Syn-exhumation magmatism during continental collision: Geochemical evidence from the early Paleozoic Fushui mafic igneous rocks in the Qinling orogen, Central China

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A combined study of zircon SIMS U-Pb ages, Lu-Hf isotopes, O isotopes, whole-rock elements and Sr-Nd isotopes was carried out for Fushui mafic complex in the Qinling orogen, central China. The results provide insights into crust–mantle interaction in the collisional orogen. Zircon SIMS U-Pb dating yields consistent ages of 488±4 to 490±4 Ma for emplacement of mafic magmas. The ages are just slightly later than zircon U-Pb ages of 500-490 Ma for ultrahigh-pressure metamorphism of the continental crust in the North Qinling unit, indicating a syn-exhumation magmatism during continental collision. These mafic igneous rocks exhibit arc-like trace-element patterns, such as enrichment in LILE, Pb, and LREE but depletion in HFSE. They show enriched whole-rock Sr-Nd isotope compositions. Some of the zircons have $\varepsilon_{Hf}(t)$ values of 0.1 to 1.6 and sub-normal mantle $\delta^{18}O$ (+2.0‰ to +2.9‰), indicating recycling of the oceanic basalt that underwent seawater-hydrothermal alteration at high temperature, into their mantle source. In contrast, the other zircons have mainly negative $\varepsilon_{Hf}(t)$ (-3.7 to 0.9) and elevated $\delta^{18}O$ (+5.1‰ to +7.9‰) values, suggesting involvement of the terrigenous sediment in their mantle source. The fluid-peridotite reaction would generate phlogopite-bearing ultramafic metasomatites beneath the North Qinling microcontinent. With the tectonic transition from the lithospheric subduction for active compression to active extension for the crustal exhumation during the late Cambrian, the mantle source underwent decompression melting to produce mafic melts in synchronous with exhumation of the deeply subducted continental crust. Our results show that the combined zircon Hf and O isotopes are powerful tracers to distinguish different recycled oceanic crust materials and, importantly, provide new geochemical insights into the nature of the orogenic lithospheric mantle and thus the tectonic evolution of this collisional orogen.