Exhumation and Duration of the Pulang Porphyry Cu-Au Deposit, SW China: Constraints from U/Pb, $^{40}Ar/^{39}Ar$, and (U-Th)/He Dating

Cheng-Biao Leng,[1]* David R.Cooke,[2] Xing-Chun Zhang,[1] Shou-Xu Wang,[1] and Noreen Evans[3]

[1] State Key Laboratory of Ore Deposit Geochemistry Institute of Geochemistry, CAS, Guiyang, China, 550002

[2] CODES, University of Tasmania, Private Bag 126, Hobart, Tasmania 7001, Australia

[3] John de Laeter Centre-Isotope Research for the Earth and Environment, Applied Geology, Curtin University, Bentley, WA 6845, Australia

*E-mail, lengchengbiao@vip.gyig.ac.cn

The Pulang porphyry Cu-Au deposit is located in the Sanjiang Tethyan orogenic belt, northwest Yunnan Province, China. It has reserves of approximately 4.3 Mt Cu @ 0.34 %, 113 t Au @ 0.09 g/t, and 0.16 Mt Mo @ 0.01%. Three intrusive phases were emplaced into Late Triassic volcanic and sedimentary rocks, including (from oldest to youngest) porphyry quartz diorite (and minor monzodiorite), quartz monzonite and granodiorite porphyries, and porphyry diorite dikes. Copper mineralization is mainly associated with porphyry quartz diorite and quartz monzonite stocks. Extending from the center outward to the margin, three major alteration zones have been identified within the mineralized porphyry body, including potassic-silicic, phyllic, and propylitic zones. Mineralization is concentrated in the potassic-silicic alteration zone.

Seventeen porphyry samples collected from drill core and outcrops yield zircon U-Pb ages ranging from 218 to 214 Ma. $^{40}Ar/^{39}Ar$ dating of hornblende and biotite phenocrysts from the quartz diorite porphyries show plateau ages of 212.7 ± 2.9 and 210.3 ± 0.9 Ma, suggesting a protracted magmatic-hydrothermal event (~6 m.y.) in the Pulang district. A much younger $^{40}Ar/^{39}Ar$ age of 181.7 ± 9.3 Ma has been obtained on K-feldspar phenocrysts from ore-bearing quartz monzonite porphyries, and may be ascribed to isotopic resetting during postintrusive activity. Three porphyry quartz monzonite samples at different altitudes (3950, 3497, and 3015 m) yielded zircon and apatite (U-Th)/He ages varying from 146.1 ± 5.7 to 117 ± 4.3 Ma, and 62.5 ± 4.3 to 50 ± 1.9 Ma, respectively. In combination with previous geochronological data, three episodes of intrusive cooling history can be outlined; 218 to 210 Ma (cooling rate: 75°–110°C/Ma), 180 to 62.5 Ma (average cooling rate: 1.7°C/Ma), and 62.5 to present (average cooling rate: 0.8°C/Ma).

These events correspond to three different exhumation stages in the history of northwestern Yunnan. The first stage coincided with the evolution of magmatic-hydrothermal activity, whereas the second may correlate with the evolution of the Neotethys. Since then, northwestern Yunnan evolved to a relatively steady state. Based on these thermochronology data, the average postemplacement exhumation rate at Pulang is estimated to about 0.03–0.05 km/Ma, which is an order of magnitude lower than the global average exhumation rate for porphyry deposits (0.158 km/Ma). The relatively low exhumation rate may have played a key role in preserving this large Late Triassic porphyry deposit in the Sanjiang Tethyan orogenic belt.