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Detections of carbonates in Valles Marineris

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Abstract

Valles Marineris is a unique place on Mars where deep crust is exposed at its original place [1]. The primitive crust is observed at the base of Coprates Chasma as well as in the eastern parts of Valles Marineris [1]. Elsewhere on Mars, several authors [2 and references therein] reported key observation of the martian primitive crust being altered thanks to CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) data. Coprates Chasma is a proposed landing site for Mars 2020 mission and is so intensely covered by CRISM data. It allows us to investigate the alteration signs of the primitive crust. We describe here the study of 3 CRISM FRT observations on the wall of Valles Marineris in Coprates Chasma and on a remnant horst in middle of the canyon seeking for alteration minerals.

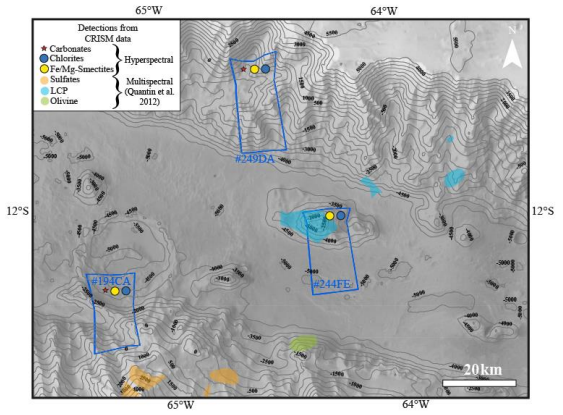

Figure 1: Geological context. CRISM observations footprints are shown in blue. The Detected mineralogy from CRISM study is reported with the following symbol: blue for chlorite, yellow for smectite, red star for carbonates, orange for sulfates, light blue for LCP and green for olivine.

1. Geological context

According to [1 and 3], the walls of Coprates Chasma exposes both the primitive Low Calcium Pyroxene rich crust and the Noachian Tharsis lava stack [1 and 3]. The sharp crustal boundary between the two types of crust would occur around our study area [1, 3]. A part of the observation on the southern wall is a 24 km crater lying down the floor of the canyon. Another observation is on the central horst (maximum of elevation around -2400m) of the canyon (Figure 1).

2. Spectroscopic investigation

We use CRISM data that we pre-process with CAT [4]. Because the signal to noise ratio in CRISM data is low, we use CoTCAT, a personal noise removal pipeline describe in [5]. The ratio used is the median by column ratio describe in [5]. We discriminate our detections by the study of the combination of the position of centre of absorption near 2.3 and 2.5 µm after continuum removal [6 and 7]. Our results highlight the presence of carbonates. The carbonates are detected by these combinations of absorption in addition to a strong absorption before 3.45µm and to the presence of the drop near 3.8 µm. All the carbonates signatures reported here present the characteristic of a mixture with a hydrated phase or a weathering of the carbonates (presence of absorptions near 1.4 and/or 1.9 µm, shoulder near 2.27 µm and drop of the reflectance after 2.2µm) [8]. We detected the carbonates signatures on the two CRISM observations on the walls of Coprates

Chasma while similar signature are absent of the CRISM observation on the floor of the chasma studied here.
We observe absorptions of the Fe/Mg-rich phyllosilicates on the horst that are close to 2.3µm rather than 2.33-2.35µm as for the observations on the walls. This suggests a better match with chlorite for the observations on the walls and a better match with smectite for the observation on the horst.

3. Discussion

Carbonates are so observed in the crater walls at the level of the southern wall as well as in the north wall (at the north at around 500m and at the south at around -3000m). The central horst shows only phyllosilicates. A relationship between the presence of the crater and the presence of carbonates is likely to be exclude because of the same detections made on the facing side of the wall of the chasma. This may suggest an extended layer of carbonated crust The absence of carbonates signature on the central horst of the chasma can be explained either because the carbonated layer is not exposed in the central horst or that the carbonation process is a spatially localized process.

4. Conclusion

Hydrothermal signatures have already been reported in this area [i. e.: 3 and 9] suggesting hydrothermal processes at a large scale in the region of Valles Marineris. Our detections of carbonates associated to phyllosilicates imply carbonation and hydration process of the crust exposed in the deepest part of Valles Marineris. Implication for exobiological perspectives will be presented by comparing the mineral assemblages detected here and geochemical modelling and the potential efficiency of H_2 and CH_4 production.

Acknowledgements

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