta blocks should provide insight into the character of subsurface Máaz formation materials.

Information from topography. First, using a series of five topographic measurements around the Séítah "thumb," we show that the exposed Máaz formation is approximately 2 meters in thickness at the interface between these two units. West of Adziilii crater, the topography descends into a horizontal plain of Us at about -2569 meters (into which Adziilii impacted). This plain continued east of Adziilii crater until slowly rising as Us regolith gives way to light-toned fractured rocks of high-standing Máaz formation (Figure 3).

Although the rim of Adziillii crater is not entirely intact, by using multiple rim-to-rim and rim-to-base measurements, we are able to estimate that Adziilii crater is 70 meter in diameter, has a rim that sits approximately 1 meter above the surrounding plains, and has a current depth of approximately 3 meters. These measurements suggest a depth-to-diameter (d/D) ratio of approximately 0.04. To better understand what the true depth of Adziilii crater, we also measured d/D ratios of six additional nearby craters (from 27-140 meters in diameter) that penetrate the Máaz formation. These craters provide d/D ratios of 0.03 to 0.07, with the freshest craters (i.e. those with clear ejecta blocks extending across the Us plains) having d/D ratios of approximately 0.06, similar to that of the much larger nearby craters Hahóótsaa (d/D=0.051) and LaOrotavia (d/D=0.067). A d/D ratio of 0.06 would suggest that true depths of Adziilii crater should be approximately 4.2 meters, which would represent approximately 3 meters beneath the surrounding plains.

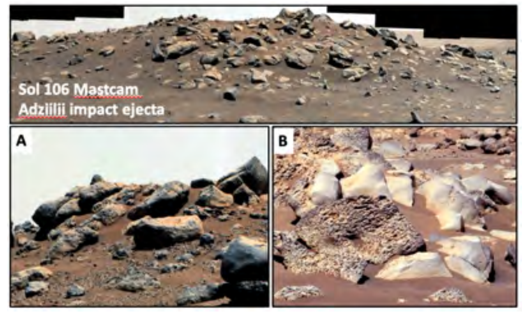

Figure 4. Adziilii crater rim as seen in a sol 106 mastcam mosaic. Image A shows intact decimeter-scale bedding between more and less vesicular components. Image B shows the most common association of ejecta, which consists of massive blocks of pale grey, non-vesicular materials and darker grey, strongly vesicular materials.

Ejecta description and interpretation. Three main macroscale rock fabrics have been identified in material ejected from Adziilii crater (Figure 4). The first, and most abundant of these materials consists of blocks that contain interbedded, decimeter-scale dark grey, variously vesicular, irregular beds. Less commonly, massive blocks of dark grey, highly vesicular materials occur interspersed with equally massive, pale grey, non-vesicular, smooth-weathering blocks. A final lithology, in which potentially vesicular blocks show a single, smooth, planar surface are relatively rare within ejecta.

Most of the observed ejecta appears to represent known components of the Máaz formation. Irregularly bedded, decimeter-scale materials are similar to the Máaz formation preserved along Artuby Ridge to the south of the Séítah inlier and flat-topped and massive light-toned boulders are similar to low-standing and high-standing (Chal-type) materials observed at the landing ellipse. Only the massive, dark-toned vesicular boulders have not been otherwise observed in the Máaz formation; these bear similarity to highly vesicular rocks that unconformably overly the Séítah formation (Content-type) within the main Séítah inlier.

References. [1] Stack et al. (2020) Space Science Reviews, 216, 127. [2] Horgan et al. (2022) JGR Planets (*submitted*). [3] Goudge, T.A. et al. (2015) Journal of Geophysical Research: Planets, 120, 775–808. [4] Mangold et al. (2021) Science, 10.1126/science.abl4051. [5] Holm-Alwmark et al. (2021) JGR Planets, 126, e2021JE006840.