PERSEVERANCE AND THE PURPLE COATING: A MASTCAM-Z MULTISPECTRAL STORY.

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Introduction: The NASA Mars 2020 Perseverance rover is currently exploring the floor of an ancient lacustrine environment at Jezero crater to investigate regional geology, evaluate past habitability, seek signs of ancient life, and cache samples for future return [1]. The Mastcam-Z instrument, a pair of zoomable multispectral cameras on the Perseverance rover, has acquired images along the crater floor traverse to help characterize morphologic, textural, sedimentological, and multispectral properties of the surrounding rock units [2]. These images have revealed rocks with various textural and morphologic expressions that suggest differences in erosional history and potentially lithology [3]. Purple-hued patches have been commonly observed by Mastcam-Z on surfaces of various crater floor rock types. Similar purple-hued patches have been previously observed on Mars by the Opportunity rover on Fe-Ni meteorites at Meridiani Planum, and were inferred to represent an altered or secondary weathering coating of ferric oxides [4,5]. Here we use Mastcam-Z multispectral data to characterize the morphologic and multispectral properties of the purple-hued patches on Jezero crater floor rocks to constrain their origin and investigate potential alteration and weathering history of the Jezero crater floor.

Morphologic properties: The purple-hued material is typically observed in less dusty areas of most rock surfaces across the Máaz (crater floor fractured rough) and Séítah formations, especially on rocks where the natural surface dust layer was cleared by SuperCam LIBS [6] or abrasion activities. The purple is particularly apparent in Mastcam-Z decorrelation stretch (DCS) images *(Fig. 1)*, which use a principal component analysis to enhance color differences. These surfaces are distinct from the underlying rock and are characterized by smooth, homogenous, and dull patches with lobate margins, consistent with a surface coating. The patches are typically confined to lower topography on wind abraded rock surfaces, including fluted grooves and pits *(Fig. 1a)*. Abraded surfaces do not display evidence of purple material whereas the nearby natural surfaces along their rims do, providing further evidence that the purple patches are likely a coating *(Fig. 1b)*.

While the purple patches occur intermittently and are relatively dust-free, other surfaces and loose exfoliated rock flakes exhibit thicker and more continuous coatings, and appear to consist of indurated dust or fine-grained regolith *(Fig. 1c-d)*. These coatings are not confined to lower topography surfaces and typically appear more muted rather than vivid purple in Mastcam-Z images.

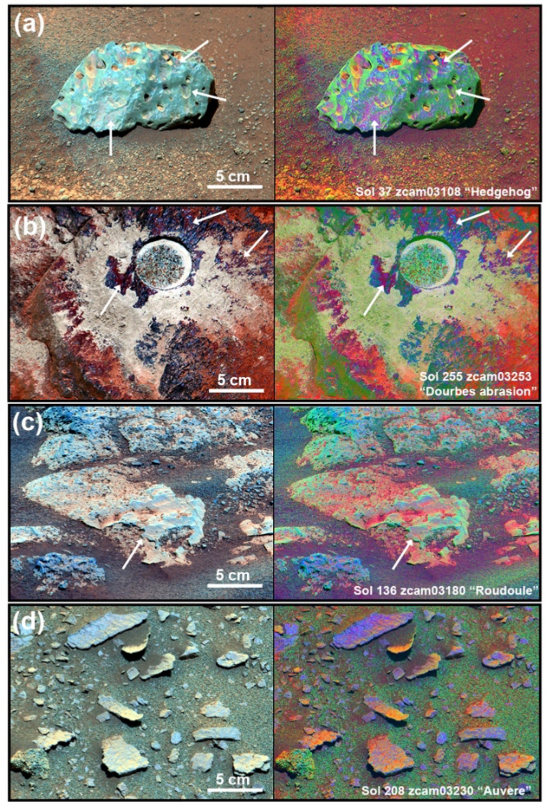

Figure 1: *Mastcam-Z (z110, L256) enhanced color (left) and decorrelation stretch (right) images showing vivid purple patches (a-b) and thicker muted purple coatings (c-d) on the Jezero crater floor.*

Multispectral properties: The spectral range and wavelengths of the Mastcam-Z instrument are useful for distinguishing ferrous (primary) and ferric (secondary) minerals. Multispectral data of the crater floor rocks suggest that the purple patches are spectrally and thus compositionally distinct from the underlying rock. This is most apparent in Séítah, where non-coated rock surfaces are more consistent with olivine while the purple coatings exhibit a peak at longer wavelengths, a weak and broad absorption band near 900 nm consistent with pyroxene or ferric minerals, a possible weak narrow band at 860 nm consistent with crystalline hematite, and stronger 528 nm absorptions consistent with nanophase or crystalline ferric oxides (*Fig. 2a*). Coatings are spectrally similar to the local fine-grained regolith, although the regolith typically displays a stronger red-slope due to dust *(Fig. 2b)*.

Comparison of coatings across various rocks suggest the purple patches are spectrally variable and may be related to variability in local fine-grained regolith.

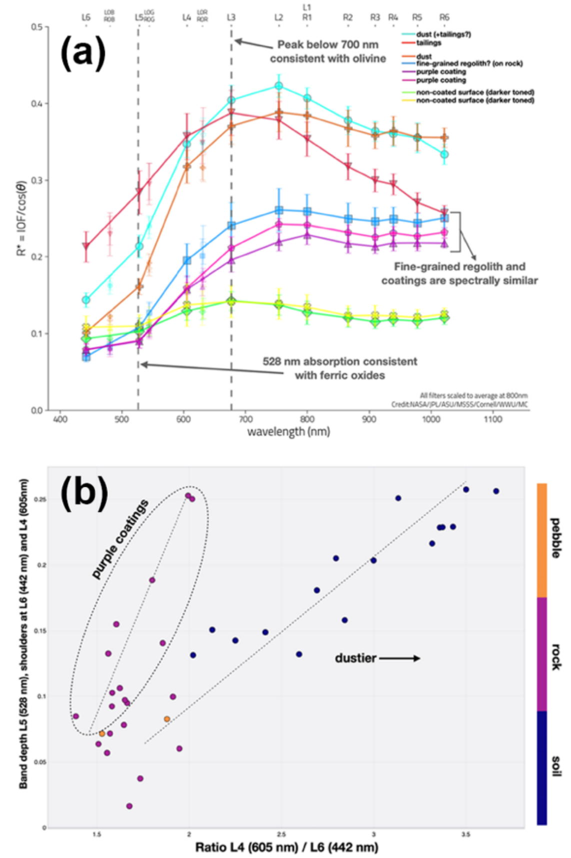

Figure 2: *(a) Mastcam-Z spectra of representative surfaces around the Dourbes abrasion patch. (b) plot showing 528 nm band depth vs. red-blue ratio of spectra collected from representative rock and soil surfaces on the crater floor.*

Discussion: A review of Mastcam-Z images suggest purple coatings are common on the Jezero crater floor. The coatings are distinct from the underlying rock and exhibit spectral properties consistent with a mixture of local fine-grained regolith and variable ferric oxides (e.g., nanophase and crystalline hematite). Local fine-grained regolith is spectrally similar to purple coatings but likely not the only contributor to coating formation *(Fig. 2b)*, and we hypothesize that the coatings represent fine-grained regolith cemented by ferric oxides as a result of widespread alteration and weathering of the crater floor. It is important to note that some purple patches may include additional materials that are more spectrally neutral to the Mastcam-Z wavelengths (e.g., sulfates), and chemical analyses with SuperCam [7] and other instruments are necessary to further constrain the composition of the coatings. The different expressions of coatings observed may represent various stages of coating formation, where the thicker muted purple coatings of indurated dust and fine-grained regolith represent a relatively early stage and the less dusty vivid purple patches are later stages resulting from episodes of burial, alteration, and subsequent exhumation and erosion *(Fig. 3)*. The presence of purple patches in local topographic lows on wind abraded surfaces suggest that coatings in some cases formed after initial aeolian erosion, and may suggest a later stage alteration event.

These results may provide a key understanding to the timing of water-rock-atmosphere interaction at Jezero and the alteration and weathering of the crater floor. Investigations of abraded patches by Perseverance suggest both crater floor units are variably altered and likely experienced multiple episodes of aqueous activity [8,9]. The purple coatings possibly represent the last episode of alteration so constraining their origin is important for understanding returned samples. Future work will aim to further constrain the relationship between fine-grained regolith and the purple coatings, investigate potential ferric oxide vs pyroxene component of coatings, and determine formation mechanisms.

References: [1] Farley et al. (2020) *Space Science Reviews,* 216 (8) 1-41. [2] Bell et al. (2021) *Space Science Reviews*, 217 (1), 1-40. [3] Horgan et al., this vol. [4] Johnson et al. (2011) *42nd LPSC* #1929. [5] Schröder et al. (2008) *J. Geophys. Res.,* 113 (E6). [6] Wiens et al. (2021) *Space Science Reviews,* 217 (1), 1-87. [7] Beck et al., this vol. [8] Meslin et al., this vol. [9] Scheller et al., this vol.

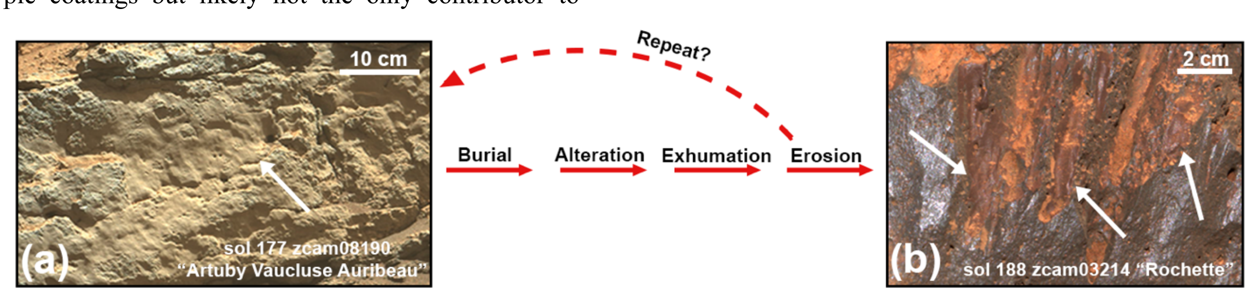

Figure 3: *Potential formation mechanism of the purple patches on the crater floor (Mastcam-Z images, z110, L0 natural color). (a) Thick muted purple coating of accumulated dust and fine-grained regolith on an eroded rock surface. (b) Vivid purple coating confined to wind abraded grooves.*