Geochemical signatures of alteration mineral zonation that surrounds adularia-sericite epithermal orebodies: Lessons from New Zealand and abroad

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Abstract

Adularia-sericite epithermal ore deposits have well-documented alteration mineral zonation patterns with distinctive geochemical signatures. Proper use of whole-rock geochemistry can provide useful vectors for exploration and can enhance efforts to characterise and quantify the mineralogy and intensity of hydrothermal alteration.

Analyses of Au and Ag provide the most direct vectors to orebodies, and pathfinder elements such as As, Sb, Hg, Zn, Pb and Se are similarly zoned around at least some orebodies. However, the minerals that contain these elements occur almost exclusively in veins, and therefore identifying geochemical vectors related to wallrock alteration that is zoned outward from orebodies is crucial for effective exploration.

Distal alteration zones contain quartz-illite-chlorite-carbonate-pyrite, whereas samples proximal to veins contain quartz-adularia-pyrite, with lesser though variable illite-chlorite-carbonate. Therefore, adularia-sericite epithermal ore deposits show K alteration in their cores. The resulting K-metasomatism can be evaluated in several ways. Areas that have been most intensely altered are commonly characterised by highest K contents, but these results can be complicated by variations in rock type across the prospective area. Potassium mass balance results provide a robust and rigorous assessment of K-metasomatism, however, knowledge about the composition of fresh rocks and correct identification of fresh precursor compositions of altered rocks are required. Three alteration indices provide effective evaluation of K-metasomatism: (1) the K number, which is the ratio K/(2Ca+K+Na) (molar); (2) Barrie values [(K_2O * 100) / Sr]; and (3) the Rb/Sr ratio. In most places these provide similar vectors, although K numbers can be complicated by the appearance of hydrothermal calcite and/or albite. Plots of K/Al vs (2Ca+K+Na)/Al (molar) allow estimation of the intensity of K-metasomatism and its mineralogical products, thereby complementing traditional XRD and petrographic studies of alteration minerals.