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Textural and geochemical characteristics, and process of formation, of ooids in the Mesoarchaean Pongola Supergroup, South Africa

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Ooids from the Mesoarchaean c. 3.0 Ga Nsuze Group, Pongola Supergroup, South Africa, are the oldest well-preserved microbial coated grains that are known today. They are mostly made of dolomite and, to a lesser extent, ankerite and show a concentric, radial-concentric, micritic and radial fabrics. The Sr content is variable among ooids with different fabrics, with the least amount in the radial ooids (ca.100-140ppm) and the highest amount in the concentric ooids (140-350 ppm). It is very likely that the primary chemical composition of radial ooids was different from that of radial-concentric and concentric ooids. It is possible that concentric ooids with a higher Sr content and better degree of fabric preservation had an aragonite precursor, while radial ooids with the least Sr content and poorer fabric preservation had a calcite precursor.

The mechanisms of ooid formation have long been debated. A number of formation processes have been suggested, including inorganic physico-chemical mechanisms in which carbonate ooids precipitated from agitated shallow-sea water supersaturated with calcium bicarbonate [1], and biologically-mediated mechanisms in which carbonate ooids were synthesized in the presence of humic acids [2].

Evidence from a combination of NanoSIMS ion mapping and scanning electron microscope (SEM) imaging, and Raman spectroscopic imaging of carbonaceous matter interwoven with the internal structure of ooids suggests that bacteria probably played an active role in the formation of the ooids. On the other hand, the mineralogical differences in the cortices of the ooids are suggested to have been a result of the degree of water agitation and the presence and concentration of specific organic acids in the environment at the time of carbonate precipitation. For example, it has been shown that the presence of certain organic acids cause Mg-calcite to crystallize from solutions which, in their absence, would crystallize aragonite [3].

In the Nsuze Group, the distribution of oolitic facies in the high-energy depositional settings of intertidal to shallow-subtidal and, to a lesser extent, to microbialite facies indicates that turbulent hydrodynamic conditions probably were controlling microbial communities that were responsible for determining ooids with different fabrics and mineralogy. It is likely that combinations of both biogenic and non-biogenic processes (hydrodynamic conditions) were responsible for ooid formation in the Nsuze Group.

References:

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