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Generation of Post-collisional Porphyry Copper Deposits in Southern Tibet Triggered by Subduction of the Indian Continental Plate

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Oligocene to Miocene postcollisional porphyry Cu deposits in the Gangdese belt in southern Tibet contain >20 Mt Cu metal resources and are genetically associated with granodioritic and quartz monzonitic porphyry intrusions with adakite signatures (e.g., Sr/Y ratios >40). The genesis of the adakite-like porphyry intrusions, as well as the geodynamic processes that triggered the generation of the melts and associated giant porphyry Cu deposits, remains controversial. This new and comprehensive synthesis of geological, geochronological, and geochemical data from the magmatic rocks and associated porphyry Cu deposits in southern Tibet has identified a northward temporal migration of adakite-like magmatism and associated porphyry Cu mineralization in the eastern part (east of 87°E) of the Gangdese belt. The adakite-like magmatic rocks in the southern subbelt of the eastern Gangdese belt range in age from ca. 38 to 18 Ma, whereas those in the northern subbelt have ages of ca. 21 to 10 Ma. Mineralization ages of the porphyry Cu deposits in the eastern Gangdese also show a decreasing trend from south to north, with ca. 30 Ma deposits in the southern subbelt and ca. 21 to 13 Ma deposits in the northern subbelt. The porphyry intrusions, many in the north associated with porphyry copper deposits, exhibit high SiO_2 (>60 wt %), Al_2O_3 (mostly >15 wt %), K_2O (>2 wt %), and Sr (>300 ppm) contents, low Y (<15 ppm) content, enrichments in large ion incompatible elements, and depletions in high field strength elements, and have extremely variable Sr-Nd isotope compositions (initial $^{87}Sr/^{86}Sr$: 0.7037–0.7120; εNd(t): +5.7 to –10.6). These data are consistent with H_2O-added melting of eclogitized subduction-modified lower crust, triggered by late Eocene to Miocene northward subduction of the Indian continental plate. This resulted in progressive fluid-fluxed melting of the metasomatized mantle wedge and(or) part of the eclogitized lower crust below the eastern Gangdese, due to the gradual liberation of metamorphic fluid from the subducting continental plate. Fluid-fluxed melting of the metasomatized mantle wedge produced ultrapotassic-like or alkaline mafic magmas. Underplating of such mafic magmas from their source (>80 km) to the lower part (~60–70 km) of the lower crust, together with direct input of aqueous-carbonic fluid liberated from the subducting Indian continental plate, resulted in H_2O-added melting of eclogitized, subduction-modified Tibetan lower crust, generating H_2O-rich, adakite-like magmas in the Gangdese belt. Continuous continental subduction with a relatively steep angle (~40°–50°) is likely to be the first-order control on the generation of the porphyry Cu deposits in southern Tibet.