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From Basin Formation to Deep Crustal Reactivation: Timescales of Paleoproterozoic Manganese Deposition in Brazilian High-Grade Terranes

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Manganese-rich metasedimentary sequences preserved in high-grade terranes provide important constraints on the coupling between surface environments, basin development, and deep crustal processes during early lithospheric evolution. This study presents new U–Pb zircon geochronological constraints from manganese-bearing successions exposed in eastern Brazil, including domains of the southern Brasília Orogen and the Borborema Province. The deposits occur within paragneisses, quartzites, and associated metasedimentary rocks that record primary chemical sedimentation subsequently modified by metamorphic and supergene processes. Geochronological data from both tectonic domains consistently indicate protolith ages around ca. 2.1 Ga, interpreted as the timing of manganese deposition during Paleoproterozoic basin formation. The reproducibility of these ages suggests large-scale geodynamic controls on manganese accumulation rather than localized depositional events. Evidence for early metamorphic zircon growth at ca. 2.0 Ga indicates rapid tectonothermal overprinting shortly after deposition, reflecting active lithospheric processes during basin evolution.Despite the Paleoproterozoic imprint, the dominant metamorphic overprint is Neoproterozoic, with ages clustering between ca. 600 and 620 Ma. This later event corresponds to intense crustal thickening and reworking under amphibolite- to granulite-facies conditions during Brasiliano orogenesis, partially resetting isotopic systems while preserving the primary depositional signature. Mineral assemblages dominated by Mn-rich garnet, quartz, and manganese oxides record a complex history involving primary sedimentation, metamorphic redistribution, and localized supergene enrichment.These results highlight a multi-stage evolution linking Paleoproterozoic surface processes to Neoproterozoic deep crustal reworking, providing new constraints on the longevity and reactivation of Archean–Proterozoic lithosphere in South America. The temporal coincidence between manganese deposition at ca. 2.1 Ga and major global environmental and tectonic transitions following the Great Oxidation Event supports a genetic relationship between basin-scale geodynamics, environmental change, and manganese metallogenesis.The first author acknowledges financial support from CNPq through Research Grant 407255/2022-2 and a Productivity Fellowship (301375/2025-9).