Comparing the Jezero Floor Unit and the Circum-Isidis Mafic Cap: Morphology, Stratigraphy, and Composition. Carol B. Hundal¹, John F. Mustard², Jesse D. Tarnas¹, Christopher H. Kremer¹. ¹Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI, 02906.²Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109. (carol_hundal@brown.edu).

Introduction: An extensive, Mafic Capping unit overlies the stratigraphy of the circum-Isidis region on Mars [e.g., 1-5]. An apparently similar mafic geologic unit covers Jezero crater’s floor and a large fraction of the Perseverance rover landing ellipse [6]. As such, it may be the subject of the mission’s first groundbreaking discoveries.

Previous work has suggested that the Mafic Capping and Jezero Floor units are genetically related due to photogeologic similarities [5,7]. Here, we integrate morphology, stratigraphy, and a compositional remote sensing investigation to further test this comparison. A strong resemblance between these geologic formations in our integrated dataset would support the hypothesis that the floor could be an explosive volcanic deposit. Additionally, it could mean the discoveries made on the Jezero floor may apply to the greater circum-Isidis region. The presence of dark-toned, mafic capping units globally (e.g., Sinus Meridians, Mawrth Vallis [8]) gives the Circum-Isidis Mafic Capping unit and this possible connection to the Jezero floor added global significance.

Methods: Morphology/Stratigraphy: We analyzed morphology using images from the High Resolution Imaging Science Experiment (HiRISE) [9] and the Context Camera (CTX) [10] aboard the Mars Reconnaissance Orbiter, as well as CTX mosaics [11]. Stratigraphic determinations were drawn from the literature, specifically [6,12-14].

Spectra: Similar spectral signatures between these two units would imply common mineralogy and lend evidence to the hypothesis of a shared origin. To refine our analyses of potentially weak spectral components, we used Factor Analysis. This statistical method calculates eigenvectors representative of independent variance in a dataset. The first eigenvector describes the greatest spectral variance, while each successive one describes less. Low-order eigenvectors—those describing the most variance—tend to have spectral shapes that can be interpreted as surface spectral signals and varying degrees of structured noise. Factor Analysis has been used on Mars in the past to identify mineral components with both narrow [e.g., 15] and broad absorption features [e.g., 16,17].

Here, we analyze data from regions of interest in MRO CRISM [18] data of the Mafic Capping, Olivine-Rich, and Jezero Floor units. In addition to Factor Analysis, we use a number of techniques to reduce structured noise—the methodology of which will be explained at the meeting.

Results: We find morphological, stratigraphic, and compositional similarities and differences between the two geologic units.

Morphology (Figure 1A): Both units are characterized by a dark-toned, crater preserving surface with steep bounding scarps. Craters extend in size from less than 10 m up to ~300 m in diameter on both units. Each shows a similar degree of crater preservation from sharp crater rims to rounded, apparently degraded rims. Crater cavities tend to be variably filled with aeolian sediments.

Although quite similar on the sub-kilometer scale, the two units differ in their regional characteristics. The Mafic Capping unit forms scattered mesas on the order of 1-5 km in diameter, while the Jezero floor is a contiguous unit on the order of 20-30 km across. However, this distinction could be due to differences in weathering and exposure.

Stratigraphy (Figure 1B): The Mafic Capping and Jezero Floor units lie above the circum-Isidis Olivine-Rich Unit (ORU). The cap is apparently in direct contact with the ORU [5,14]. For the Jezero Floor, however, it is uncertain whether it lies stratigraphically above or below the delta unit [6]: does the floor directly overlie the olivine-rich unit, or is the delta in-between? For example, the floor near the delta is smooth, perhaps suggesting it was protected by a previously overlying

Figure 1: (A) Morphologic comparison of the pitted capping unit (HiRISE PSP_009718_2005) and the Jezero floor (HiRISE ESP_048908_1985). (B) Stratigraphic comparison (simplified). Both the pitted capping unit and the Jezero floor unit are above the olivine-rich unit. The position of the delta is debated [6].
unit, and there are no moat-like features between the floor and delta as is seen at Columbia Hills [19]. On the other hand, the floor also slopes upward in proximity to the delta remnant, perhaps suggesting the floor was emplaced after the delta [12].

Several stratigraphic hypotheses from the literature and from new photogeologic mapping are synthesized into possible endmember scenarios in [6]. These include both stratigraphic possibilities, as well as the speculation that the Jezero floor and the underlying olivine may be part of the same unit. The true stratigraphic position of the delta has important implications. Crater dating has been done for the Jezero floor [18]; knowing how that age stratigraphically relates to other geologic units, particularly the delta unit, is hugely significant.

Composition (Figure 2): Both the floor and the cap produce eigenvectors with broad, crystal field absorption shapes at one and two microns. We interpret this to be consistent with a mix of high- and low-calcium pyroxene. It should be noted that the southern portion of the Jezero Floor also has a second eigenvector consistent with reduced glass, similar to green lunar glass, which is not present in the Mafic Capping unit.

Apart from the above comparison, there are eigenvectors from both the cap and the Olivine-Rich Unit (ORU) which match each other closely (Figure 2).

**Implications for the Perseverance rover mission:** We interpret these compositional and photogeological similarities to suggest the two geologic units are linked, either in terms of a formation mechanism or even a formation event/phase, corroborating the conclusions of [5,7].

Work by [4,7] showed the Mafic Capping unit is a clastic deposit, possibly of an ash-fall origin like the Olivine-Rich Unit, which it directly overlies [14, 19]. The similarities between the eigenvectors from the Olivine-Rich Unit and the cap unit may indicate a compositional transition in a sequence of explosive volcanism. We believe this is more likely than the presence of weathered material because this spectral signal is relatively uniform over both units instead of concentrated in craters, pits, and the edges of scarps.

The instruments on the Perseverance rover could test this hypothesis, while a returned sample could provide invaluable information about the timing and the mechanisms of Mars’ transition from explosive to effusive volcanism in the Hesperian [20,21].

**Acknowledgments:** Many thanks to Tim Goudge, Michael Bramble, Ralph Milliken, and Jim Russell for insightful discussions. We used CTX mosaics produced by the Bruce Murray Laboratory for Planetary Visualization.