

The Timing and Geochemistry of Dolphin W Skarn, King Island, Tasmania: A Micro-Scale Study of Garnet and Scheelite

Angela Isaura Santos Costa¹, David R. Cooke¹, Lejun Zhang¹, Yamila Cajal¹, Owen Missen¹, Carlos Carrasco¹

¹CODES - University of Tasmania, Hobart, Australia

The development of critical metals, such as tungsten (W), is crucial for sustainable technologies. Australia hosts 12% of global W resources with ~26% in Tasmania, including the poorly understood Dolphin W skarn in King Island. This study integrates macro- and micro-scale approaches to enhance the understanding of the timing and chemical characteristics of Dolphin. We conducted mine-scale mapping, 3D modeling, HyLogger3 spectral analysis, and SEM-CL, LA-ICP-MS, and state-of-art synchrotron XFM analyses of scheelite and garnet.

Our data, integrated with previous studies, identify Dolphin as a calcic skarn, characterized by two mineralization lenses, formed by the replacement of carbonate-rich units of the Neoproterozoic Grassy Group by magmatic-hydrothermal fluids from post-Tabberabberan granodiorites. Mineralization is structurally controlled, concentrated near east–west faults striking sub-parallel to the Sandblow Granodiorite contact and dipping 30–60° toward the intrusion. HyLogger3 mapping reveals a wavelength shift from grossular (~11,500-12,000 nm) to andradite (~11,800-12,400 nm) near mineralized intervals.

We explored micro-scale analyses of garnet and scheelite to investigate the temporal evolution of the skarn system, from high-temperature metamorphic-magmatic to magmatic-hydrothermal conditions. Our results show multiple stages of garnet and scheelite precipitation, with complex trace element zoning. Prograde garnet features Ca-Fe rich cores with HREE+Y halos, while the rims are Fe-Mn rich with higher Nb. Early-stage scheelite precipitation occurs as disseminations within Mn-rich garnet rims, exhibiting CL oscillatory zoning, Mo contents up to 12%, and elevated As. Retrograde-stage scheelite precipitates interstitially to garnet with later quartz-calcite infill, displaying CL-homogeneous textures, lower Mo (<2%), and higher Nb, Sr, and REE. U-Pb dating of garnet provides Late Devonian-Early Carboniferous ages (363.6 ± 2.6 Ma to 355.9 ± 2.4 Ma), predating the emplacement of the Sandblow Granodiorite (350.8 ± 1.8 Ma). These findings provide new key geochronological and geochemical insights into the Dolphin skarn, highlighting its significance for critical metal exploration in Tasmania.