Origin of Postcollisional Porphyry Cu-Mo Deposits in the Eastern Gangdese Belt, Southern Tibet

Rui Wang,[1,*] Jeremy P. Richards,[2] Zeng-qian Hou,[3] and Zhi-ming Yang[3]

[1]CSIRO Mineral Resources Flagship, Perth, WA 6101, Australia
[2]Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3, Canada
[3]Institute of Geology, Chinese Academy of Geological Sciences, Beijing 100037, PR China

*E-mail, Rui.Wang@csiro.au

The India-Asia collision was accompanied by voluminous but largely barren Paleocene-Eocene magmatism in southern Tibet. These magmatic rocks constitute a major part of the Gangdese magmatic belt, which extends for more than 1,600 km. Following this event, small-volume calc-alkaline to alkaline magmatism intruded and/or erupted in the Gangdese belt between ~30 and 9 Ma, with the eastern parts (east of ~89°E) being commonly associated with porphyry-type mineralization. We propose the controls on magma fertility reflect fundamental changes in tectonomagmatic processes in the Cenozoic.

Paleocene-Eocene magmas throughout the Gangdese belt have continental arc features. Their intrusive rocks have intermediate La/Yb and intermediate to low Sr/Y ratios, negative Eu anomalies, and consist mainly of pyroxene and plagioclase. These geochemical and mineralogical characteristics suggest that their magmas were less hydrous and evolved primarily by fractionation of pyroxene and plagioclase. In addition, their magmas were also less oxidized (ΔFMQ –1.2 to +0.8). The relatively low water contents and oxidation state of these magmas may reflect the rollback and final dehydration of the remnant Neo-Tethyan slab, with the result that only three small porphyry Cu-Mo deposits associated with this suite.

The Oligo-Miocene igneous rocks show a sharp longitudinal distinction of petrography, magmatic geochemistry, and association with porphyry-type mineralization. The eastern Gangdese Group (east of ~89°E) is characterized by mainly intermediate-felsic calc-alkaline plutons related to porphyry Cu-Mo deposits and minor alkaline volcanic rocks. Their intrusive igneous rocks have high La/Yb and Sr/Y ratios, weak or absent Eu anomalies, and amphibole as common phenocrysts. Their magmas were more hydrous and fractionated significant amounts of hornblende and lesser plagioclase prior to upper crustal emplacement. In addition, their magmas were also more oxidized (ΔFMQ +0.8 to +2.9). In contrast, the western group is characterized by alkaline volcanic rocks with relatively high Th and K_2O contents, low Sr/Y ratios, and low εNd_i values. There is only one small porphyry Cu deposit to the west of ~89°E. We suggest that this difference reflects the variable extent of underthrusting of the Indian plate continental lithosphere beneath Tibet in the Oligo-Miocene, and diachronous breakoff of the Greater India slab. In the absence of underthrust Indian lithosphere to the east of ~89°E in the Oligo-Miocene, slab breakoff triggered asthenospheric upwelling and partial melting of previously subduction modified Tibetan lithosphere, generating hydrous, oxidized calc-alkaline magmas with the potential to generate porphyry Cu-Mo deposits. In contrast, underthrusting of the Indian plate to the west at this time limited the involvement of asthenospheric melts and the extent of lithospheric partial melting, with the result that melts ± fluids derived from the underthrust lithosphere were infertile.