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A Supergene-Hydrothermal Origin of the BIF-Hosted High-Grade Iron Ores in the Mbarga Prospect, Mbalam Iron Ore District, Southern Cameroon, Congo Craton

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The Mbarga prospect lies within the Mbalam iron ore district of the Ntem Complex on the Congo Craton (CC). It is characterized by Banded Iron Formations (BIFs), high-grade supergene, and specularite ores. This study presents mineralogical, geochemical, and isotopic datasets on these ores to determine their origin. Ore microscopic studies indicate that the BIFs are of the oxide facies type, with magnetite showing alteration to hematite-martite. The supergene ores consist of hematite + martite + goethite ± gibbsite ± magnetite ± quartz, while the specularite ores are composed of hematite + martite ± quartz. Magnetite microchemistry suggests formation under low-*T* hydrothermal conditions (~200–300 °C) with high fO_2. Geochemical analyses suggest that the supergene and specularite ores have higher Fe_2O_3 (88.27 to ~100 wt%) and lower SiO_2 (<0.01 to 0.18 wt%) contents than the BIFs (31.95 wt% Fe_2O_3, 67.16 wt% SiO_2). The enrichment of Fe in the supergene ores is attributed to the depletion of major oxides and trace elements due to weathering and supergene enrichment, while the high Fe content in the specularite ores stems from the precipitation of iron-rich, but trace- and REE-deficient hydrothermal fluids. The slightly higher Al_2O_3 content and positive Ce anomalies in the supergene ores suggest retention of Al-bearing minerals (gibbsite) and reveal highly oxidative conditions during martitization. Stable isotope analyses reveal that the supergene and specularite ores have $\delta^{18}O$ values of -2.5 to -0.3‰ and -2.0 to -3.4‰, and $\delta^{2}H$ values of -75 to -123‰ and -70 to -119‰, respectively, suggesting the involvement of isotopically light-evolved meteoric water in their formation. In contrast, the BIFs exhibit heavier $\delta^{18}O$ (8.5 to 10.2‰) and $\delta^{2}H$ (-85 to -91‰) values, suggesting formation from mixed magmatic-metamorphic fluid sources. A “polygenic-supergene-hydrothermal” model is suggested for the formation of the Mbarga BIF-hosted iron ores.