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Soil Material Investigation using High-Resolution Micro-CT setups

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Abstract

Current extraction techniques to retrieve gold particles (micron size) from its ore matrixes are, to date, energy consuming. If the location is known where the gold particle is located, new energy saving techniques can be applied for its extraction. X-ray micro-tomography imaging, as non-destructive analytical investigation, has the potential to be an ideal probe for the qualification and quantification of gold particles and the surrounding materials. Nevertheless, the heterogeneous and highly absorbent materials (high Z) have a challenge in resolution for setups equipped with polychromatic X-ray sources. Here we present measurements of a sample investigated with a multi-scale lab-based X-ray CT (VersaXRM-500) from ZEISS [1] that showed enhanced results compared to a conventional lab-based X-ray device.

Motivation

Hoffmann & De Beer [2] bench-marked the X-ray Micro-CT technique in South Africa with elemental/phase analysis techniques such as XRD and quantitative evaluation of minerals using Scanning Electron Microscope (QEMSCAN) in order to determine their amount within rocks from goldfields. They used a Nikon XTH 225 ST micro-focus machine at the MIXRAD facility at Necsa[2] to acquire high resolved tomograms (Fig. 1). Afterwards, different grey values were assigned to those tomograms with respect to relevant phases. Phase methods investigated by the previous authors showed the existence of materials such as muscovite, Quartz, Quartz pyrite (sulfide minerals) and gold [3] . However, only three materials are observed in (Fig. 1). Therefore, the use of more powerful setups or techniques is necessary to enhance the contrast between compounds with similar absorbance (low difference in Z) like gold and uranium and quantify the materials of interest.

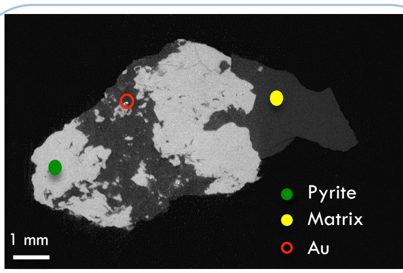

Fig. 1: Tomogram of a soil sample investigated with a conventional micro-CT setup (Nikon XTH 225 ST, 180 kV).

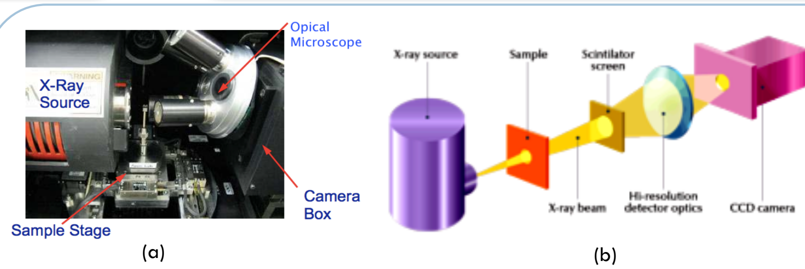

Fig. 2: Schematic of a lens-based X-ray microscope VersaXRM-500 [1]. (a) Photograph showing the different components of the setup, (b) Sketch of the installation.

Results

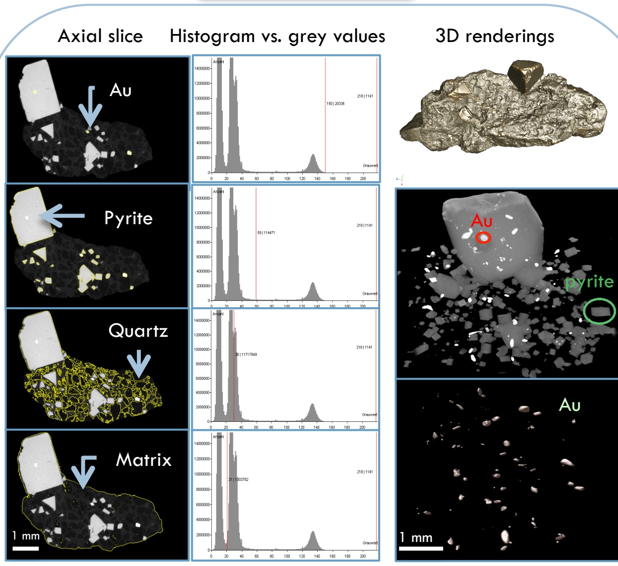

Fig. 3: Components analysis of a raw gold sample based on grey values with a scan operated on VersaXRM-500 (60 kV, 4.35 µm).

Summary

Two materials are observed in both presented cases: Gold and pyrite. Moreover, two different elements has additionally been distinguished by using the VersaXRM-500 (Quartz, Chlorite–muscovite matrix).

Outlook:

- A 3D rendering of the collected (Fig. 3) can already help to quantify the gold particles but,
- Dual energy considering gold K-edge at 80 kV is an option to threshold the pure gold.

References

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[3] Nwaila et al. 2013. A Geometallurgical Study of the Witwatersrand Gold Ore at Carletonville, South Africa.

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