High Magmatic Water Content Disproves Genesis of Postcollisional Copper Ore-Forming High Sr/Y Magmas by Dehydration Melting of Lower Crust

Yongjun Lu,[1,*] Robert R. Loucks,[1] Marco L. Fiorentini[1], Zhiming Yang,[2] and Zengqian Hou[2]

[1]Centre for Exploration Targeting and Australian Research Council Centre of Excellence for Core to Crust Fluid Systems (CCFS), School of Earth and Environment, University of Western Australia, Crawley, WA 6009, Australia
[2]Institute of Geology, Chinese Academy of Geological Sciences, Beijing 100037, PR China

*E-mail, yongjun.lu@uwa.edu.au

The Miocene Gangdese porphyry copper belt in southern Tibet developed in the Indo-Asian continental collision zone and is a typical porphyry belt in a collisional setting. These postcollisional porphyry Cu deposits occur in the eastern Gangdese magmatic belt (east of 89°E longitude). The ore-forming porphyries were emplaced between 18 and 13 Ma, postdating the Indo-Asian continental collision by about 40 m.y. There are currently four porphyry Cu-Mo deposits actively being mined, including Tinggong, Nanmu, Jiama, and the world-class Qulong deposit, with a total resource of 18 Mt of copper. All these Miocene porphyry Cu deposits are spatially and temporally associated with high Sr/Y (>40) dacitic-rhyolitic intrusions. Previous workers have attributed their genesis to dehydration melting of garnet-amphibolite in a thickened lower crust.

To test the dehydration melting of lower crust hypothesis and examine the hydration state of copper ore-forming high Sr/Y magmas, we utilize a geohygrometer for granitoid rocks, entailing zircon saturation thermometry and H_2O-dependent phase equilibria. The results show that these Tibetan high Sr/Y magmas had dissolved H_2O contents >10 wt %, which considerably exceeds the water supply by dehydration melting of basaltic amphibolites (maximum of 6.7 ± 1.4 wt %). Our results indicate that high Sr/Y dacitic-rhyolitic magmas cannot be produced by dehydration melting of basaltic amphibolites. In fact, while H_2O-added melting of basaltic amphibolites can produce high Sr/Y dacitic-rhyolitic melts, it does not yield high enough Mg# (>50) to match the Tibetan ore-forming porphyries. Dehydration melting of basaltic amphibolites normally exhausts hornblende before plagioclase, producing low Sr/Y felsic melts. In this study, we propose an alternative model for the genesis of copper ore-forming high Sr/Y magmas in Tibet. It is advocated that the high Sr/Y dacitic-rhyolitic porphyries in southern Tibet are residually H_2O enriched, high-pressure differentiation products of hydrous mafic partial melts of Tibetan mantle. This new hypothesis is based on the previous investigation of Miocene mafic microgranular enclaves (mantle-derived melts), which define a fractionation trend with and have Sr-Nd-Hf isotope compositions similar to the host Tibetan ore-forming porphyries.