

## Geology and Isotope Geochemistry of the Tongchanggou Mo-Cu Deposit, Southeast Yidun Terrane, East Tibet

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The newly-discovered Tongchanggou Mo-Cu porphyry-skarn deposit is located in the southern Yidun Terrane, southeast Tibet Plateau, and contains 0.3 Mt at 0.3% Mo and 34 kt at 0.8% Cu. The Mo-Cu orebodies are hosted in Permian basalt, Triassic limestone, and Late Cretaceous granodiorite porphyry. Rhenium-osmium isotope analyses on molybdenite separates from skarn, granodiorite porphyry and the massive molybdenite orebody yielded model ages ranging from 86.8 to 85.2 Ma. LA-ICP-MS U-Pb age determinations on zircons from the granodiorite porphyry yielded ages ranging from 87.4 to 84.2 Ma, indicating a temporal link between granitic magmatism and Mo-Cu mineralization. Three types of orebodies occur in the Tongchanggou district, including vein-type—occurs along fracture zones and faults, lenticular porphyry-type—occurs within the granodiorite porphyry, and skarn-type—occurs within the limestone and marble.

Skarn-type alteration is extensively exposed in the Tongchanggou district. Based on results from detailed adit mapping and drill-hole logging, the Tongchanggou skarn can be divided into three distinct skarn assemblages that formed a zonation pattern surrounding the granodiorite porphyry. This pattern is defined by a proximal zone of garnet skarn, a medial zone of tremolite skarn, and a distal zone of diopside skarn. Outboard of the diopside skarn the host marble has a bleached appearance. The grain size of garnet also displays a zonation pattern, whereby proximal garnet is more coarse-grained (up to 2 cm) and distal garnet is more fine-grained (~ 2 mm). The compositions of garnet are mainly grossularite (62–78%), followed by andradite (17–34%), and minor spessartite, almandine, and pyrope. The  $\text{Fe}^{2+}/\text{Fe}^{3+}$  ratios of garnet from the Tongchanggou deposit range from 0.00 to 0.20, with an average value of 0.06, indicating relatively oxidized conditions of formation. The  $\delta^{18}\text{O}_{\text{VSMOW}}$  values of garnet range between +5.2 and +9.5‰, suggesting that the skarn-type alteration might have directly inherited its oxygen isotope compositions from the granodiorite porphyry. Additionally, sulfides (molybdenite, pyrite and chalcopyrite) are characterized by uniform S and Pb isotopes, with  $\delta^{34}\text{S}_{\text{VCDT}}$  values ranging between +0.7 and +1.4‰, and  $^{206}\text{Pb}/^{204}\text{Pb}$  ratios ranging from 18.332–18.694,  $^{208}\text{Pb}/^{204}\text{Pb}$  ratios ranging from 38.454–39.088, and  $^{207}\text{Pb}/^{204}\text{Pb}$  ratios ranging from 15.588–15.663, indicating that the ore-forming fluids at Tongchanggou likely originated from crustally-derived felsic magmas.