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Authigenic silica and primary productivity in the Mesoproterozoic oceans: insights from the organic rich mudstones of the Velkerri Formation (Northern Territory Australia).

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The secular evolution of marine silicon, carbon and phosphorous cycles influence interpretation of life and climate histories on Earth. In today's oceans, dissolution and recrystallization of siliceous skeletons of marine plankton results in Si sequestration in sediments as diagenetic opal and quartz. In the absence of biosiliceous skeletal grains, the pathway for Si transfer from seawater and its distribution into Pre-Cambrian sediments remains enigmatic.

We determine the abundance and stratigraphic distribution of authigenic quartz in the ca. 1.38 Ga Velkerri Formation Velkerri Fm., a key archive for the Mesoproterozoic ocean chemistry and an economically important source rock of the McArthur Basin, Northern Territory (Australia). Using petrographic, geochemical and isotopic analyses, we demonstrate that a major fraction of quartz (up to 45 % of the rock volume) is not of detrital origin. Instead, it precipitated in situ as an early diagenetic phase in subunits characterized by high organic and phosphorus contents indicative of high primary productivity at the time of deposition. We infer that this early diagenetic quartz results from recrystallization of amorphous silica sequestered from the sea water through mediation of a planktonic and benthic cyanobacterial role.

Probabilistic volumetric estimations show that the Velkerri Formation contains several thousands of km^3 of authigenic quartz. This quartz volume represents an important mineral record of the silica cycle that suggests a critical and, so far, overlooked cyanobacterial role in Si sequestration in Mesoproterozoic sedimentary basins.