

Mineral chemical anomalism in magmatic-hydrothermal epidote from SW Pacific porphyry and epithermal deposits

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Discrimination between mineralized and barren magmatic-hydrothermal systems, the ability to effectively locate well-mineralized deposits, and recognition of the distal geochemical indicators of porphyry-related mineralization continue to present a significant challenge to explorers. Recent advances in the micro-analysis of alteration minerals formed from hypogene magmatic-hydrothermal processes surrounding porphyry-related systems has demonstrated that the detection of low-level geochemical anomalism can be used to discriminate metal associations and styles of mineralization. In addition, these micro-analytical techniques can also be used to discriminate minerals and mineral assemblages formed by mineralizing and non-mineralizing processes, such as regional and contact metamorphism.

In this study, we compare laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) mineral chemical analyses of epidote collected from regional metamorphic terranes, with epidote sampled from the hypogene alteration zones surrounding a diverse range of porphyry-related mineralizing systems throughout the south west Pacific. Epidote analyses derived from magmatic-hydrothermal alteration zones include samples from known porphyry Cu-Au deposits (Batu Hijau and Grasberg, Indonesia; Black Mountain, Philippines) and several small porphyry Cu-Au prospects (Ampucao and Camp 4, Philippines; Kele, Solomon Islands; Sekongkang, Indonesia), low and intermediate sulfidation epithermal deposits (Gosowong and Batu Hijau, Indonesia), and skarn deposits (Ertsberg and Big Gossan, Indonesia; Mexico prospect, Philippines). Epidote formed from regional metamorphic processes include samples from the Dalradian and Moine Supergroups (west Scotland), east Arunta Inlier (Northern Territory, Australia), and the Georgetown Inlier (Queensland, Australia).

Measurable differences in the concentrations of several trace and rare earth elements are observed in the analysed samples, and can be used to effectively discriminate between epidote formed from regional metamorphism and from hydrothermal alteration related to mineralization. In particular, regional metamorphic epidote returned higher concentrations of Ca, Al, Sr, Lu and Yb, and lower concentrations of Fe, As, Sb, Zn, Mn and Bi, relative to magmatic-hydrothermal epidote. In addition, it is possible to discriminate between epidote related to porphyry mineralization, and epidote related to skarn mineralization. Epidote sampled from the propylitic alteration halos surrounding porphyry Cu-Au deposits contained higher concentrations of Pb, Zn, Mn, Ca and V, and lower concentrations of Bi, U, Sb, Sn and Sr, relative to epidote associated with skarn mineralization. The ability to geochemically distinguish epidote paragenesis has substantial implications for mineral exploration in regionally metamorphosed terranes, as well as for situations where epidote-bearing magmatic-hydrothermal alteration, but not mineralization, is exposed at surface. It may also provide a beneficial tool for exploration in regions of limited outcrop, such as the tropical environments common to the west Pacific region.