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Mineralogy of excessive fines-producing manganese ore, Kalahari Manganese Field, South Africa

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The Kalahari Manganese Field (KMF) is the largest land-based manganese deposit in the world. It is located in the Northern Cape Province in South Africa, approximately 80 kilometres north of Kathu. The mined portion of the KMF forms part of the Transvaal Supergroup chemical sediments of the Voëlwater Group in the Hotazel Formation. Three manganese horizons are developed, the lower Manganese 1 (Mn1) seam, the Manganese Marker Seam, referred to locally as Manganese 3 (Mn3) seam that forms part of the BIF-dominated middling, and the upper Manganese 2 (Mn2) seam [1] [2] The northern part of the deposit was subjected to tectonic deformation and low grade hydrothermal alteration. This resulted in the development of two ore types. The lower grade ore is referred to as Mamatwan type and the higher grade hydrothermally altered ore is referred to as Wessels type ore. Sub-vertical and sub-horizontal joints dominate the deposit.

At manganese underground mines, mining Wessels-type ore, both the Mn1 and Mn2 seams are developed. Three distinct mineralisation styles are observed in both of the mined seams. The dominant mineralisation style is a very fine-grained massive ore, yielding a lumpy product after blasting with manageable fines generated. The second mineralisation type is irregularly developed and is a coarser-grained massive, ore yielding a lumpy product after blasting, but with excessive fines being produced. The third mineralisation style is also irregularly developed. It is a highly ferruginised, fine-grained massive material that is considered waste.

All three mineralisation types were submitted for x-ray fluorescence (XRF), x-ray diffraction (XRD) and a petrographic examination by reflected light microscopy. The hard, fine-grained manganese ore was found to consist dominantly of hausmanite, braunite, bixbyite, andradite and minor hematite and calcite. The friable, coarse-grained ore consist of a monomineralic, equigranular braunite. The ferruginised material consists of andradite, apatite, barite, calcite and dolomite with minor epidote, hematite, richterite and trace rhodochrosite.

The conclusion is that the extent of fines being produced per blast is a result of mineralogy and texture. The more fine grained and heterogeneous the ore is, the better the lumpy product produced after a blast. The finer-grained minerals in effect act as cementing agent between the coarser grains. The coarser-grained, monomineralic and equigranular ore is more prone to producing excessive fines. Physical features such as banding and jointing have a lesser impact. The ferruginised material appear to be the result of the precursor rock containing a carbonate, such as dolomite, prior to being subjected to hydrothermal alteration.

References:

[1] Astrup J and Tsikos H (1998) In *The Mineral Resources of South Africa*. Council for GeoScience, 450 -460