Petrogenesis of the Intrusions in the Zhunuo Porphyry Cu Deposit and Implications for Miocene Porphyry Cu-Mo ± Au Mineralization in the Gangdese Belt, Southern Tibet

Xiang Sun[1,*] and Youye Zheng[1,2]

[1]State Key Laboratory of Geological Processes and Mineral Resources, School of Earth Science and Resources, China University of Geosciences, Beijing, 100083, China
[2]State Key Laboratory of Geological Processes and Mineral Resources, Faculty of Earth Resources, China University of Geosciences, Wuhan, 430074, China

*E-mail, sunxiang@cugb.edu.cn

The Gangdese Miocene porphyry Cu-Mo ± Au belt is characterized by porphyry mineralization formed in postcollisional setting, which is distinct from that generated in oceanic island or continental arc settings. Numerous porphyry-style Cu-Mo ± Au deposits (e.g., Qulong, 10 Mt at 0.44% Cu and 0.44 Mt at 0.02% Mo) are located in the eastern parts of the Gangdese belt, whereas smaller porphyry occurrences (e.g., Zhunuo 2.3 Mt at 0.53% Cu) are located in the western belt. We present here whole-rock geochemical, U-Pb zircon geochronological, zircon Hf, and whole-rock Sr-Nd isotope compositions of Miocene intrusive rocks to help better constrain the formation of ore-forming melts in the Gangdese belt. Specifically, our work focuses on the Zhunuo ore-bearing intrusions and the mafic enclaves.

Zircon U-Pb data indicate that the time of crystallization of the monzogranitic intrusions ranges from 14.6 to 14.5 Ma, with slightly younger ages (14.0 Ma) for the monzogranite porphyry and the mafic enclaves at ~14.6, ~14.5, and ~14.0 Ma, respectively. Ore-related intrusions are high-K calc-alkaline in composition and characterized by high Sr/Y ratios (24–102). They are enriched in large-ion lithophile elements and light rare earth elements, and are depleted in high field strength elements. Their whole-rock geochemistry (low MgO, Ni, and Cr contents; εNd(t) [–6.5 to –2.8], $^{87}Sr/^{86}Sr(i)$ ratios [0.7073 to 0.7084], and εHf(t) [–4.8 to –0.2]) indicates that they were derived from magma mixing between the melts of subduction-modified lower crust and the underthrust Indian plate. The high Mg numbers, high abundance of mafic immobile elements (e.g., Cr and Ni), low εNd(t) (–1.3 to –0.8) and εHf(t) (–4 to +2.2) values, and high $^{87}Sr/^{86}Sr(i)$ ratios (0.7070 to 0.7080) imply that the mafic melts of the Zhunuo enclaves were derived from partial melting of enriched lithospheric mantle beneath the Lhasa terrane mixing with melts derived from the underthrust Indian plate.

Our new data, together with previously published work, lead us to conclude that the Neo-Tethyan oceanic subduction beneath southern Tibet during the Mesozoic provided preconditioning of the Earth's crust into which porphyry-related mineralization was emplaced. The timing of the known Gangdese porphyry Cu-Mo ± Au deposits is collisional, and localized in a nearly E-W belt parallel to the Indus-Yarlung-Zangbo suture zone, similar to the distributions of arc-related porphyry Cu-Mo ± Au deposits worldwide. In addition, the underthrust Indian plate played a more significant role in the formation of the intrusions associated with mineralization in the western Gangdese belt than those in the eastern Gangdese belt, which may be one important reason why the porphyry mineralization in the western belt is significantly weaker than that in the eastern belt.