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Experimental silicification of the extremophilic Archaea *Methanocaldococcus jannaschii* and *Pyrococcus abyssi*. Applications in the search for evidence of life in early Earth and extraterrestrial rocks.

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Early life on Earth was anaerobic and apparently thermophilic. It included chemolithotrophs organisms that could have existed on early Mars, as well as photosynthesisers. Since the earliest life forms known to date ($>$ 3 Gyr) were preserved due to the precipitation of dissolved silica on cellular structures (silicification), we undertook an experiment to silicify a type of microorganism that could have existed in the environmental conditions of early Earth and early Mars, given the different environmental conditions. We chose the thermophilic species *Methanocaldococcus jannaschii* (methanogenic Archaea) as a representative of an anaerobic, autotrophic, thermophilic microorganism. We also chose *Pyrococcus abyssi*, another hyperthermophilic Archaea, for this study, in order to be able to compare and better understand the results.

This is the first time that Archaea have been used in a simulated fossilisation experiment and one of the very first fossilisations of hyperthermophilic microorganisms.

After having been cultured, the microorganisms were placed in a silica-saturated medium in order to study the evolution of both cells and biofilms exposed to silica. SEM and TEM observations showed that, although the *M. jannaschii* cells themselves were not preserved, their extracellular polymeric substances (EPS) were silicified. On the other hand, both *P. abyssi* cells and their EPS were preserved and silicified.

These results suggest that differences between species have a strong influence on the potential for different microorganisms to be preserved by fossilisation.

This experiment provides valuable insight into the silicification and preservation processes of the kind of microorganisms that could have existed on the early Earth. Knowledge of these mechanisms can be helpful for the search and the identification of microfossils in both terrestrial and extraterrestrials rocks, and in the particular case of Mars.