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The Himalayan Yulong Porphyry Copper Belt: Product of Large-Scale Strike-Slip Faulting in Eastern Tibet

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Abstract

The Yulong porphyry copper belt is the most significant porphyry copper belt in Tibet and is located in the Qiangtang terrane of the Himalayan-Tibetan orogen. The terrane is a collage of continental blocks joined by ophiolitic sutures and volcano-plutonic arc complexes. The Yulong belt is approximately 300 km long and 15 to 30 km wide, contains one giant, two large, and two medium- to small-sized porphyry copper deposits, and more than 20 mineralized porphyry bodies. The Yulong belt is located in the Changdu continental block that comprises Proterozoic to early Paleozoic crystalline folded basement and middle to late Paleozoic platform facies carbonate and clastic sedimentary rocks similar to the Yangtze continent. The porphyry belt is closely associated with Tertiary potassic volcanic rocks and alkali-rich intrusions in the area and controlled by north-south–north-northwest, large-scale, strike-slip faults, which are perpendicular to the collision zone between the Indian and Asian continents. Isotopic age determinations of the ore-bearing porphyries indicate that the magmatism occurred over at least three stages, peaking around 52, 41, and 33 Ma, respectively. The timing of middle and late shallow-level emplacement of these magmas is consistent with the ages of associated potassic volcanism and alkali-rich magmatism in the area. Although the porphyry deposits in the Yulong belt were developed in the intracontinental convergent environment, their mineralization styles and features are comparable to porphyry copper deposits in arc environments.

Compared to ore-bearing calc-alkaline porphyries in island arcs or continental margin arcs, the porphyritic intrusions in the Yulong belt are characterized by high K_2O contents and enrichment in Rb and Ba, suggesting a shoshonitic magmatic affinity. Strong negative anomalies for Nb, Ta, P, and Ti and positive anomalies for Rb, Ba, Th, and LREE, normalized by chondrite, are characteristic of arc magmas. These intrusions yield a narrow $^{143}Nd/^{144}Nd$ range varying from 0.51243 to 0.51253 and $^{87}Sr/^{86}Sr$ values from 0.7065 to 0.7077, which are transitional between type II enriched mantle and mid-ocean ridge basalt (MORB) values and closer to the former in terms of ε_{Nd}-ε_{Sr}. This suggests that the porphyritic magmas were derived either from a hydrous-enriched mantle metasomatized by components such as H_2O, K, Rb, Ba, Th, and LREE or by melt derived from the subducted oceanic slab of the Paleozoic Jinshajiang oceanic plate. The hypothesis is supported by Pb isotope data for the intrusions.

Large-scale strike-slip faults in eastern Tibet, which accommodated the compressive strains produced by the Asian-Indian continent collision, also localized the porphyry Cu mineralization. North to north-northeast–directed convergence and collision produced a dextral strike-slip fault system around 60 to 70 Ma. Northeast-directed wedging of the Indian continent and subsequent collision with the Yangtze continent during the Paleocene-Eocene produced conjugate strike-slip fault zones. The transition from a dextral strike-slip fault system to conjugate strike-slip zones resulted in stress relaxation and formation of strike-slip pull-apart basins. Crustal-scale strike-slip faulting may have caused upwelling and partial melting of the hydrous-enriched mantle by decompression and facilitated the rise of a large volume of volatile-enriched porphyry magma that had ponded near the base of the lithosphere during this period.

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