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Cassiterite geochemistry as a provenance indicator-An Australian case study

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Cassiterite (SnO_2), the primary ore mineral for tin, is found in various mineralised settings from highly fractionated pegmatites and rare metal granites to distal hydrothermal vein and skarn systems. It can host several minor and trace cations such as Ta, Nb, Ti, W, In, Fe, Mn, Zr, Hf etc. Kumar et al., (2024) and Wang et al., (2022) using data mined trace element geochemistry and principal component analysis (PCA), evaluated the potential of cassiterite as an indicator mineral and identified that Ta, Nb, Mn, Hf, Fe and Sc are useful indicators for pegmatitic cassiterites while Fe, Al and Ti are useful indicators for hydrothermal systems with grains from different provenances clustering together.

Australia hosts numerous tin deposits of diverse styles (pegmatites, greisen, hydrothermal vein, etc.,). Detailed geochemical analysis of cassiterites from these deposits has not previously been reported. Our aim is to assess the application of cassiterite trace and minor element chemistry from grains of known source as an indicator of the provenance, for exploration purposes.

We obtained minor and trace element compositions of cassiterites from 82 different Australian deposits using electron microprobe and LA-ICP-MS analysis. Low Nb/Ta, Fe/Mn and Zr/Hf ratios and enrichments in Nb and Ta are characteristic of pegmatitic systems, with extremely low Fe/Mn and Nb/Ta values found in LCT pegmatites. Nb enrichments are present in greisen systems while W enrichments are present Sn-W greisen and hydrothermal systems. Ti contents and Ti/Zr ratios are high in hydrothermal quartz-cassiterite vein systems with polymetallic vein systems showing slight enrichments in Sb.

We are currently building a Decision Tree (DT) and Random Forest (RF) statistical model to evaluate the ability of cassiterite geochemistry as an indicator for critical metal deposits.

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