The paleoenvironmental and economic significance of the post-GOE pre-Gamagara unconformity, South Africa

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The ~2.2-2.0 Ga pre-Gamagara unconformity is one of the oldest post-GOE weathering profiles developed in South Africa's geological record. It intersects multiple sedimentary and intrusive units of the ~2.6-2.2 Ga Transvaal Supergroup in the Griqualand West region of the Kaapvaal Craton. Paleoweathering profiles are developed along the unconformity, which provide insight into the post-GOE surface environments in the region.

Where the unconformity intersects the Neoarchean Campbellrand carbonates, a paleokarst system is developed that contains significant Mn wad deposits. These were derived from the weathering of Mn- and Fe-rich dolostones. The unconformity also intersects multiple iron formation units throughout the Transvaal Supergroup. In each of these instances high-grade (>90% Fe_2O_3) hematite ore is developed, where the iron formation protolith has been completely oxidized and leached of silica. Ce anomalies, which are absent in the protolith, are developed in the ores. The largest of these deposits occur where these iron formation blocks have collapsed into paleokarst sinkholes of the underlying Campbellrand carbonates. The unconformity also intersects mafic sills in the region, with distinct chemostratigraphic profiles developed in the homogenous protolith. These profiles are marked by upward depletion of alkali earth metals, U, Mn, P and Cu as well as an upward increase in Fe^{3+}.

The weathering profiles all indicate highly oxygenated, low latitude, hot and humid terrestrial surface conditions at ~2.2-2.0 Ga, with groundwaters evolving from low to high pH and high to low Eh with depth, similar to modern lateritic weathering environments. Furthermore, the mobility of P and Cu in the mafic sill-hosted weathering profiles are suggestive of organic acid-induced weathering, implying terrestrial life on the post-GOE Kaapvaal Craton. The development of post-GOE weathering profiles in Archean to Paleoproterozoic sedimentary successions also mark major ore-forming events where these unconformities can act as exploration vectors.