



Discrimination between original and non-original biosignatures in banded iron formations: petrological and geochemical evidences from the 2.7 Ga Manjeri Formation, Belingwe Greenstone Belt, Zimbabwe

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The role of microorganisms in the formation of, and the origin of organic matter within, banded iron formations (BIFs) and cherts has been investigated for many years. However, organic carbon could have been introduced at any time after deposition of the BIFs and, consequently, isotopic and biochemical signatures (e.g. C, N, S) may be mixtures of primary and later introduced organic materials. The Belingwe Greenstone Belt (BGB, 2.9–2.6 Ga) is one of the best preserved and least deformed Archean greenstone belts in the world. BIFs and cherts were studied from the shallow marine facies of the Spring Valley Member (SVM) and the deeper marine facies of the Jimmy Member (JM), both belonging to the 2.8 - 2.7 Ga old Manjeri Formation.

Two different facies occur within the SVM BIFs and cherts; an oxidised facies composed of banded jaspilites with minor carbonates and a reduced facies composed of carbonate- and Fe-Cu-sulphide-bearing cherts. These represent, respectively, distal and proximal chemical precipitates of a hydrothermal source. A terrigenous component is reflected by the presence of minor aluminosilicates. Within the reduced facies, ankerite, siderite and calcite form bedding-parallel bands and lenses and are associated with small, disseminated pyrites. In both facies, disseminated carbonates are a result of percolation of seawater-derived (elevated Sr concentration) diagenetic fluids. The final product is calcite, particularly in the reduced facies, after removal of Fe and Mg from the fluid. The primary mineralogy of the JM is pyrite and quartz \pm carbonates.

Some time after deposition of the Manjeri Formation, but prior to 2.6 Ga ago, deformation and reducing hydrothermal fluid activity affected the Manjeri Formation. Attributed to the last hydrothermal event is the brecciation of some of the jaspilites and precipitation of a black, organic matter-rich chert and/or the crystallization of large euhedral magnetite (oxidized SVM facies), pyrite (reduced SVM facies & JM facies) and carbonate (JM facies).

The $\delta^{13}\text{C}_{\text{PDB}}$ values of the carbonates are negative in both the SVM (-3.04 to -10.12 ‰) and JM (-7.99 ‰ and -8.58 ‰). These values are too low for marine carbonates (0 ± 2 ‰). In order to explain these low values it is suggested that primary organic matter was converted into carbonates during burial diagenesis resulting in overall low C_{org} values (<100 – 300 ppm). The high C_{org} content in the brecciated black chert (1300 ppm) is due to the last, reducing hydrothermal event, indicating that the introduction of secondary Archean organic matter into the BIFs resulted in the $\delta^{13}\text{C}_{\text{PDB}}$ value being a mixture of two Archean organic compounds. A sample of highly weathered JM contains the highest C_{org} concentrations (up to 1800 ppm). It is likely that part of this organic matter is due to the influence of modern weathering and the $\delta^{13}\text{C}_{\text{PDB}}$ represents a mixture of Archean and post-Archean compounds.