Orbital Context and In Situ Observations of Nili Fossae Olivine-Carbonate

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Abstract

Perseverance landed at the Octavia E. Butler landing site next to the *Séítah* dune region in Jezero crater on 18 February 2021, in close proximity to the largest exposed carbonate deposit on Mars. These carbonate signatures have been shown to be associated with the strongest olivine signatures at Jezero crater (Goudge+ 2015, Brown+ 2020). Alteration of olivine can lead to carbonate+H2 production, an energy source for microbes (Mayhew+, 2013). The question of the origin of the olivine-carbonate unit represents both an opportunity and a challenge for the rover mission and future sample return efforts. Carbonate The landing site is not near the region of carbonate detections (Figure 1), however the rover's westward traverse will take us over the carbonates on approach to the crater rim. No reliable indications of the 2.5 μm carbonate band have yet been convincingly detected by the SCAM VISIR instrument. Olivine Studies of the olivine-carbonate unit concluded the olivine is relatively Fe-rich and coarse grained (mm: Poulet+ 2007, Clenet+ 2013). The strongest in-situ olivine signatures are found in dune material analysed by LIBS/VISIR (Beyssac+ Mandon+ this conf). This grain size characterization work may be used to investigate the interaction of olivine with water and CO2 (Escamilla-Roa+ 2020). These surface-gas processes are enhanced when olivine is in fine grain form. Ash dispersal modeling is ongoing (Ravanis+ this conf) to determine the range different sized ash particles could have traveled on ancient Mars. We cannot directly compare the 1 μm band for CRISM and VISIR, so we developed

a new method that measures the curvature of three points on the absorption bands to assess their relative Fo# shifts and applied it to both datasets. Lab spectroscopy will be used to assess spectral variations with composition versus grain size. Two key factors driving the Fo# are mantle composition and melt temperature. Brown+ (2020) estimated a range of Fo44-65 for the most redshifted olivine observed by CRISM. McGetchin+Smythe (1978) showed that an Fe-rich mantle composition would produce highly viscous lavas and suggested an upper bound of Fo70 for olivine. Understanding the astrobiological potential of the olivine-carbonate unit is a priority of M2020 (Farley+ 2020) and we will speculate on potential formation models in this contribution.

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Plain Language Summary

Perseverance landed at the Octavia E. Butler landing site next to the *Séítah* dune region in Jezero crater on 18 February 2021, in close proximity to the largest exposed carbonate deposit on Mars. These carbonate signatures have been shown by past orbital studies to be associated with the strongest olivine signatures in the region, which is called Nili Fossae. Alteration of olivine can lead to carbonate+H2 production, an energy source for microbes, which makes the origin of this mineral association a vital connection to the habitability of the region.

In this study we will present a comparison of detections of olivine using orbital data from the CRISM instrument on Mars Reconnaissance Orbiter and the M2020 Supercam infrared spectrometer, called VISIR. We will also discuss the context we have gained via the orbital investigations so far, and how these have been sharpened and altered by ongoing in situ investigations.

The question of the origin of the olivine-carbonate unit represents both an opportunity and a challenge for the rover mission and future sample return efforts. Understanding the astrobiological potential of the olivine-carbonate unit is a priority of M2020 and we will speculate on potential formation models in this contribution.

Abstract Text

Perseverance landed at the Octavia E. Butler landing site next to the *Séítah* dune region in Jezero crater on 18 February 2021, in close proximity to the largest exposed carbonate deposit on Mars. These carbonate signatures have been shown to be associated with the strongest olivine signatures at Jezero crater (Goudge+ 2015, Brown+ 2020). Alteration of olivine can lead to carbonate+H_2 production, an energy source for microbes (Mayhew+, 2013). The question of the origin of the olivine-carbonate unit represents both an opportunity and a challenge for the rover mission and future sample return efforts.

Carbonate

The landing site is not near the region of carbonate detections (Figure 1), however the rover's westward traverse will take us over the carbonates on approach to the crater rim. No reliable indications of the 2.5 μm carbonate band have yet been convincingly detected by the SCAM VISIR instrument.

Olivine

Studies of the olivine-carbonate unit concluded the olivine is relatively Fe-rich and coarse grained (mm: Poulet+ 2007, Clenet+ 2013). The strongest in-situ olivine signatures are found in dune material analysed by LIBS/VISIR (Beyssac+ Mandon+ this conf). This grain size characterization work may be used to investigate the interaction of olivine with water and CO_2 (Escamilla-Roa+ 2020). These surface-gas processes are enhanced when olivine is in fine grain form. Ash dispersal modeling is ongoing (Ravanis+ this conf) to determine the range different sized ash particles could have traveled on ancient Mars.

We cannot directly compare the 1 μm band for CRISM and VISIR, so we developed a new method that measures the curvature of three points on the absorption bands to assess their relative Fo# shifts and applied it to both datasets. Lab spectroscopy will be used to assess spectral variations with composition versus grain size.

Two key factors driving the Fo# are mantle composition and melt temperature. Brown+ (2020) estimated a range of Fo44-65 for the most redshifted olivine observed by CRISM. McGetchin+Smythe (1978) showed that an Fe-rich mantle composition would produce highly viscous lavas and suggested an upper bound of Fo70 for olivine. Understanding the astrobiological potential of the olivine-carbonate unit is a priority of M2020 (Farley+ 2020) and we will speculate on potential formation models in this contribution.

Character limit: 2000 (currently 2000)

Figure 1 - Jezero crater showing Seitah and the landing site and traverse to Sol 137. Images is colour coded for carbonates using orbital CRISM data, and overlain by a Sol 113 Navcam image of the main deck of the rover with Ingenuity in the background. Image from CAMP [(Calef+ 2021 5th Planetary Data workshop)]