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Mesozoic porphyry-skarn Cu-polymetallic systems of the Yidun terrane, Eastern Tethys: Implications for subduction- and transtension-related metallogeny

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Most porphyry deposits including giant deposits mainly occur in continental margin and island-arc settings, although recent studies indicate that porphyry Cu deposits are also related to continent–continent collision. The NNW-striking Yidun terrane is the Sanjiang Tethyan metallogenic domain in the Tibetan Plateau, experienced subduction of Garze-Litang oceanic plate (a branch of the Paleotethys) in the Late Triassic and witnessed two mineralization events respectively associated with the ca. 215 Ma arc-related intermediate-felsic porphyries (e.g., Pulang, Xuejiping, and Chundu) and the 88–79 Ma mildly-alkaline granitic porphyries (e.g., Hongshan, Xiuwacu, Relin, and Tongchangou). It is, therefore, an ideal place to investigate the genetic linkage between the subduction related porphyry deposits and post-subduction porphyry deposits. All of the late Triassic ore-related porphyry have similar, highly fractionated REE patterns and high La/Yb (13–49) ratios with no prominent Eu anomalies. They display pronounced negative Nb–Ta and Ti anomalies. All the rocks have high Sr (258–1980 ppm), and low Y (13–21 ppm) with high Sr/Y ratios (29–102). These features suggest that porphyritic intrusions were derived from adakitic magmas. They have similar initial $^{87}Sr/^{86}Sr$ ratios (0.7058 to 0.7077), εNd (−1.88 to −4.93) and εHf(-3.2 to +4.3) values, but belong to high silica (HSA) and low silica adakitic rocks (LSA). The HSA represent an early stage of magmatism (218 to 215 Ma) and were derived from oceanic slab melts with limited interaction with the overlying mantle wedge during ascent. We propose that the early adakitic magmas (HSA) formed by flat subduction leading to melting of oceanic slab, whereas subsequent slab break-off caused the significant interaction between slab melts and the mantle wedge and thus the generation of the later adakitic magmas (LSA). The Late Cretaceous (82–77 Ma) highly fractionated I-type granite belt and related porphyry Cu–Mo deposits and magmatic-hydrothermal Cu–Mo–W deposits occur along approximately N–S-trending faults in the Yidun terrane. The ore-related porphyries are characterized by high silica and high total alkalis, with enrichment in large ion lithophile elements (LILEs; Rb, U and K) and depletion in high field strength elements (HFSE; Nb, Ta, P and Ti) and Ba. They have lower εHf(t) values varying from -9.55 to -2.75, and significant negative Eu anomalies, indicating that the ore-bearing porphyritic magmas originated from ancient middle-upper crust. The arc-like elemental signatures and the mixed Sr–Nd–Hf isotopic signatures of the Late Cretaceous ore-related porphyries indicate a genetic linkage between the Late Triassic and Late Cretaceous porphyry systems. This suggests that the remelting of underplated arc-related mafic rocks formed during the subduction of the Garze–Litang Ocean could be responsible for the mixing between the mantle-derived components and the Mesoproterozoic lower crustal materials, when postsubduction transtension occurred in the Late Cretaceous. The formation of the Late Cretaceous porphyry–skarn Cu–Mo–W deposits could most likely be related to the remelting of Late Triassic residual sulfide-bearing Cu-rich cumulates in the subduction-modified lower crust that triggered by the Late Cretaceous transtension.