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BIF-hosted manganese deposits of Africa

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Africa hosts just over 80 percent of the world's known land-based ore resources of manganese metal and produced some 41.1 percent of the 18 million tons of manganese metal in ores that was mined during 2014. The deposits are mainly of sedimentary and supergene origin comprising four major types, namely banded iron formation (BIF)-hosted, black shale-hosted, oolitic and supergene/karst-hosted deposits. It is the purpose of this presentation to review the geological setting and ore characteristics of the BIF-hosted manganese deposits that include the giant ~2.2 Ga Kalahari Manganese Field (KMF) of South Africa (holding some 4,200 million tons of manganese metal that represents about 77 percent of the world's known land-based resource) and small ~2.4 Ga Rooinekke and Cryogenic (~0.74 Ga) Otjosondu deposits of South Africa and Namibia respectively.

The Kalahari Manganese Field (KMF) is hosted by the Hotazel Formation, composed of BIF with three interbeds of manganese, of the Transvaal Supergroup in the Griqualand West (Cairncross and Beukes, 2013). It is preserved in five erosional relicts below an unconformity at base of ~2,0 Ga Gamagara/Mapedi red beds along the Dimoten syncline, northwest of Kuruman. Currently all production comes from the largest of these relicts, known as the Main Kalahari deposit, and essentially from the lower manganese bed that reaches a thickness of up to 45 m in the southeast and thins to around 8-10 m in the northwest. A major low-angle thrust fault system, with estimated eastward displacement of 35–60 km, duplicates strata along the western margin of the Main deposit. There are three main ore types present in the Main Kalahari deposit, namely low-grade (30-38 wt % Mn) primary sedimentary braunite-kutnahorite Mamatwan-type ore comprising some 97% of the resource; high-grade (42-60 wt % Mn) hydrothermally altered hausmannite-bixbyite-braunite Wessels-type ore, and high grade cryptomelane-bearing supergene ore developed at the base of the Cenozoic Kalahari cover succession making up not more than 0,1 % of the total ore resource.

The small Rooinekke deposit is situated in the ~2.4 Ga Rooinekke Iron Formation of the Koegas Subgroup of the Ghaap Group of the Transvaal Supergroup. It comprises of two jacobsite-braunite-hausmannite-hematite ore beds, each ~1 m thick, interbedded with clastic-textured Rooinekke BIF. The manganese ore beds developed from ancient ~2.0 Ga supergene alteration of primary sedimentary manganese carbonate beds that are interbedded with Rooinekke iron formation. Barite and quartz are common gangue minerals related to a later (~1,1 Ga) hydrothermal alteration event that also introduced rhodochrosite and Mn-silicates. Recent weathering resulted in formation of manganomelane and pyrolusite.

The Otjosondu deposit in Namibia consists of two, 4–7 m thick, braunite-jacobsite sedimentary manganese ore beds bordering a central 30–40 m thick banded iron formation enclosed by quartzite. The iron formation unit, with associated manganese beds, is correlated with the Sturtian glaciogenic

Chuos Formation in the Khomas Subgroup of the Swakop Group, Damara Supergroup. In the area of the mine the lithogical succession is isoclinally folded and metamorphosed to upper amphibolite facies.

REE data suggest that the iron formations and manganese in these deposits were sourced from hydrothermal fluids mixed in with open marine water in the basins. Early diagenetic manganese carbonates in the KMF and Rooinekke deposit are highly depleted in C^{13} indicating that they were derived from reduction of original manganese oxide precipitates in presence of organic matter. This in turn suggests activity of manganese oxidizing bacteria in precipitation of the manganese beds. A flux of free oxygen must have been available in the basins to have allowed deposition of the original manganese oxide beds.