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Geometallurgical Evaluation of the Lowermost, Low-Grade Manganese Bed in the Kalahari Manganese Field, South Africa

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The Kalahari Manganese Field (KMF), situated in the Northern Cape of South Africa, boasts a significant portion, approximately 77%, of the world's known land-based manganese reserves. The focus of the study is on the lower most Mn seam, in the eastern portion of the KMF, at one of the mines containing ore of lower grade, approximately <36 wt% Mn.

Macroscopic visual logging identified five distinct textures within the ore, each containing a unique composition. This study unravels the intricate relationship between these textural features, the geochemical characteristics, and the comminution behaviour of the ore within the low-grade mine of the KMF.

Utilizing a random forest regression algorithm, the study elucidates the relationship between the geochemical and textural variability within the ore. Findings from this analysis underscore a direct relationship between manganese grade and the textural attributes, facilitating the creation of a predictive Mn model, using the five textures as the input variables to prevent off-seam underground mining. Furthermore, the comminution behaviour of each texture is evaluated through relative crushability measurements using a laboratory-scale jaw crusher. Integrated analyses reveal the mineralogy as the driving factor for differences in crushability among the textures.

Mineralogical analyses, conducted through scanning electron microscopy and reflective microscopy techniques, identified two primary ore types. Unaltered braunite lutite, containing carbonate ovoids and laminae of diagenetic origin, and altered ore, characterized by an influx of bedding-parallel hausmannite due to metasomatic influx during late-stage, low-grade metamorphism.

The strong correlation between the textural variation and geochemical properties of the ore, together with the varying comminution behaviour and mineralogy, will aid in developing detailed models of the geometallurgy and genesis of the Mn ore at the mine, to not only improve the understanding of the ore but also improve the processing effectiveness and increase the life of mine.