
G5
Postsubduction Porphyry Cu-Au Emplacement During Transtension in Northwestern British Columbia (Canada): The Norm Rather Than the Exception?

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Most porphyry Cu±Au±Mo systems are postulated to have formed under broadly contractional stress regimes marked by crustal thickening, surface uplift, and rapid exhumation in a synsubduction tectonic setting. We present evidence that most porphyry Cu-Au systems in the prolific Golden Triangle of northwestern BC were emplaced during transtension in a postsubduction tectonic setting. Such a structural and tectonic arrangement is probably more common globally than previously appreciated.

The Golden Triangle is a world-class mineral district containing seven >1 Gt porphyry Cu-Au deposits, five >1 Moz Au epithermal Au deposits, and numerous smaller deposits; it includes two operating mines. The district is in the Stikine terrane, one of the largest (2,000 x 300 km) island-arc terranes of the Canadian Cordillera that accreted to ancestral North America in the mid-Jurassic. However, significant preaccretionary mineral deposits within the terrane are restricted to a 300-km-long N-trending western belt (Golden Triangle) and a 100-km-long N-trending eastern belt (Toodoggone), formed during several distinct Late Triassic to Middle Jurassic metallogenic epochs. Most porphyry systems are coeval with the local onset of latest Triassic to Early Jurassic lower Hazelton Group volcanism, with magmatism hitherto ascribed to opposing subduction underneath Stikinia. The area north of these belts (Stikine arch) underwent latest Triassic to Early Jurassic uplift and erosion, and lacks lower Hazelton Group strata, their magmatic roots, and coeval mineral deposits.

We present detailed studies of Cu and/or Au systems at Bronson, KSM, Tennyson, Red Mountain, and Big Bulk (~204-190 Ma, latest Triassic to Early Jurassic). Our work shows that cogenetic intrusions are commonly tabular shaped and parallel to sheeted porphyry-style veins, indicating strong structural control during magmatic-hydrothermal deposit formation. The presence of fault-proximal megaconglomerates and rapid facies variations suggest lower Hazelton Group deposition was controlled by penecontemporaneous basin-bounding faults. Within the district, east-striking faults show normal movement, whereas north-striking faults show dextral strike-slip kinematics, suggesting porphyry and related deposits were emplaced into active transtensional pull-apart basins. Many of these nearly orthogonal faults likely represent reactivated pre-Devonian basement structures. Cretaceous Skeena fold-and-thrust-belt deformation overprints and inverts preexisting structures.

A postsubduction model for the Golden Triangle during the latest Triassic to Early Jurassic, starting ~207 Ma, is supported by 1) thin volcano-sedimentary successions exhibiting high structural control, 2) preceding contractional deformation (~215-208 Ma folds, thrusts, angular unconformity), 3) coeval uplift along the adjacent Stikine arch, 4) the Au-rich nature of mineralization and association with the onset of volcanism (both common features of postsubduction mineralization worldwide), and 5) geometric problems with long-lived opposing subduction zones. Transtension across preexisting translithospheric structures likely provided the mechanism and pathway for magma generated by remelting of previously subduction-metasomatized subarc lithosphere. Exploration programs should evaluate the potential of district-scale lineaments and possible dilational jogs or step-overs for hosting porphyry and related mineralization.

Globally, numerous postsubduction porphyry systems formed in extensional or transtensional settings (e.g., Cadia, Grasberg, Apuseni district), and we suggest that—particularly for porphyry deposits emplaced in postsubduction settings—a transtensional setting may be the norm, rather than the exception.