

Slab Tearing as a Driver of Porphyry Ore Deposit Formation in Indonesia and the Philippines

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Discovering new porphyry ore deposits is vital to address the rapidly rising demand for strategic and critical metals. On a global scale, porphyry ore deposits are largest and most abundant in mature continental arcs, such as the Andes, where lower-crustal garnet fractionation may produce oxidised magmas suitable for metal enrichment during fluid saturation in the upper crust. Nevertheless, porphyry ore deposits (including giant porphyry deposits, characterised by >2 Mt contained Cu) also occur in island arcs, where the crust is too thin to fractionate garnet. In this study, we test the hypothesis that slab tearing (associated with the subduction of buoyant features such as aseismic ridges) facilitates deep melting within the garnet stability field, emulating the petrogenetic effects of thick continental crust and enabling the formation of Pliocene–Holocene porphyry ore deposits in Indonesia and the Philippines. To do so, we first modelled slab geometry using high-resolution seismic tomography models to establish spatial relationships between deposit distribution and slab tears. To identify possible geochemical contributions of slab tearing to porphyry metallogenesis, we collected new, high-resolution geochemical data (collected via LA-ICP-TOF-MS) from the groundmass of the most primitive and least-altered samples from Batu Hijau (Indonesia), Far Southeast (Philippines), Black Mountain (Philippines), and Santo Thomas II (Philippines), which we integrated with a compilation of published whole-rock data. Our multi-disciplinary approach demonstrates that porphyry ore deposits in Indonesia and the Philippines are concentrated at the margins of slab tears. Despite appreciable inter- and intra-deposit geochemical diversity, geochemical signatures putatively imparted by garnet, either as a residual or fractionating phase, are consistently detected, suggesting that deep, tear-driven melting is a plausible means of generating porphyry ore deposits in island arcs.