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Metamorphic overprinting and impact on the interpretation of 1.1 Ga Mesoproterozoic paleoenvironmental marine conditions in the Taoudeni Basin, Mauritania: Insights from Trace Elements and Iron Isotope Compositions.

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The concentration of redox sensitive trace metals and their isotopic composition preserved in Precambrian marine sediments, are critical for the reconstruction of ocean-atmosphere oxygenation history. Particularly, the concentration of Fe, its redox speciation, and isotopic distribution, have gained widespread use for inferring the biogeochemical processes that controlled Fe cycling in Precambrian oceans, linked to the reconstruction of Earth surface redox budget. However, questions remain about the impact of post-depositional processes (including diagenesis and metamorphism) that affect most ancient sedimentary rock records, on the reliability of the Fe redox proxy. Here we present a multi-proxy mineralogical and geochemical study of the ~1.1 Ga Atar and El Mreiti strata of the Taoudeni Basin in Mauritania, to better understand how post-depositional processes impacted seawater Fe mineralogy, speciation, and isotopic ratios during this time. We compare the Fe systematics of the unmetamorphosed Mesoproterozoic rocks with those subjected to regional late-stage dolerite sill intrusion. Notably, the well-preserved and unmetamorphosed samples exhibit δ^{56}Fe compositions consistent with a change in seawater redox state from oxic to anoxic and sulfidic conditions. However, the metamorphosed rocks display δ^{56}Fe heterogeneity with light and heavy signatures reflecting secondary Fe-mineral precipitation produced by metamorphic and metasomatic overprinting of carbonate-rich rocks during interaction with hot circulating fluids. This study suggests post-depositional metamorphic/metasomatic overprinting complicates direct reconstruction of seawater biogeochemical processes and redox state using δ^{56}Fe systematics. However, careful integration of petrographic and mineralogical data with δ^{56}Fe distribution, enabled the untangling of these post-depositional processes from primary marine signals and more reliable interpretation of seawater biogeochemical Fe cycling and redox evolution.