X-ray Computed Tomography – a Geometallurgical Tool for 3D Textural Analysis of Drill Core?

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ABSTRACT

Although the role of texture has been increasingly recognised as a geometallurgical indicator of ore characteristics and their variability, the ability to appropriately quantify and correlate it with metallurgical performance remains an ongoing challenge. In this study, we propose the 3D characterisation and quantification of ore textures from drill core using X-ray computed tomography (XCT) with an appropriate image analysis methodology (grey level co-occurrence matrices, GLCM). This methodology has been specially customised for application of 3D XCT grey-scale volumes. This approach has potential as an online mine site analysis tool providing detailed 3D information on both quantitative texture and simple mineralogy.

The approach is illustrated in this paper using drill core samples that were manually extracted from various rock types and textures representing the Nkomati Main Mineralized Zone (MMZ) sulfide nickel ore deposit. A preliminary classification of the samples was performed based on their particle size distribution after laboratory scale rod milling. Accompanying QEMSCAN analyses were also used to guide the interpretation of the grey-scale mineralogy and texture in the 3D XCT volumes. The resultant GLCM produced from quantitative 3D image analysis of the XCT volumes indicated sensitivity to ore variability and was able to capture a simple mineralogy and grain size distribution. The approach holds many possibilities for geometallurgy, of which the potential for automation is promising.

INTRODUCTION

Geometallurgy, ore variability and texture

In recent years, there has been an increased awareness of the role of ore variability in plant design and the disadvantages of designs catering for an 'average' ore (Powell, 2013). Consequently, these historical designs are unable to cope with the heterogeneity and fluctuations in ore characteristics that are so very prevalent in the complex low-grade ores that the modern mining industry is faced with treating (Baum, 2014). It is well-known that the inherent mineralogical and textural properties of the ore, and the variation thereof ultimately control the response of the ore to minerals beneficiation. In the extreme, the complex mineralogy of the ores presents a barrier that can only be overcome by the development of new and innovative engineering technologies. One example of this would be the development of the more energy efficient stirred milling technology for ultra-fine grinding needed to liberate finely disseminated valuable minerals (Pease, Young and Curry, 2005; Rule and Schouwstra, 2011).

Geometallurgy, however, goes well beyond just plant design. Instead it aims to embed the geological and mineralogical information with its associated metallurgical response into the orebody block model for all aspects of mineral resource management – to provide appropriate and timely ore characterisation information to all relevant parties (geology, mining engineering, mineral processing, environmental, finance) enabling the economic and sustainable operation of the current and future mine site (Stradling, 2011; Williams and Richardson, 2004; Jackson, McFarlane and Hoal, 2011). In practice, the ability to effectively geometallurgically characterise the mineralogy of an orebody representing several million tonnes without statistically averaging its variability is a challenge. It requires ongoing, simple, robust, quick, cost-effective measurements that can be run on thousands of samples producing data that can be correlated to metallurgical response (Hunt, Kojovic and Berry, 2013; Parbhakar-Fox *et al*, 2011; Schouwstra *et al*, 2013). Although chemical assay information is generally quick and cheap, it is not always appropriate, given that the elements of interest may be deported through a range of different minerals (Lund, Lamberg and Lindberg, 2013; Parian *et al*, 2015). Where available, mineral assay information can be of use in routine hyperspectral imaging

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