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Exceptional preservation of aragonite in a circa 3.3 billion year old microbial mat from the Barberton greenstone belt, South Africa

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Aragonite occurs as a biologically-formed mineral precipitate within modern calcifying microbial mats. It is, however, rarely preserved in the geological record because, as one of the least stable polymorphs of calcium carbonate, it readily converts to calcite in present environmental conditions at the Earth's surface. In an in situ investigation at the micro- to nanometer-scale, we show that 5-10 nm sized nanocrystals of aragonite are preserved within the organic framework of a partially calcified microbial mat from the $\sim$ 3.3 billion year-old Josefsdal Chert in the Barberton greenstone belt, South Africa. Transformation of the aragonite to calcite was blocked by a combination of chemical inhibitors within the crystal lattice, organic molecules coating the nanocrystals and, in particular, to the precocious permeation of the mat by hydrothermal silica. Apart from its exceptional preservation for 3.3 billion years, the identification of aragonite in the Josefsdal microbial mat is the earliest evidence for in situ calcification of a microbial mat. Furthermore, the indications of associated sulphur-reducing bacteria (SRB) activity with calcification strongly support a photosynthetic origin for the mat. This is the most direct evidence for photosynthesis in early Archaean rocks.