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The Origins of Miocene Ore-Bearing and Ore-Barren Porphyry Rocks in Jiama, South Tibet: Implications for Porphyry Cu Mineralization in Continental Collisional Zone

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Porphyry copper deposits that formed in continental collisional belts represent an increasingly important source of copper worldwide. However, the genetic links between felsic igneous rocks and porphyry copper deposits in continental collisional belts, such as in southern Tibet, are still debated. In this study, we report data for mineralized and barren intrusive rocks from Jiama, one of the largest porphyry copper deposits, with associated skarn, in southern Tibet, to better understand the genetic relationship between magmas and Cu mineralization. The barren intrusions consist mainly of granodiorite, whereas the mineralized intrusions range in composition from diorite to granodiorite. LA-ICP-MS zircon U-Pb dating shows that both were formed at the same time, ca. 15 Ma. All of the barren rocks have adakitic signatures (e.g., high Sr, low Y, high Sr/Y = 68.99–155.77), but the mineralized intrusions have lower Sr/Y (18.34–97.20), lower SiO_2, and higher MgO, Mg#, and Th/U compared with the barren intrusions. The barren intrusions have $^{87}Sr/^{86}Sr$ = 0.70548 to 0.70560, eNd(t) = –0.99 to –0.08, and zircon eHf(t) = 4.18 to 9.29, indicating a newly formed lower crustal source. In contrast, the mineralized intrusions have more enriched Sr-Nd isotope compositions that fall between the barren intrusions and ultrapotassic rocks from south Tibet, which have been suggested to originate from enriched lithospheric mantle. The contrasting geochemical characteristics between these two suites of intrusions indicate that the barren granodiorites were derived from partial melting of the thick juvenile lower crust, whereas the mineralized intrusions resulted from magma mixing between the lower crust-derived felsic magmas and the enriched mantle-derived mafic magmas. Mixing between mafic and felsic magmas also is strongly supported by the occurrence of mafic xenoliths and the inverse zoning of major elements (e.g., MgO) in the mineralized intrusions. The contrasting origins between these two suites of intrusions at Jiama thus most likely indicate that the input of mantle-derived magmas enriched in Cu and H_2O into the crust may be a key for the formation of extensive porphyry copper deposits in continental collisional belts.