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Determination of Hematite and Magnetite Attenuation Coefficients for the Optimisation of X-ray Computed Tomography Scanning Resolution

Bam, L.C.[1, 2], Miller, J.A. [2], Becker, M. [3], Basson, I. [4] and De Beer, F.C.[1]

[1]Radiation Science, South African Nuclear Energy Corporation (Necsa), Pretoria, 0001, South Africa [email: lunga.bam@necsa.co.za]
[2] Department of Earth Sciences, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa
[3] Centre for Minerals Research, Department of Chemical Engineering, University of Cape Town, Private Bag, Rondebosch 7701, South Africa
[4] Tect Geological Consulting, Unit 8, AMDEC House, Steenberg Office Park, Tokai, South Africa

X-ray computed tomography (XCT) is a non-destructive technique that uses X-rays to identify materials according to their X-ray attenuation coefficient. Theoretically, the attenuation coefficient is a function of sample thickness, density and X-ray energy. It is calculated using the Beer-Lambert law. The experimental attenuation coefficient shows a strong dependence on magnification (resolution) due to scattering contributions and the polychromatic nature of the X-ray beam. The scattering contribution to the attenuation coefficient decreases as the sample is moved closer to the detector. This means that the experimental attenuation coefficient accords with the theoretical attenuation coefficient only when the sample is close or much closer to the detector. This becomes a problem when characterising samples/particles that are resolution-dependent.

Recently, improvements in XCT capability have expanded the use of XCT across a wide range of scientific projects. Of interest in this study is the application of XCT to the 3D study of drill core from various deposits. In many deposits, the relatively large grain size and significant differences in atomic density between the ore minerals and host minerals allows the determination of the distribution of ore minerals in situ by XCT. However, in some cases the physical and chemical properties of the constituent minerals make it challenging to differentiate them using only XCT. Differentiation of hematite and magnetite exemplifies this problem, wherein their compositional similarity makes phase differentiation by X-ray challenging.

In this study, different thicknesses of hematite and magnetite samples were scanned at different magnifications to monitor changes in the attenuation coefficients or grey values on radiographs. The maximum sample thickness simulates the typical diameter of hematite and magnetite drill cores. This is important when compiling a grey value database that may be used for comparison when routinely scanning complex samples of hematite and magnetite. The grey value difference will be used to predict the unknown material with respect to its attenuation coefficient. This will add more value to 2D data (radiographs) which may be augmented by 3D data (tomography). The goal is to develop a correction method or protocol that will allow direct comparison, of the calculated experimental attenuation coefficients of hematite and magnetite, with the theoretical attenuation coefficients at all magnifications. It is intended that the correction method will provide reliable hematite and magnetite

XCT grey-level data that may be used as a proxy for determining the texture and mineralogy of iron ore samples, using 2D radiographs. This technique, once developed, could play a crucial role in improving mineral processing and circuit design.