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Causes for Large-Scale Metal Zonation around Mineralized Plutons: Fluid Inclusion LA-ICP-MS Evidence from the Mole Granite, Australia

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Abstract

Detailed reconstruction of the fluid evolution in several ore deposits associated with the Sn-, W-, and base metal-mineralized Mole Granite shows that multiple factors contributed to the zonal metal distribution around this intrusion. Information about the mechanism of ore formation was obtained from field relationships, detailed petrographic studies, and laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) microanalysis of single fluid inclusions. Premineralization fluid inclusions in Sn deposits are characterized by high Sn/W ratios, whereas early fluid inclusions from W deposits contain higher W concentrations and comparatively low Sn/W ratios. This indicates that the metal ratio in these deposits already was predefined by the composition of the magmatic input fluid. However, in both types of deposits the input fluid actually contained much higher concentrations of base metals (Pb, Zn, Cu, etc.) than Sn and W, demonstrating that metal precipitation was highly selective. The metal zonation around the Mole Granite, therefore, reflects both a compositional variation of the source fluid, as well as sequential metal precipitation from it.

An additional process contributing to metal fractionation occurred by phase separation of the hydrothermal fluid into saline brine and low-density vapor, whereby Cu, B, Li, As (±S, Ag, La) preferentially partitioned into the vapor phase. Analyses on six assemblages of unambiguously coexisting vapor and brine inclusions allowed direct determination of vapor/brine distribution coefficients for 24 elements.