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What would Martian biosignatures look like if entombed in clay-rich sediments?

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The astrobiological exploration of Mars is ongoing mainly with the MSL and Mars2020 missions, but identifying traces of life in ancient rocks remains challenging [1,2]. Nevertheless, odds to find traces of life in ancient Martian rocks rich in clay minerals are considered as very high, especially because of their absorption and protection capacities, conferring them a high biopreservation potential [3,4]. Plus, the loss of the Martian atmosphere resulted in a drastic decrease of surface temperatures, transmuting Mars subsurface into a giant freezer. However, in addition to irradiation degradation [5], the biosignatures potentially preserved within Martian clays may have been degraded during episodes of fluid circulation [6], the past occurrence of which being attested by the numerous veins intersecting ancient clay-rich terrains [7,8]. The present experimental study aims at determining the effect of such fluid circulation on biological organic material trapped within clays. We conducted laboratory experiments under Martian conditions (*i.e.* under a CO_2-rich atmosphere) with *E. coli* cells associated with synthetic Mg-rich smectites (*e.g.* saponite) in presence of pure water, at different temperatures (from 100 to 200°C) and for different durations (from 1 to 100 days). Results show a significant detrimental effect on the microbial FTIR-signature and a progressive reduction of the interlayer trapping efficiency (XRD) with increasing time and temperature, suggesting that saponite is not that effective in protecting organic compounds from thermal degradation. Yet, smectite is prone to preferentially trap of N-rich compounds as indicated by increasing N/C values. But even these sorbed and intercalated N-rich compounds eventually encompassed chemical degradation with increasing temperature or experimental duration. As illustrated here, we should not expect to detect pristine biogenic organic compounds on Mars, but rather by-products of their degradation, intimately associated with clay minerals.

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