

Supergene Ferromanganese Wad Deposits Derived from Permian Karoo Strata along the Late Cretaceous–Mid-Tertiary African Land Surface, Ryedale, South Africa

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Abstract

A previously unknown type of ferromanganese wad deposit is described at the Ryedale mine situated 110 km west of Johannesburg in the northwestern province of South Africa. The wad was derived from supergene alteration of Glossopteris-bearing Permian strata of the Karoo Supergroup that fill shallow karstic depressions in Neoproterozoic Malmani dolomite of the Transvaal Supergroup. The depressions contain up to several million tons of friable and highly porous ferromanganese wad with an average Mn/Fe ratio of about 0.3 and high grades of between 77 and 91 wt percent Fe₂O₃+ MnO. A detailed mineralogical, petrographical, and geochemical study of the orebody suggests that the wad is a saprolitic residue of manganese-bearing blackband iron ores known to be associated with Permian coal measures of the Karoo Supergroup. The protore was deposited in shallow lakes in preexisting karstic depressions in the Malmani dolomite as finely laminated mud composed of biogenic detritus and Mn-Fe oxyhydroxide precipitates. Siliciclastic detritus is conspicuously absent, suggesting that the lakes were exclusively fed by reducing and acidic ground water that leached manganese and iron from the underlying Malmani dolomite. Anaerobic early diagenesis led to the transformation of oxide precipitates into Mn-Fe carbonates. Much later, during the African cycles of erosion and weathering, the blackband ores were exhumed, partly eroded, and altered by deep lateritic weathering to form the present ferromanganese wad.