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Zircon and Apatite U-Pb Geochronology and Geochemistry of the Mafic Dykes in the Shuangxiwu Area, Northwestern Zhejiang Province: Constraints on the Initial Time of Neoproterozoic Rifting in South China

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Previous studies have shown that there are some ca. 770–750 Ma mafic dykes at the western segment of the Neoproterozoic Jiangnan orogen (JO), and they represent post-orogenic magmatism due to orogenic collapse (Wang et al., 2008). Diachronous post-orogenic magmatism at the eastern segment of the JO took place after ca. 805 Ma, represented by bimodal volcanism in south Anhui Province (Wang et al., 2012). However, we know little about the Neoproterozoic dykes in this area. In this study, we investigate the geochronology and geochemistry of the dykes at the Shuangxiwu area in northwestern Zhejiang Province, South China. The mafic dykes mainly intruded the Shuangxiwu arc volcanic rocks and the unconformably overlying Heshangzhen Group. The dykes were dated as at ca. 860–850 Ma by Li et al (2008) and Yao et al (2014), although they have absolutely different opinions on the tectonic settings (plume vs. arc). However, according to field study, the mafic dykes in either Shuangxiwu Group or Heshangzhen Group are dominantly with a NNW strike. So it is questionable that the Neoproterozoic mafic rocks in the Shuangxiwu area are diachronous since the observed mafic rocks in Heshangzhen Stratum mainly intruded the Luojiamen Formation whose maximum depositional age is ca. 850–820 Ma.

Our dating results suggest that the zircon grains from the mafic dykes are all xenocrysts, and their age spectrum is consistent with that of the basement metasedimentary sequences in the JO. We carried out LA-ICP-MS apatite U-Pb dating for the dykes and the results indicate that studied mafic rocks formed at ~760 Ma, which is consistent with the post-orogenic mafic rocks in western JO. According to our geochemical analyses, the mafic rocks in the Shuangxiwu area mainly show SiO2 contents in the range of 44.1–52.8 wt.%, except that four samples having slightly elevated SiO2 of 58.6–61.2 wt.%. They belong to subalkaline basalt and constitute a tholeiitic trend. The rocks can be divided into three groups based on their geochemistry, and the Sr-Nd-Pb isotopes indicate three endmembers for their formations: depleted asthenospheric mantle, metasomatized lithospheric mantle, and enriched continental crust. The upwelling of asthenosphere at ca. 760 Ma led to partial melting of the pre-existed metasomatized lithospheric mantle to generate mafic rocks with arc-like geochemical features. Continued extension resulted in low-degree partial melting of asthenospheric mantle to form the rocks with OIB-like geochemical characteristics. The incorporation of continental crust in magma source and possible later crustal contamination contribute the formation of the intermediate rocks.

In conclusion, the ~760Ma mafic dykes in the Shuangxiwu area and the ca. 770–750 Ma mafic dykes in the western JO constitute a parallel dyke set throughout the JO. Zircon ages from the Shuangxiwu dykes suggest that the folded basement of Jiangnan Orogen has been connected with the Shuangxiwu terrane at ca. 760 Ma. The mafic dykes were formed in a post-orogenic extensional setting, representing the transition of the tectonic regime from orogenic to anorogenic, and constitute a system from orogeny to post-orogenic within-plate process for a typical orogenic belt.

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