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Important role of magma mixing in generating the Mesozoic monzodioritic–granodioritic intrusions related to Cu mineralization, Tongling, East China: evidence from petrological and in situ Sr-Hf isotopic data

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The Mesozoic ore-bearing high-Mg monzodioritic–granodioritic rocks in the Tongling mining district (East China) have been described as having adakitic affinities, and their origin has been attributed to partial melting of delaminated eclogite at depth in the mantle, followed by interaction of the resultant granitic magma with mantle peridotite. Here we present petrological data and in situ Sr isotopic data for zoned plagioclase that are inconsistent with the eclogite-derived model, and instead propose a model that involves magma mixing of siliceous crustal melts and basaltic magma that was derived from metasomatized mantle by subduction zone fluids in an extensional regime. The principal geochemical signatures of these Mesozoic rocks include a hydrous and high-K calc-alkaline affinity, high values of Mg#, high Sr abundances, high Sr/Y and La/Yb ratios, εNd(t)=-13.1 to -9.0, and ISr=0.70707–0.70824. The magma mixing model is supported by (1) the common existence of mafic microgranular enclaves (MMEs) and the disequilibrium textures of plagioclase and hornblende, (2) the increase in Ti and Al(IV) from hornblende cores to rims, and the overgrowths of high-Ca pyroxene around hornblende grains as well, indicative of episode of heating and rejuvenation of the magma chamber as a result of recharge of mafic magma, (3) the 87Sr/86Sr ratios of embayed high-Ca cores of plagioclase that are distinctly lower than in the euhedral low-Ca overgrowth rims, (4) negative correlations between whole-rock Nd and Sr isotopic ratios, and (5) the significant differences in the values of εHf(t) (-9.5 to -26) within different zircons from the same intrusion. We propose that underplating of hydrous basaltic magma from the metasomatized lithospheric mantle in the lower crust resulted in partial melting of the lower crustal rocks (Precambrian TTG gneisses and amphibolite/granulite) under water-saturated conditions, during which plagioclase decomposed, leaving hornblende-rich restites and forming granitic melts with high Sr and high Sr/Y ratios. This is different from the traditional model that involves eclogitization of lower crustal rocks under high pressures due to over-thickening of continental crust.