Chalcophile element fertility and the formation of porphyry Cu ± Au deposits

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Magma fertility for Cu ± Au deposits is expected to be controlled by the chalcophile element content of the magma at the time of fluid exsolution, but there is no empirical evidence to support this hypothesis. This is due to the difficulty of measuring the metal content of the magma from which the ore-forming fluid exsolved. Recent studies on platinum group element (PGE) geochemistry of felsic rocks, associated with magmatic-hydrothermal deposits, have shown that PGE can be used as a chalcophile element fertility indicator.

The role of chalcophile element fertility in the formation of porphyry Cu ± Au deposits was investigated by comparing PGE geochemistry of barren and ore-bearing Cu ± Au granitic suites. The barren suites are depleted in PGE abundances at the time of fluid exsolution (< 0.1 ppb Pd and Pd/Pt < ~ 3), which is attributed to early sulfide saturation in a mid to lower crustal magma chamber. In contrast, the Cu ± Au ore-bearing suites contain at least an order of magnitude higher PGE contents than the barren suites at fluid saturation (up to ~ 10 ppb Pd and Pd/Pt of 0.1–40), and are characterized by late sulfide saturation, which allows both chalcophile elements and sulfur to concentrate by fractional crystallization before volatile saturation. We suggest that the relative timing of fluid and sulfide saturation has an important influence on the chalcophile element fertility of the arc magma systems. Plots of Pd/MgO against Pd/Pt for igneous suites can be used to estimate chalcophile element fertility and distinguish between barren, porphyry Cu, and porphyry Cu-Au granitoid systems. The positive correlation of these chalcophile element fertility indicators and Au ore grades suggests that metal contents in magmas play an important role in controlling ore grade, particularly Au, in porphyry Cu ± Au deposits.