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# The influence of veins on mineral liberation as described by random masking simulation

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ABSTRACT

This paper describes the role of vein structures to better understand and interpret the origin of mineral liberation based on random masking simulation. An HQ half core from a copper porphyry deposit was selected and was cut into semicircular slabs of 1 cm thickness. Selected slabs were polished for MLA analysis. Classified MLA images were then subjected to image processing to identify and separate the veins from the disseminated grains. Random masking was applied on the images to simulate breakage and generate progeny particles from which liberation of sulphides was determined. Results of the simulation provided an indication of the contribution of veins in the liberation of minerals at coarser size and the increased degree of liberation. The work in this paper also suggests cutting drill cores and using slabs for texture analysis provides more intact textural features of the ore both at micro and mesoscale. Particularly, if veins occur to some extent, cutting the drill core into slabs is more suitable to preserve this structure providing a better understanding of the origin of mineral liberation.



## 1. Introduction

Ore texture displays the fundamental properties that will determine the ease of mineral liberation and the subsequent mineral separation (Ferrara et al., 1989; Jones, 1987; Hayes, 1993; Gaudin, 1939; King, 2001; Petruk, 2000). The texture of the ore refers to the spatial arrangement, distribution, association, orientation, size and shape of the mineral grains that make up the ore (Barton, 1991; Ferrara et al., 1989; Gaudin, 1939; King, 1994; Preti et al., 1989). In most published works it is the ore microtexture that is classified and/or quantified to have significant effect on mineral processing. The influence of mesotexture on mineral processing particularly its influence on mineral liberation is poorly understood (Bojcevski, 2004).

Typical approach of sample preparation for quantitative texture analysis is by crushing the particles and choosing the coarse particle size fractions that approximately represent the unbroken texture of the valuable minerals (Evans, 2010). However, sample images of crushed particles of an ore in the size fraction −1400/+1000 μm obtained from the Mineral Liberation Analyser (MLA) shows liberated chalcopyrite and pyrite (Fig. 1). MLA measurements of liberation (by particle composition) of four ores also show certain percentage of high grade particles indicating liberated sulphides in the coarse particle size fractions −4000/+1000 μm (Fig. 2). The occurrence of liberated sulphides in the coarse particles suggests that crushing the ore could have destroyed some of the inherent textural features of the ore which makes it challenging to interpret the origin of sulphides liberation.

This paper presents an alternative approach of texture characterisation to better understand the origin of liberation. This includes cutting the drill core into semicircular slabs and investigating the ore mesotexture. The paper was focused on the contribution of vein-hosted minerals to liberation based on random masking simulation.

## 2. Sample preparation and image acquisition

An HQ diamond drill core from a copper porphyry deposit with evident veining structure was selected as a sample. The drill core was cut into two along the axis. The half core was further cut to create semicircular slabs approximately 1 cm thick using a high precision diamond saw. To ensure that the slabs meet the required quality for MLA imaging, a polishing foot (shown in Fig. 3a) was adopted to accommodate the slabs and allow them to be polished

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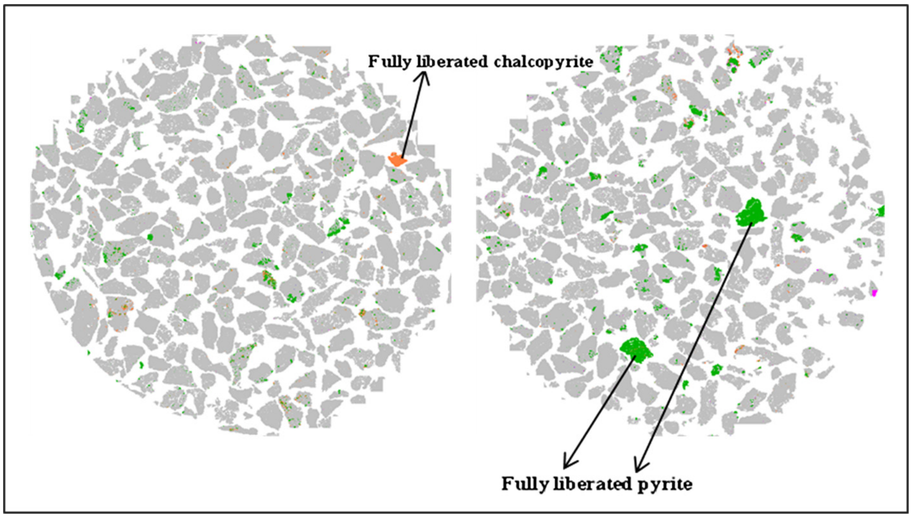


**Fig. 1.** MLA images of polished blocks of −1400/+1000 μm particles showing liberated sulphides.

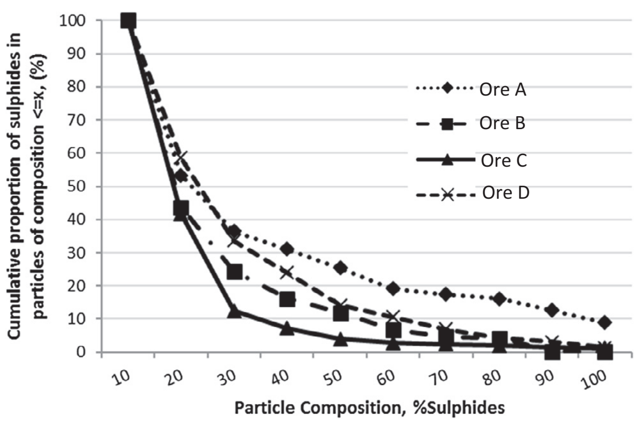


**Fig. 2.** Liberation of sulphides by particle composition of four ore types. Liberation measured from particle size fractions −4000/+2800, −2800/+2000, −2000/+1400 and −1400/+1000 μm in the MLA. No stereological correction was made.

using the standard automated polisher. The polished slabs were analysed in the MLA according to the method of imaging and measuring HQ core in MLA described by Wightman et al. (2014). Selected polished slab is shown in Fig. 3b.

An example of original classified MLA image of a slab is shown in Fig. 4a. The original images show mineral grains that are disseminated as well as minerals hosted in veins hence these images represent the combination of veins and disseminated grains. The original images were imported into Microsoft Paint to separate the veins and the disseminated mineral grains. The veins were identified as the distinct sheet-like structure filled with minerals (Caputo and Hancock, 1998). From the original images, the veins were removed to create images showing only the disseminated grains as illustrated in Fig. 4b. Using the original images, the disseminated grains were removed creating images showing only the veins as illustrated in Fig. 4c. The original and processed images were used to simulate breakage and generate progeny particles from which liberation of the sulphides was determined. This work applied the random masking approach on the images to simulate breakage (Bonifazi and Massacci, 1995; Evans, 2010; Hunt et al., 2011). The images were masked by overlaying square grids of known size. The size of the grid represents the fragmentation size and a square grid represents a simulated progeny particle. An illustration of a masked particle is shown in Fig. 5. The image was broken into simulated progeny particles along the grids of the mask. The characteristics of the progeny particles (in terms of particle composition %sulphides) were obtained from which the liberation classes were defined.

Random masking of the images was performed in eCognition Developer 64, a commercially available image processing software (eCognition, 2014). In the eCognition, the rule set was developed in order to fill the remaining part of the slab with non-sulphide


**Fig. 3.** (a) Specifically designed polishing foot to accommodate the slabs to be polished in the standard polisher and (b) a final polished slab 1 cm in thickness, 63.5 mm in diameter (Wightman et al., 2014).