Sulfide saturation in thick arc crust plays no role for porphyry Cu deposit formation

RUI WANG[1*], JEREMY P. RICHARDS[2] AND JINGBO ZHANG[1]

[1] Skate Key Laboratory of Geological Processes and Mineral Resources, Institute of Earth Sciences, China University of Geosciences, Beijing 100083, China (*correspondence: rw@cugb.edu.cn)

[2] Mineral Exploration Research Center, Harquail School of Earth Sciences, Laurentian University, Sudbury, Ontario P3E 2C6, Canada

Cu, as the moderately incompatible element, is depleted in the bulk continental crust that is ultimately derived from primary basaltic arc. The paradox exists that the bulk continental crust with low $Mg^{\#}$ has much lower Cu than the basaltic high $Mg^{\#}$ mantle melts. Recent studies suggest the missing Cu has been remained as Cu-bearing sulfides at the base of the arc, especially a thick arc. However, a thin island arc with relatively high Cu contents is thought to have late or no sulfide saturation during magmatic evolution. If this was the case, then porphyry Cu deposits should not preferentially form from calc-alkaline magmas in mature arcs with thick crust, but they do. The early sulfide saturation appears to play no role for upper crustal porphyry Cu formation during the arc period. A large porphyry Cu deposits can readily be formed from normal arc magmas containing only 50 ppm Cu. Cu contents in intermediate calc-alkaline magmas may indeed be lower than those in equivalent tholeiitic magmas, but the former are not devoid of Cu.

We suggest the shallow-crustal exsolution of a volatile phase from evolved, hydrous arc magmas, which efficiently scavenges Cu from the melt (or early crystallized sulfides) and transports it into the hydrothermal environment, where a separate set of variables control the precipitation of Cu sulfides to form porphyry ore deposits. Conversely, in immature arcs, less hydrous tholeiitic magmas will be less likely to form voluminous subvolcanic plutons or to exsolve a volatile phase prior to eruption, and will therefore be less likely to form subvolcanic porphyry Cu deposits, despite their relatively high Cu contents.