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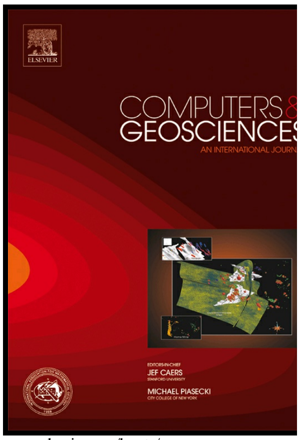

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The quantitative analysis of tungsten ore using X-Ray microCT: case study

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Abstract
Volumetric quantification of ore minerals is of interest using non-destructive laboratory X-ray tomography, as it allows high throughput, fast analysis, without any/limited sample preparation. This means traditional chemical analysis can still be performed on the same samples, but good information can be provided in a very short time assisting in exploration, mining and beneficiation decision making as well as sample selection for further chemical analysis. This paper describes a case study in which tungsten WO3/scheelite is quantified in 35 mm diameter drill core samples and compared to subsequent traditional chemical analysis for the same samples. The results show a good correlation and indicates that laboratory X-ray CT scanning could replace the more time consuming traditional analytical methods for ore grading purposes in some types of deposits. Different image processing methods are compared for these samples, including an advanced thresholding operation which reduces operator input error. The method should work equally well for other types of ore minerals in which the mineral of interest is the most dense particle in the scan volume, and for which the bulk of the particle sizes are at least 3 times larger than the scan resolution.

Keywords: Ore minerals, X-ray tomography, Tungsten/scheelite

1. Introduction

X-ray microCT (XCT) has increasingly been used in the geological and earth sciences in the last few decades [1,2]. There are a variety of different applications in which the method is used with great success, including visualization and quantification of soil macro-porosity formed through chemical displacement [3], quantifying and characterizing the different types of porosity in reservoir rocks [4], petroleum engineering by imaging the distribution of porosity and permeability of fluid phases in porous rocks [5], development of new software for mineral characterization in geological samples [6] and determining the liberation efficiency of copper using through heap leaching [7] and phosphate rock flotation techniques [8], amongst others.

To date, there have been limited reports of the use of XCT to determine ore grade or concentration. In a study by Godel [9] XCT scans were performed on Cu-Ni-PGE samples in order to determine the different mineral phases, shapes and as well as quantify each of the mineral phases in the sample [9]. Some research has also been performed to investigate mineral size and shape relating to the origin of a Fe-Ti-(V) oxide deposit in China [10]

The industry standard techniques for determining ore grade are X-ray Fluorescence (XRF), Inductively Coupled Plasma Spectroscopy atomic emission (ICP-OES) and Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) analysis on powder milled samples to determine bulk major and trace element concentrations. These are destructive techniques which are not only time consuming but require significant sample preparation and result in the loss of information with regard to particle/grain sizes and particle distribution in the sample. The advantage XCT has over these techniques is that it is non-destructive, requires no sample preparation if the sample dimensions are within the required range and can be used to perform a fast analysis of the mineral phases in situ. Recent studies have used XCT in conjunction with non-destructive XRF, however this was only applied to small samples and can only do surface analysis and does not take the entire sample into account [11, 12].