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Insights Into U-REE-Cu-Au Skarn Occurrences in the Eastern Mount Isa Inlier from Garnet Geochemistry and Geochronology

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Complex U-REE-Cu-Au skarn occurrences in the Mount Isa Inlier, Australia, are suggestive of a larger mineralising system. U-REE mineralisation hosted in uraninite-apatite-allanite assemblages are intimately associated with skarn garnet, but the nature of that relationship is ambiguous. Although understanding of individual skarns has improved, processes controlling trace element enrichments are contentious. Previous and ongoing research on garnets related to mineralisation in other deposits demonstrates that garnet records information that is key to understanding the evolution of those deposits.

Detailed studies of garnet mineral geochemistry and U-Pb geochronology using EPMA, LA-ICP-MS, and Synchrotron XFM indicate two main events of garnet formation associated with U-REE mineralisation between ca. 1750 and 1500 Ma. Initial skarn formation and U-REE mineralisation is associated with intrusion of the Burstall granite during E-W-directed compression ca. 1750 to 1700 Ma. Garnet-dominated skarn (Group A) overprinted early, regional clinopyroxene-dominated skarn and was itself partially replaced by late-stage U-REE mineralisation. Although garnet U-Pb geochronology suggests one phase of garnet growth associated with Cu-Au mineralisation and U-REE remobilisation between ca. 1550 and 1500 Ma, garnet mineral geochemistry reveals two phases of garnet growth during that period – a premineralisation group (B) and a synmineralisation group (C).

Group A garnet generally forms inclusion- and fracture-rich crystals with well-developed concentric zonation of Fe, Ti, Y, and Zr. Group B garnet mainly forms concentrically zoned (Fe, Ti, Zr, Y) rims around vugs in older garnet skarn. Group C garnets are characterized by higher Fe, Mn, Ti, Nd, Y, Zr, U, Th, and Rb than group B garnet, and are associated with Cu-Au-U-REE mineralisation hosted in allanite-sulfide-feldspar-epidote assemblages. This assemblage occurs in vugs rimmed by group B garnet as well as in veins cross-cutting older skarn lithologies. This study illustrates the ability of garnet to record important stages of mineralisation in complex multi-element skarn deposits.