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Experimental fossilisation of two strains of methanogen, *Methanoculleus bourgensis* MAB-2 and *Methanobacterium oryzae* in silicates, carbonates, and phosphates

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Mineralization has long been considered a prime mechanism for fossilising organisms at cellular level with a high degree of precision. Rapid entombment of microbes in minerals is often essential for their long-term preservation since it reduces decay and oxidation of the organic matter. This may occur in environments like hydrothermal vents or infilling of fractures with mineral rich fluids or through biomineralization. These processes have previously been studied both from modern analogue environments like hot springs [1], and through experimental fossilisation in the lab [2]. Changes in pH, temperature or pressure are usually the driving factors for abiotic mineral precipitation but organic matter may often function as a nucleation point or template for precipitation [3]. In this work the fossilisation processes of silicification, calcification and phosphatization on two strains of methanogens, one coccoid *Methanoculleus bourgensis,* MAB-2 and one filamentous *Methanobacterium oryzae* are analysed. Differences in the fidelity of morphological preservation of the two methanogens in the various fossilisation agents were observed over a period of 3 months. This work will have important outcomes for the search for life on early Earth and for recognising fossilised archaea as opposed to abiotic pseudofossils. Furthermore, it will help in the understanding of the potential for finding fossilised methanogens in the rock record, something which can be applied also to the research on extra-terrestrial life. Finally, the analysis of silicification, calcification, and phosphatization will allow for a direct comparison of the three mechanisms in preserving organic matter and microbial morphology and give us insights into how these mineralization processes work and what conditions may favour one over the other.

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