Time in porphyry Cu ± Au development– exploration implications

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The staged model for the development of porphyry Cu deposits accounts for overprinting events of alteration and mineralisation and provides exploration vectors within wall rocks towards blind porphyry deposits partly as an aid to interpretation of geophysical data.

Prograde hydrothermal alteration and mineralisation is associated the initial emplacement of vertically attenuated porphyry apophyses to a deeper magma source bodies. The outwards zonation in hydrothermal alteration from magnetite-bearing potassic, to wall rock propylitic, locally with quartz-magnetite lodes (G veins), provides important exploration vectors. Initial mineralisation grades in time and laterally from more Au-rich bornite to chalcopyrite within linear A style quartz-sulphide and laminated quartz-magnetite-sulphide veins.

As porphyries evolve venting overpressurised B-rich fluids form overlying tourmaline breccia pipes and barren shoulders of zoned advanced argillic alteration result from of acid fluids reaction with wall rocks. Deeper structurally controlled barren shoulders provide better vectors to porphyry deposits than the more distal lithologically controlled forms.

Later stage retrograde phyllic (silica-sericite-pyrite) alteration develops as sinks of acid waters formed by condensation of rising volatiles in the upper porphyry collapse during cooling drawdown resulting in magnetite destruction and pyrite deposition (discernible as chargeability anomalies). While phyllic alteration represents part of the porphyry model it need not constitute the exploration target. Development of centrally terminated B style quartz veins, initiated during prograde alteration, continues into retrograde alteration with fill of commonly later sulphides, including C veins. Extremely acidic conditions form advanced argillic alteration lithocaps within the upper cores, while cooler and more neutral fluids result in the development of overprinting argillic alteration.

The buried magmatic source of the porphyry cools more slowly than the apophysis to vent pebble dykes and later mineralised D veins into the wall rocks as vectors to the blind porphyry deposits.