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Potential for fossilization of an extremotolerant bacterium isolated from a past mars analog environment

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In the context of astrobiological missions to Mars, the key question is what biosignatures to search for and how? Indigenous Martian organisms, if they existed or still exist, can be classified as extremophile per se. Following this precept the FP7-funded European MASE project (Mars Analogues for Space Exploration} is investigating various aspects of anaerobic life under Mars' extreme envrionmental conditions, including the potential for preservation over long geological time periods
of certain strains.
In this contribution, we report on the mineralisation and preservation of Yersinia sp. in silica and gypsum, two minerals that have been reported on Mars, in cold and anaerobic conditions, similar to Martian conditions. The organism, polyextremotolerant bacterium Yersinia sp. MASE-LG-1 (hereafter named Yersinia. sp.) was isolated from the Icelandic Graenavatn Lake, an acidic (pH3), cold and oligotrophic volcanic crater lake. These organisms have a strong tolerance to diverse Mars-like stresses (Rettberg et al., 2015).
We also studied the effect of physiological status on mineralisation by exposing Yersinia to two common stresses thought to have increased du ring Mars history, desiccation and radiation. The mineralisation process has been studied using microbiological (microbial viability), morphological (scanning and transmission electron microscopy), biochemical (GC-MS, Rock-Eval) and spectroscopic (FTIR and RAMAN spectroscopy) methodologies. Based on these approaches, the potential of mineralised Yersinia sp. cells to be preserved over geological time scales is also discussed.
Salient results include the fact that fossilisation in gypsum solutions is slower than in silica; not all cells were mineralised, even after 6-months in the fossilising solutions, although the FTIR, Raman and SOLID biomarker signatures were lost by this time period; Rock-Eval analysis suggests that the kerogen in the fossilised strain may not survive preservation over long geological periods, although carbon molecules preserved in fossil microbial traces up to ~3.45 Ga have been detected in the rock record.
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