Epidote as a Discriminator of Skarn Deposits: Insights from Dolphin W Skarn, King Island, Tasmania

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Epidote chemistry provides valuable insights into the evolution of magmatic-hydrothermal systems. We analyzed epidote samples from Dolphin W skarn, King Island, Tasmania and regional Skipworth Subgroup Volcanics (up to 6.5 km northeast of Dolphin) to assess the use of epidote chemistry as a discriminator of skarn deposits. In the studied samples, endoskarn and volcanic-related epidote replace feldspar or occur as veins, whereas exoskarn epidote replaces prograde-stage garnet.

Our results from LA-ICP-MS analyses show that skarn-related epidote has higher Pb and Mn than volcanic-related epidote, with exoskarn epidote displaying lower Fe/Al ratios (<0.5). Skarn epidote is enriched in W and U, whereas volcanic epidote has higher Cu. Exoskarn epidote is enriched in Sn (>100 ppm) and Bi (>10 ppm), while endoskarn epidote has higher B, Li, As, Sb (>10 ppm). LA-ICP-ToF-MS mapping reveals chemical zoning in exoskarn epidote, indicating multistage precipitation during retrograde skarn alteration. Zones enriched in Fe (>10%) and Mn (>0.3%) correlate with elevated Bi and Sn, forming a distinct geochemical cluster as defined by k-means cluster analysis. U-Pb dating of exoskarn epidote yields an age of 353.4 ± 9.1 Ma, which is slightly older but within analytical uncertainty of the Sandblow Granodiorite (350.8 ± 1.7 Ma).

A comparative LA-ICP-MS analysis of epidote from metamorphic and porphyry-skarn systems (~7,000 compiled spot-analyses) reveals distinct geochemical signatures. Arsenic and Sb are higher for porphyry-related epidote, particularly from Chilean giant deposits (e.g., El Teniente and Collahuasi). Bismuth is a distinctive tracer of skarn-related epidote, as exemplified by Las Bambas Cu skarn, whereas anomalous Sn is characteristic of W-skarn systems (e.g., Dolphin and Kara). In contrast, metamorphic epidote is distinguished by its enrichment in HREE (>10 ppm). Our findings demonstrate that epidote chemistry is a powerful tool for evaluating ore potential in magmatic-hydrothermal systems and for differentiating skarn from other deposit types.