

Records of pre-GOE sedimentation: Signatures of continental weathering and the resulting detrital baseline

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Efforts to constrain the delivery of continental (detrital) sediment to the shallow ocean during the Archean are challenged by the scarcity of oxic settings and, correspondingly, the likelihood of intense enrichments of iron and trace metals under the ferruginous and less frequent euxinic conditions that characterized this time period. Knowing the composition of the primary detrital inputs is essential because those data provide a baseline against which enrichment processes and related environmental controls can be assessed. Furthermore, the river-sourced materials provide a window to the presence or absence of oxidative weathering processes and the degree to which reactive iron delivery to the ocean is control by continental inputs versus hydrothermal sourcing from the seafloor.

Here we present data from shales from Batatal Formation (~2.6 Ga), Caraça Group, Minas Supergroup, Brazil. The Batatal Formation is comprised of offshore sediments deposited on a slowly subsiding continental shelf along a passive margin. General comparisons have been made to the Mt. McRae Shale (2.5 Ga) of W. Australia. However, unlike the Batatal, the Mt. McRae is marked by strong ferruginous/euxinic metal enrichments and a likely episode ('whiff') of oxidative continental weathering. The Batatal, by contrast, is characterized by subcrustal levels of trace metals, compared to the younger continental baseline, and unusually low levels of total and reactive iron. The implication is that the site of deposition, if ferruginous, was swamped by high rates of detrital sedimentation or lacked the carbonate and oxide mineralization pathways that can enrich marine sediment in iron in an anoxic ocean. The very low iron levels argue against appreciable oxidative continental weathering at this time given the extensive delivery of Fe oxide-coated grains that characterize younger intervals of Earth history. Another possibility is deposition within a surface-ocean oxic oasis, although we might expect iron enrichments linked to oxidation of ferrous iron delivered by rivers beneath an oxygen-poor atmosphere. We will address all these possibilities in detail, including the special glimpse the Batatal may provide into continental weathering/transport processes and the fluxes of reactive and unreactive minerals/elements that were delivered to the ocean before the GOE.