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Slab Failure as a Driver of Fertile Adakitic Magmatism in Generating Porphyry Cu-Au-Ag Deposits: inhibited fractionation during rapid trans-lithospheric emplacement

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Petrogenesis of fertile adakites is a function of source character, and emplacement dynamics, which affect porphyry Cu-Mo±Au-Ag deposit (PCD) formation. Traditional PCD models are typically applied to arc settings, whereas slab break-off more appropriately describes temporally post-collisional magmatism in orogenic belts. Both arc-related, break-off magmas display HREE-Y depletion, indicating garnet & amphibole residues, linked to slab melting. Small Eu/Eu* anomalies, and higher Sr reflect plagioclase is absent in the oxidized residue, resulting in Me-S-rich melts with elevated Sr/Y. In recent studies [1, 2], compositionally intermediate, fertile adakites are interpreted as predominantly oxidized I-type magmas exhibiting geochemical characteristics of post-collisional slab break-off magmas with higher Nb-Ta contents during high-T melting of residual rutile-titanite. The arc-like magmatic system are governed by key petrogenetic processes, notably AFC, volatile enrichment, and lack of compositional diversity in arc-related magmas; however, slab failure adakitic magmas do not have evidence of differential hornblende or plagioclase fractionation, so inherit their fertile signatures from the source, i.e. there is minimal evidence for MASH zone lower crustal reservoirs, postulated in current models. Rather, the role of transpression to transtension in deeply sourced fertile magma emplacement is key during syn- to post-collisional magmatism. A significant correlation has been established between the emplacement of these derivative magmas in paleo-subduction zones and strike-slip faulting, related to transpression. Transpressional to transtensional control on fertile magma ascent means they are rapidly emplaced trans-lithospherically, which inhibits hornblende and plagioclase differential crystal fractionation. Slab failure-related high-silica adakitic magma ascends through the thickened subcontinental lithospheric mantle. The thickening of the mantle lithosphere is attributed to subduction refrigeration, which enhances lithosphere thickness. Magmas generated from high-T partial melting of oceanic slab and (or) suprasubduction zone mantle lithosphere exhibit and retain high oxidation states as there is negligible crustal involvement. Negligible fractionation (inhibited saturation) of sulfides within rapidly ascending high fO_2 magmas maintains maximum fertility (high Me) and high fS_2 during shallow emplacement and exsolution of a magmatic volatile phase during depressurization; this scenario directly links to Cu–Au porphyry-forming potential [1].

[1] Yousef and Lentz (2024) *Geosci. Front* **15**, p.101927. [2] Yousefi et al. (2024) *Geosciences* **14**, p. 241.