

Neoproterozoic iron formation of Carajás (Brazil) linked to anoxygenic photosynthesis

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The chemical and isotopic compositions of iron formations (IFs) are commonly used to constrain the redox state of the Precambrian ocean-atmosphere system, but ongoing debate remains concerning the role of microbial metabolisms in the precipitation of these chemical sediments. Here, we combine Fe and C isotopes with major and trace element analyses to constrain the redox pathways pertaining to the deposition of the 2.7 Ga old IFs of the Grão Pará Group, Carajás, Brazil. The IFs studied consist of two main types of rocks: finely laminated IFs consisting of alternate mm-scale layers of Fe-oxides, chert and carbonate (Type 1); relatively massive carbonate with minor mm-scale Fe-oxide layers (Type 2). Bulk rock chemistry shows a minor detrital component (e.g., $Al_2O_3 < 1\text{wt}\%$) and argues for an overall anoxic environment of deposition (positive Eu anomaly, absence of Ce anomaly, low U/Th ratio). An average $\delta^{13}C_{org}$ value of $\sim -25\text{‰}$ in both Type 1 and Type 2 IFs points to the important role of microbial photosynthesis in this oxygen-free environment. $\delta^{56}Fe$ values range between -0.8‰ and $+1.59\text{‰}$, with Type 1 and Type 2 showing a positive ($+0.6$ to $+1.59\text{‰}$) and a negative (-0.2‰ to -0.8‰) range of values, respectively. The occurrence of both a sharp contrast in Fe isotope composition and a constant C_{org} isotope and major and trace element compositions between Type 1 and Type 2 IFs is best attributed to different degrees of partial Fe(II) oxidation by anoxygenic phototrophs coupled with precipitation of various proportions of Fe-oxides and Fe-bearing carbonate in anoxic water column and sediments, respectively.