



## **Geochemical, zircon U-Pb and Hf isotopic study on metabasalt in the Cathaysia Block: Implications of Paleozoic migmatization of Precambrian crustal and mantle materials in South China**

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Metamorphic rocks scattered in northeastern Cathaysia Block experienced upper-amphibolite to granulite facies metamorphism. This study focuses on the mafic metamorphic rocks (including biotite-amphibolite and amphibolite) found in migmatite. The whole rock geochemical characteristics of ten mafic metamorphic rock samples suggest that their protoliths are subalkaline basalts, including tholeiites and calc-alkaline basalts resemble those in E-MORB, within-plate and volcanic-arc tectonic settings. Eighty zircon grains from three representative samples (samples FJ39-1, FJ61-3 and FJ125-4) were picked for geochronology analyses. Cathodo-luminescence images show that most zircons are elongated subhedral to euhedral crystals with oscillatory zoning. Some of them are surrounded by thin, homogeneous luminescent overgrowth rims, which may present a later thermal event. LA-ICP-MS analyses indicate that most analyzed zircon grains have high Th/U ratios (0.16–1.41,  $n = 69$ ) and yield U–Pb zircon ages of  $444 \pm 3$  Ma (FJ39-1),  $445 \pm 2$  Ma (FJ61-3),  $448 \pm 3$  Ma and  $473 \pm 4$  Ma (FJ125-4), respectively for each sample. The Hf model ages calculated for these zircons ranges from  $\sim 3613$  to  $\sim 853$  Ma with  $\varepsilon_{Hf}(t)$  values from  $-20.0$  to  $+7.1$ ; zircons with model ages of  $1121$ – $853$  Ma show positive  $\varepsilon_{Hf}(t)$  values ( $+0.2$  –  $+7.1$ ). This implies that the protoliths of the mafic metamorphic rocks contain diverse basalts erupted in various tectonic settings during the Precambrian, rather than being Ordovician new crustal addition. The data suggest that there could be an Archaean basement component in the Cathaysia Block and the basement possibly had crustal additions during the Meso- to Neoproterozoic. The zircon U–Pb ages of the mafic metamorphic rocks are the same as those of leucosomes ( $471 \pm 4$  Ma and  $445 \pm 3$  Ma). The metamorphic P–T conditions are constrained by the zircon Ti-content thermometer, the Amp–Pl thermobarometer and mineral stability fields of titanite and garnet to be  $722$ – $779$  °C and  $8$ – $9$  kbar. It suggests that the metamorphic rocks were products of tectonothermal events in the Cathaysia Block during the Ordovician, i.e. the Wuyi–Yunkai orogeny. We conclude that at least two episodes of high-grade metamorphism occurred during the Wuyi–Yunkai orogeny in the Cathaysia Block, one at ca. 470 Ma and the other at ca. 445 Ma.