

Microstructural controls on the chemical heterogeneity of cassiterite revealed by cathodoluminescence and elemental X-ray mapping

JASON M. BENNETT^{1,*}, ANTHONY I.S. KEMP¹, AND MALCOLM P. ROBERTS²

¹Centre for Exploration Targeting, School of Earth Sciences, University of Western Australia, Western Australia 6009, Australia

²Centre for Microscopy, Characterisation and Analysis, University of Western Australia, Western Australia 6009, Australia

ABSTRACT

Quantitative X-ray element maps of cassiterite crystals from four localities show that Ti, Fe, Nb, Ta, and W define oscillatory zonation patterns and that the cathodoluminescent response is due to a complex interplay between Ti activated emission paired with quenching effects from Fe, Nb, Ta, and W. Sector zonation is commonly highlighted by domains of high Fe, incorporated via a substitution mechanism independent of Nb and Ta. A second form of sector zonation is highlighted by distributions of W separate to the Fe-dominant sector zone. Both sector zones show quenched cathodoluminescence and are indistinguishable under routine SEM CL imaging. For cassiterite already high in Fe (and Nb or Ta), such as in pegmatitic or granitic samples, the internal structure of the grain may remain obscured when imaged by cathodoluminescence techniques, regardless of the presence of sector zonation. Careful petrogenetic assessments using a combination of panchromatic and hyperspectral CL, aided by quantitative elemental X-ray mapping, is a prerequisite step to elucidate cassiterite petrogenetic history and properly characterize these grains for in situ microanalysis. The absence of a clear petrogenetic framework may lead to unknowingly poor spot selection during in situ analyses for geochronology and trace element geochemistry, and/or erroneous interpretations of U-Pb and O isotopic data.

Keywords: Cassiterite, hyperspectral cathodoluminescence, X-ray element mapping, oscillatory zonation, sector zonation