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Porphyry and epithermal Cu-Au mineralization of the Duolong district, central Tibet

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The Duolong district in central Tibet, comprising four significant deposits (Duobuza, Bolong, Naruo, and Rongna) and one prospect (Dibaonamugang-Nadun) with a total resource of approximately 2, 000 million metric tons (Mt) grading at 0.4 percent Cu and 0.2 g/t Au at present, is considered as an emerging world-class metallogenic district in China.

Field investigation exhibits a spectrum of porphyry-related deposits/prospects existing at the Duolong district. Of those deposits, Duobuza, Bolong, and Naruo are recognized as typical porphyry-style deposits as the Cu-Au mineralization is centered on multiple porphyry stocks, and high ore grades are associated with the early potassic alteration that composed of quartz, secondary K-feldspar, magnetite, biotite, and ± anhydrite, where Cu minerals are chalcopyrite and bornite. The Rongna deposit is considered as a telescoped porphyry system characterized by widespread high-sulfidation style epithermal veins. Unlike the other three porphyry deposits, the major introduction of Cu-Au mineralization at Rongna took place at a relatively late stage, which coincided with development of advanced argillic alteration, defined by the abundance of alunite, quartz, kaolinite, and dickite. The Dibaonamugang-Nadun prospect is featured by widespread advanced argillic lithocaps exposed on the surface, this prospect incorporates a subeconomic porphyry system at Dibaonamugang, which is characterized by the presence of distinguishing “dark” quartz veins, and closely associated high-sulphidation epithermal veins at Nadun (Au grade up to 20g/t), which is hosted within diatreme breccias that formed upon the shallow emplacement of porphyritic intrusions.

The field investigation, fluid inclusion studies, combined with published geochronological data, indicate the development of major porphyry and epithermal Cu-Au mineralization occurred at an early stage, which extended from 120 to 116 Ma. Accompanied by intense magma injection, ore-forming fluids were expelled from the underlying plutons and accumulated at shallow depth (2, 000 to 2, 500 m) along the NE-trending magmatic–structural corridor, leading to the ore formation at the Bolong, Duobuza, Naruo, and Rongna deposits. After a nearly 5 Myr lull at the Duolong district, magmatic activity resumed at 111 Ma with the emplacement of mineralized granodiorite porphyry at Dibaonamugang, and the “dark” quartz veins formed at depth of ~1, 500 m, simultaneously high-sulfidation epithermal Cu-Au mineralization took place at Naun at similar elevation. The identical ages, close spatial relationship, similar mineralogical assemblages and fluid inclusion characteristics collectively indicate a clear genetic relation between the Nadun and Dibaonamugang sections. Additionally, the extrusion of andesite of the Meiriqie Formation (110 to 105 Ma) greatly assisted the preservation of Cu-Au ore bodies at the Rongna deposit.

In conclusion, we propose the Duolong district represents a typical porphyry copper-gold system that developed episodically in a protracted period. Hydrothermal alteration and mineralization at each ore center were related to magmatic-hydrothermal fluids that evolved at a shallow level.

Magmatism not only contributed to the ore formation but also played a critical role in ore preservation as the postmineral volcanic rocks can serve as effective shelters to avoid erosion.