

Delving into Olivine - Clay replacement in Terrestrial Analog: Insights on Martian alteration process.

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Potential for extraterrestrial habitability relies on identifying suitable energy sources and electron donors like H₂ and CH₄ in other planets (e.g. Mars). Despite substantial evidence of olivine hydration in generating H₂, information on olivine hydration in the “wet” Mars is scarce. Martian crust is substantially comprised of olivine that can potentially react with aqueous solution to produce phyllosilicates like clay minerals, chlorite, serpentine and H₂.

Mineral identification was performed using XRD analysis and Raman spectroscopy in the terrestrial samples. Further detailed SEM and EPMA analysis revealed orthocumulate olivine gabbro with cumulates being olivine and plagioclase, which are forsteritic ($X_{Mg} = 0.88 \pm 0.01$) and bytownitic ($X_{Ca} = 0.80 \pm 0.02$) in compositions respectively whereas intercumulus clinopyroxenes are augite ($X_{Mg} = 0.91 \pm 0.01$). Serpentes, clay minerals and chlorites replacing olivine varies micro-mineralogically and compositionally at the interface scale. Intra-olivine serpentines are less aluminous as compared to that in the olivine-plagioclase interfaces although their X_{Mg} values are comparable. Chlorite replacing olivine are clinocllore ($X_{Mg} = 0.818 \pm 0.048$) with higher FeO_(t) of 10.67 ± 1.73 wt% and lower Al₂O₃ of 14.50 ± 2.62 wt% compared to chlorites replacing plagioclase ($X_{Mg} = 0.94 \pm 0.04$) with lower FeO_(t) of 3.64 ± 2.21 wt% and higher Al₂O₃ of 20.49 ± 3.67 wt%. Intra olivine clays are saponites ($X_{Mg} = 0.83 \pm 0.03$) with minimal Al₂O₃ content (0.04 ± 0.09 wt%), whereas clays present at olivine plagioclase interface exhibit X_{Mg} values of 0.80 ± 0.02 and substantial Al₂O₃ proportions (2.82 ± 0.56 wt%).

The textural and compositional observations combined with reaction path modelling under different water - rock ratio, pH conditions and initial reactants along with activity diagrams elucidates the control of protolith and reacting fluid composition (mainly Al, Fe and Si) on secondary phyllosilicate composition at the various replacement interface in olivine - clinopyroxene - plagioclase system, which may be relevant to unravel the alteration textures in many SNC meteorites and in Mars-like environment.

[1] Nozaka et al. (2008) *Geochemistry, Geophysics, Geosystems*, 9(11). [2] Majumdar et al. (2020). *Lithos*, 374, p.105730.