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Assessing the Role of Tectono-magmatic Setting in the Precious Metal (Au, Ag, PGE) and Critical Metal (Te, Se, Bi) Endowment of Porphyry Cu Deposits

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Porphyry Cu deposits commonly contain critical and precious metal by-products, including the chalcophile and siderophile elements Au, Pd, Pt, Ag, Te, Se and Bi. These elements partition into residual sulfides during the partial melting of mantle wedge peridotite during subduction, potentially depleting the source magma for subduction-related porphyry deposits. The chalcophile-rich residual sulfides in subduction-modified subcontinental lithosphere are thought to be the source of metals in post-subduction porphyry deposits, and as such these deposits may be more enriched in chalcophile and siderophile elements than subduction-related porphyry deposits. However, many post-subduction deposits have low Au grades and some subduction-related porphyry deposits have high Au and PGE concentrations.

We test the role of tectonic setting in precious and critical metal endowment of porphyry Cu deposits by comparing whole rock assay, PGE data and LA-ICP-MS sulfide trace element data from three case studies with a newly compiled global database. The Skouries Cu-Au-(PGE) porphyry deposit, Greece, and the Muratdere Cu-Au-Mo porphyry deposit, Turkey are both post-subduction; these are contrasted with the El Teniente Cu-Mo porphyry deposit, Chile, which is a classic subduction-related system. We show that post-subduction porphyry deposit sulfides are relatively enriched in Bi, Te and Se compared to sulfides from subduction-related deposits. However, although some critical and precious metals (Ag, Bi and Se) reside in primary sulfide ore minerals, others (Au, Te, Pd and Pt) are hosted in minor accessory minerals. Whole rock data from mineralized samples show that globally both subduction-related and post-subduction deposits can be precious and critical metal enriched, with metal endowment independent of tectonic setting. PGE-enriched porphyry Cu deposits are also enriched in Bi, Te and Au, and semi-metal melts are suggested to play an important role in PGE transport and concentration in porphyry Cu deposits.