Origin of andesitic rocks: geochemical constraints from Mesozoic volcanics in the Luzong basin, South China

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The composition of andesitic rocks has bearing on the origin of continental crust, and various models such as FC, AFC and MASH have been purposoed for their petrogenesis. However, it is still enigmatic with respect to interpretation of geochemical data. We advocate that the source mixing at the slab-mantle interface in oceanic subduction channel is responsible for generation of mafic-ultramafic sources for andesitic magmatism. This is illustrated by a combined study of whole-rock major-trace elements and Sr-Nd-Hf isotopes as well as zircon U-Pb ages and Hf-O isotopes for Mesozoic basaltic-andesitic volcanics from in the Middle-Lower Yangtze River Belt, South China. These volcanics are primarily composed of basaltic trachyandesite and trachyandesite, with small amounts of trachybasalt and trachyte. They exhibit variable contents of SiO_2 (48.66-63.43 wt. %), MgO (0.39-4.85 wt. %), Na_2O (1.22-6.07 wt. %) and K_2O (2.53-10.10 wt. %), with highly variable K_2O/Na_2O ratios from 0.45 to 7.39. They are characterized by arc-like trace element distribution patterns, with significant enrichment of LILE, Pb and LREE but depletion of HFSE. They exhibit relatively enriched Sr-Nd-Hf isotope compositions, with initial $^{87}Sr/^{86}Sr$ ratios of 0.7050 to 0.7066, negative $\varepsilon_{Nd}(t)$ values of -8.0 to -3.1 and negative $\varepsilon_{Hf}(t)$ values of -11.1 to -1.1. Zircon U-Pb dating yields consistent ages of 127±2 to 137±1 Ma for magma emplacement through volcanic eruption. The zircon exhibits slightly high $\delta^{18}O$ values of 5.3 to 7.6‰ and variable $\varepsilon_{Hf}(t)$ values of -13.1 to 2.6. An integrated interpretation of all these geochemical results leads to the conclusion that the Luzong basaltic-andesitic volcanics were primarily derived from partial melting of fertile and enriched mantle sources that are similar to those of continental arc andesites. Such mantle sources are hypothesized to form by reaction of the mantle wedge peridotite with hydrous felsic melts derived from subducting seafloor sediment due to the Andes-type oceanic subduction. As a consequence, the mantle wedge would be metasomatized by larger amounts of the felsic melts than the case for common oceanic arc basalts. Therefore, the significant incorporation of sediment-derived felsic melts into the mantle wedge is a key to the origin of continental arc andesites. This provides insights into the origin of mantle sources above the fossil Andes-type oceanic subduction zone and thus into the petrogenesis of continental arc andesites.