Oxygen isotope and trace element geochemistry of zircons from porphyry copper system: Implications for Late Triassic metallogenesis within the Yidun Terrane, southeastern Tibet

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The oxygen isotopic composition, U–Pb ages and trace element compositions of zircons from the mineralized Pulang porphyries and the coeval Disuga and Lannitang andesites of the Yidun Terrane, eastern Tibet, have been determined by SIMS and LA–ICP–MS, respectively. The new SIMS U–Pb zircon ages indicate that these rocks formed between 217 and 213 Ma. The majority of these zircons have relatively high but invariant $\delta^{18}O$ values (5.83‰–6.89‰) that are indicative of derivation from magmas that did not assimilate crustal material and were generated from homogeneous mantle or a similarly homogenous mantle-derived reservoir. The relationship between whole-rock SiO_2 and $\delta^{18}O_{whole\text{-}rock}$ compositions suggests that the elevated $\delta^{18}O$ values of these zircons were generated by the open-system fractional crystallization of mafic and/or accessory minerals. The zircons have trace element (e.g., U, Yb, Y, Hf, and U/Yb) characteristics that indicate formation in a continental magmatic arc setting. We propose a model for the Late Triassic magmatism in the Yidun Terrane involving either subducted slab melts and/or underplated juvenile mafic magmas that underwent fractional crystallization of mafic and/or accessory minerals, or alternatively magmas derived from partial melting of subduction-metasomatized mantle peridotitic material that subsequently experienced melting–assimilation–storage–homogenization (MASH) processes. The low calculated Ti-in-zircon temperatures (644°C–863°C, although generally between 640°C and 690°C) for these zircons may be caused by the lower solidus temperature for zircon in these hydrous magmas, a factor that might have promoted the crystallization of amphibole and suppressed the crystallization of plagioclase. The high oxidation state (high zircon Ce^{4+}/Ce^{3+} ratios) of the parental magmas that formed these zircons was probably controlled by magmatic processes occurring at deeper levels rather than any upper crustal processes. All of these data suggest that the Pulang porphyries that host the zircons formed from highly oxidized and hydrous magmas. The contemporaneous and barren andesites have similar zircon Ce^{4+}/Ce^{3+} ratios and water contents to the porphyries, suggesting that the mineralization in this area was controlled by a combination of magmatic and hydrothermal processes, and the absence of such processes generated barren rather than mineralized intrusions and the associated loss of prospectivity.