

Insights into oncoidal morphology and sedimentology of a Mesoarchean granular iron formation from southern Africa using 3D X-ray computed tomography (μ XCT)

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The oldest known granular iron formation (GIF) occurs in the ca. 2.96–2.92 Ga Mozaan Group of the Pongola Supergroup of southern Africa. The GIF comprises stacked beds interbedded with deeper water facies iron formation. The chert granules are marked by irregular rims composed of magnetite and calcite and can be defined as oncoids. Initial geochemical studies showed that the calcite is isotopically light, suggesting an organic carbon source for CO₂, and that the Fe isotope characteristics of shallower water GIF are decoupled from those in the deeper water iron formation. Due to the complexity of the oncoidal rim morphologies, traditional petrography is complicated by the bias inherent to 2D intersections of the samples. However, the different mineral densities allow successful μ XCT revealing that the rim morphologies are fairly homogenous, consisting of multiple, multi-directional, micro-scale chert, magnetite and calcite domes surrounding the granule cores. The chert cores of the granules and domes suggest continuous chert precipitation in a wave-reworked environment. A surprising result was that calcite was not limited to the granule rims, and that some granules contain abundant calcite in their cores, indicating that calcite formation is not linked to that of magnetite. Ferric iron can therefore not be the organic carbon oxidant. 3D reconstruction of granules and samples shows that the GIF contains multiple upward fining beds, with granules decreasing in size, followed by granule and rim fragments, terminating in an Fe-rich clay layer. Granule rims can also be seen to have been broken off. These characteristics support deposition from storm surge currents.