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Petrogenesis of Permian intermediate-mafic dikes in the Chinese Altai, NW China: implication for a post-accretion extensional scenario

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The Central Asian Orogenic Belt was a long-lived accretionary orogen and the late Paleozoic is considered to be a critical period for its terminal amalgamation of three tectonic collages. However, the exact timing of amalgamation and geological process of such a huge accretionary orogenic belt are poorly understood. This paper presents new geochronological and geochemical data for Permian intermediate-mafic dikes in the Chinese Altai, a key region between the Mongolian and the Kazakhstan collage systems. Based on the mineral assemblage and petrographic texture, the intermediate-mafic dikes can be categorized as gabbro-norite and quartz diorite. The grabbro-noritic and quartz dioritic dikes yield zircon U-Pb ages of 276.7 ± 2.9 Ma and 273.2 ± 4.3 Ma, respectively. The gabbro-norites are characterized by variable SiO_2 (47.1-51.3 wt.%) and MgO (5.33-8.46 wt.%), and moderate Cr (71.2-95.7 ppm) and Ni (80.6-192 ppm) contents. Geochemical modeling indicates that the parental magma was possibly contaminated by 4-12% crustal materials. Zircon $\varepsilon_{Hf}(t)$ (+13.2~+16.7) and whole-rock $\varepsilon_{Nd}(t)$ (+4.9~+6.1) values as well as moderate Sm/Yb ratios (1.75-1.89) imply that the parental magma was likely derived from a depleted mantle source dominated by spine lherzolite. The quartz diorites exhibit higher SiO2 (57.3-58.3 wt.%), slightly lower whole-rock εNd(t) (~+2.5) and zircon $\varepsilon_{Hf}(t)$ (+9.1~+14.4) values, suggesting derivation of the parental magma from mafic lower crust. The quartz diorites have high Y (>39.8 ppm) and HREE (Yb>3.64 ppm) concentrations as well as low Sr/Y (<12) ratios, having geochemical fingerprints of partial melts at crustal depths above the garnet stability field (< 10 kb). Major element compositions of the quartz diorites are comparable to the intermediate liquids generated by ~40% partial melting of alkali-enriched basaltic rocks at conditions of T=1050-1100 °C and P=8 kbar. Such a high geothermal gradient, in response to regional tectono-thermal event, is inferred to be a consequence of intraplating and/or underplating of hot basaltic magmas in an extensional setting, which may shed a light on the ubiquitous tectonic scenario after complete amalgamation of tectonic collages.

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