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Production of carbon-containing pyrite spherules induced by hyperthermophilic Thermoccocales: a biosignature?

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Thermococcales, a major order of hyperthermophilic archaea inhabiting iron- and sulfur-rich anaerobic parts of hydrothermal deep-sea vents, are known to induce the formation of iron phosphates, greigite (Fe_3S_4) and abundant quantities of pyrite (FeS_2), including pyrite spherules [1]. Using X-ray diffraction, synchrotron-based X-ray absorption spectroscopy and scanning and transmission electron microscopies, we report the characterization of the pyrite crystals produced in the presence of Thermococcales. The pyrite spherules consist of an assemblage of ultra-small nanocrystals of a few ten nanometers in size, showing coherently diffracting domain sizes of few nanometers. Importantly, they sequester biogenic organic compounds in small but detectable quantities, typical of the functional groups measured in mineralization studies involving prokaryotes [2] [3]. In order to explore their use as biosignatures of hydrothermal microorganisms, we conducted experiments to test if similar pyrite spherules presenting the same crystallographic and organic compound features could form in hydrothermal abiotic conditions.

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