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Application of a comprehensive workflow to characterize the petrology and mineralogy of ore samples in 3D.

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Ore geology research conventionally relies on macroscopic and microscopic two dimensional (2D) observations of hand specimens and thin or polished sections. Although 2D techniques such as optical microscopy and scanning electron microscopy (SEM) are well-known and, therefore, commonly used for the characterization of ore samples, they are not capable of reproducing the real three-dimensional (3D) interior (Wang & Miller, 2020). A rising number of new developments in innovative characterization methods and data analysis methods in the field of ore geology research (e.g. Pearce et al., 2018; Warlo et al., 2021 & Guntoro et al., 2019) indicates the current necessity for adequate 3D ore characterization.

By combining X-ray micro-computed tomography (µCT) and SEM within a comprehensive workflow, we investigated a case study of the pegmatite-hosted Sn-Nb-Ta mineralization of the Gatumba area (Rwanda) (Dewaele et al., 2011). In this research, we present the possibilities to both visualize and quantify mineralogical data in 3D.

Automated mineralogy software within a SEM equipped with a field emission gun (Hrstka et al. 2018) served as an ideal tool to provide us the ground truth to interpret 3D µCT data. A new depth of information was obtained by describing the shape and orientation of individual minerals and the 3D inter-relationships between different mineral phases, by respectively using the Pearson correlation coefficient and the coefficient of variation. Additionally, relative elemental concentrations of niobium and tantalum for the solid-solution series columbite-tantalite and the concentration of economic interesting low atomic number elements (e.g. lithium) were deduced from µCT images.

The combination of SEM and µCT, within a lab-based workflow, enables the description of ore samples into 3D, which is especially important to provide representative mineral inter-relationships and quantitative estimations of economically interesting elements. Extending the

potential of this technique to economic geology studies (e.g. core logging for exploration studies or to improve extraction procedures) will improve the sustainable management of ore deposits.

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