



Monitoring the evolution and mineralization of porphyry systems by using the geochemical inventory of apatite

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Apatite minerals host a range of geochemical tracers, such as rare earth elements, volatile components (H₂O, halogens, sulfur), and radiogenic isotope systems (e.g., Sm-Nd), which can be used to gain insights into the source and evolution of magmatic (porphyry) systems. In this study, we investigate porphyry systems of the Macquarie Arc (New South Wales, Australia), which led to mineralization over an extended time period. The general compositions of the different porphyry systems vary from alkaline and shoshonitic to calc-alkaline. We aim to characterize and understand the evolution of fertile melts responsible for Cu-Au mineralization between ~468 Ma and ~435 Ma and the lifetime of the arc. Trace element analyses of apatite, their Nd isotope signatures, combined with whole rock geochemistry, allow detailed insights into the geochemistry and metal loads of the mineralized and “barren” porphyry systems of the Macquarie Arc. The development of in situ S isotope analysis in apatite by SIMS permit to resolve the S isotope signatures in strongly zoned apatite minerals in samples, which represent pre-, syn- and post-mineralization stages of the individual porphyry systems. Our analyses show large contrasts in S isotope ratios within single apatite grains implying that the sulfur isotope ratios together with micro-inclusions provide a unique snap-shot into processes, which lead to the exsolution of base metals and associated mineralization.