Paper Number: 4908

Re-evaluating models for manganese ore genesis in the Postmasburg Manganese Field, Northern Cape, South Africa

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The Postmasburg Manganese Field (PMF), located in the Northern Cape Province of South Africa, once represented one of the largest sources of manganese ore worldwide. However, the discovery of the giant manganese deposits of the Kalahari Manganese Field (KMF) led to the gradual decline in manganese mining activity in the PMF. Two belts of manganese ore deposits have been distinguished in the PMF, namely the Western Belt of ferruginous manganese ores and the Eastern Belt of siliceous manganese ores. Prevailing models of ore formation in these two belts invoke karstification of manganese-rich dolomites and residual accumulation of manganese wad which later underwent diagenetic and low-grade metamorphic processes. For the most part, the role of hydrothermal processes in ore formation and metasomatic alteration is not addressed.

The identification of an abundance of common and some rare Al-, Na-, K- and Ba-bearing minerals, particularly aegirine, albite, microcline, banalsite, sérandite-pectolite, paragonite and natrolite in the PMF ores, observed in this study, is indicative of the influence of hydrothermal activity. Enrichments in Na, K and/or Ba in the ores are generally on a weight percent level for the majority of samples analysed through bulk-rock techniques. The discovery of tokyoite, a Ba-Mn arsenate/vanadate similar to gamagarite may also indicate that the hydrothermal fluid affecting the ores was not only alkali-rich but also probably contained some As and V. The fluid was likely to be oxidizing and alkaline in nature and is thought to have been a mature basinal brine. Various replacement textures, particularly of Na- and K-rich minerals by Ba-bearing phases, suggest sequential deposition of gangue as well as ore-minerals from the hydrothermal fluid, with Ba phases generally being deposited at a later stage.

The stratigraphic variability of the studied ores and the deviation of their character from the pigeon-hole-type classification of ferruginous and siliceous ores in the literature, suggests that a re-evaluation of genetic models is warranted. The discovery of hydrothermally-deposited, alkali-rich assemblages in the PMF and KMF provides grounding for further investigation into a possible regional-scale hydrothermal event at least re-constituting the ores. Some shortcomings in previous works include disregard for the highly variable nature of the PMF deposits, the effects of hydrothermal activity of the ores and the existence of stratigraphic discrepancies. This study provides a single, broad model for the development of all manganese deposits of the PMF. The source of metals is attributed to all formations that stratigraphically overly the Reivilo Formation of the Campbellrand Subgroup (including the Reivilo Formation itself). The main process by which metals are accumulated is attributed to karstification of the dolomites. The interaction of oxidized, alkaline brines with the ores is considered and the overlying Asbestos Hills Subgroup BIF is suggested as a potential source of alkali metals.

This study was made possible through the kind contribution of Kumba Iron Ore, who sponsored the project and provided access to drill-cores for sampling.