Lithos 236–237 (2015) 90–105

Contents lists available at ScienceDirect

Lithos

journal homepage: www.elsevier.com/locate/lithos

# Early Neoproterozoic multiple arc–back-arc system formation during subduction–accretion processes between the Yangtze and Cathaysia blocks: New constraints from the supra-subduction zone NE Jiangxi ophiolite (South China)

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ARTICLE INFO

*Article history:*
Received 12 May 2015
Accepted 6 August 2015
Available online 28 August 2015

*Keywords:*
Zircon geochronology
Supra-subduction zone ophiolite
NE Jiangxi ophiolite
Back-arc basin rifting
Assembly of the South China

ABSTRACT

The NE Jiangxi ophiolite in the eastern Jiangnan Orogen is a tectonic mélange that mainly consists of individual tectonic blocks comprising pyroxenite, gabbro, basalt, diorite, granite and chert in a matrix of serpentinite or tuffaceous greywacke. A combined geochemical and geochronological study of the NE Jiangxi ophiolite was undertaken to constrain the timing and tectonic setting of its formation. The basalts were geochemically subdivided into three groups with different FeOt and $TiO_2$ contents. Group 1 basalts have the lowest FeOt (12.17–13.07 wt.%) and $TiO_2$ (1.48–1.62 wt.%) contents and the lowest Nb/Yb (0.80–0.88) and Th/Nb (0.02–0.03) ratios. Furthermore, they have normal mid-ocean ridge basalt (N-MORB)-like trace element patterns, suggesting derivation from an N-MORB-type mantle source without subduction input. Group 2 Fe–Ti basalts have the highest FeOt (15.52–16.30 wt.%) and $TiO_2$ (3.06–3.23 wt.%) contents, Nb/Yb and Th/Nb ratios from 1.75 to 1.89 and from 0.11 to 0.15, respectively, and trace element patterns similar to those of back-arc basin basalts. The geochemical characteristics suggest that Group 2 basalts were derived from a slightly enriched MORB-type mantle source with a minor subduction contribution. In contrast, Group 3 Fe–Ti basalts have moderate FeOt (12.98–13.40 wt.%) and $TiO_2$ (2.37–2.71 wt.%) contents, and Nb/Yb and Th/Nb ratios from 1.28 to 1.45 and from 0.27 to 0.30, respectively. These basalts further display markedly negative Nb–Ta anomalies and show a geochemical affinity to island-arc basalts (IAB), indicating a slightly enriched MORB-type mantle source that was significantly influenced by subduction-derived fluids and/or melts. SIMS zircon U–Pb dating on gabbros gave ages of 995 ± 22 Ma and 993 ± 12 Ma, which are interpreted as the formation age of the NE Jiangxi ophiolite. Positive zircon $\varepsilon_{Hf}(t)$ (+8.8 to +13.8) values for the gabbros and whole-rock $\varepsilon_{Nd}(t)$ (+5.5 to +6.6) values for the basalts indicate that the NE Jiangxi ophiolite originated from an isotopically homogeneous depleted mantle source. The diversity of MORB- to IAB-like basalts and the presence of Fe–Ti basalts favor a formation of the NE Jiangxi ophiolite during the initial rifting phase of an intra-oceanic back-arc basin between an oceanic arc (Huaiyu Terrane) and the continental margin of the Yangtze Block (Jiuling Terrane) at ca. 990 Ma. Both the present and previous studies imply that multiple arc–back-arc systems formed during long-lasting subduction–accretion processes between the Yangtze and Cathaysia blocks during the early Neoproterozoic.



## 1. Introduction

Ophiolites represent allochthonous fragments of upper mantle and overlying oceanic crustal sections that can be geochronologically and petrologically correlated (e.g., Dilek and Furnes, 2011). They are tectonically displaced from their locations of (primary igneous) generation and commonly emplaced on a passive continental margin and island arc or in an accretionary complex as a result of plate convergence (e.g., Cawood et al., 2009; Dilek and Flower, 2003; Dilek and Furnes, 2011). Ophiolites are generally observed along suture zones in both collisional-type and accretionary-type orogenic systems that mark major boundaries between collided plates or accreted terranes (Dewey, 1977; Dilek and Furnes, 2011; Furnes et al., 2013; Lister and

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http://dx.doi.org/10.1016/j.lithos.2015.08.007
0024-4937/

Forster, 2009). The diversity in structural architecture, geochemical fingerprinting and age ranges observed in ophiolites commonly reflect variations in petrological, geochemical and tectonic processes involved in the formation of oceanic crust in different geodynamic settings (Dilek, 2003; Dilek and Furnes, 2011).

The South China craton was formed through the welding of the Yangtze and Cathaysia blocks along the intervening Jiangnan Orogen (Fig. 1b). Numerous studies have led to a consensus that the assembly of the two blocks occurred during the Neoproterozoic Jiangnan orogeny (e.g., Charvet, 2013; Chen et al., 1991; Li et al., 2009; Wang et al., 2006; Zhao, 2015). However, the exact timing and evolution of the orogeny remains controversial. Some authors argue that the Jiangnan orogeny was part of the global Grenvillian-age (1.0–0.9 Ga) orogeny and place the South China craton in an intra-cratonic position between Laurentia and Australia (e.g., Li et al., 2007, 2008; Ye et al., 2007). In contrast, other authors propose that the Jiangnan orogeny lasted until ca. 800 Ma and the South China craton was located either on the margin of Rodinia near Australia (Cawood et al., 2013; Yao et al., 2014a,b; Zhao and Cawood, 2012; Zhou et al., 2002) or outside the supercontinent (Yang et al., 2004). Thus, the exact timing of the collision of the Yangtze and Cathaysia blocks can provide crucial constraints on the Neoproterozoic tectonic evolution of the South China craton.

Two Precambrian mafic–ultramafic complexes have been documented along the Jiangnan Orogen, namely the NE Jiangxi ophiolite (NJO) and the South Anhui ophiolite (SAO) (Fig. 1b). Recently, LA–ICP–MS and SHRIMP zircon U–Pb geochronology and detailed geochemistry of the South Anhui ophiolite suggested its formation between 840 and 820 Ma in a supra-subduction zone (SSZ) fore-arc or back-arc

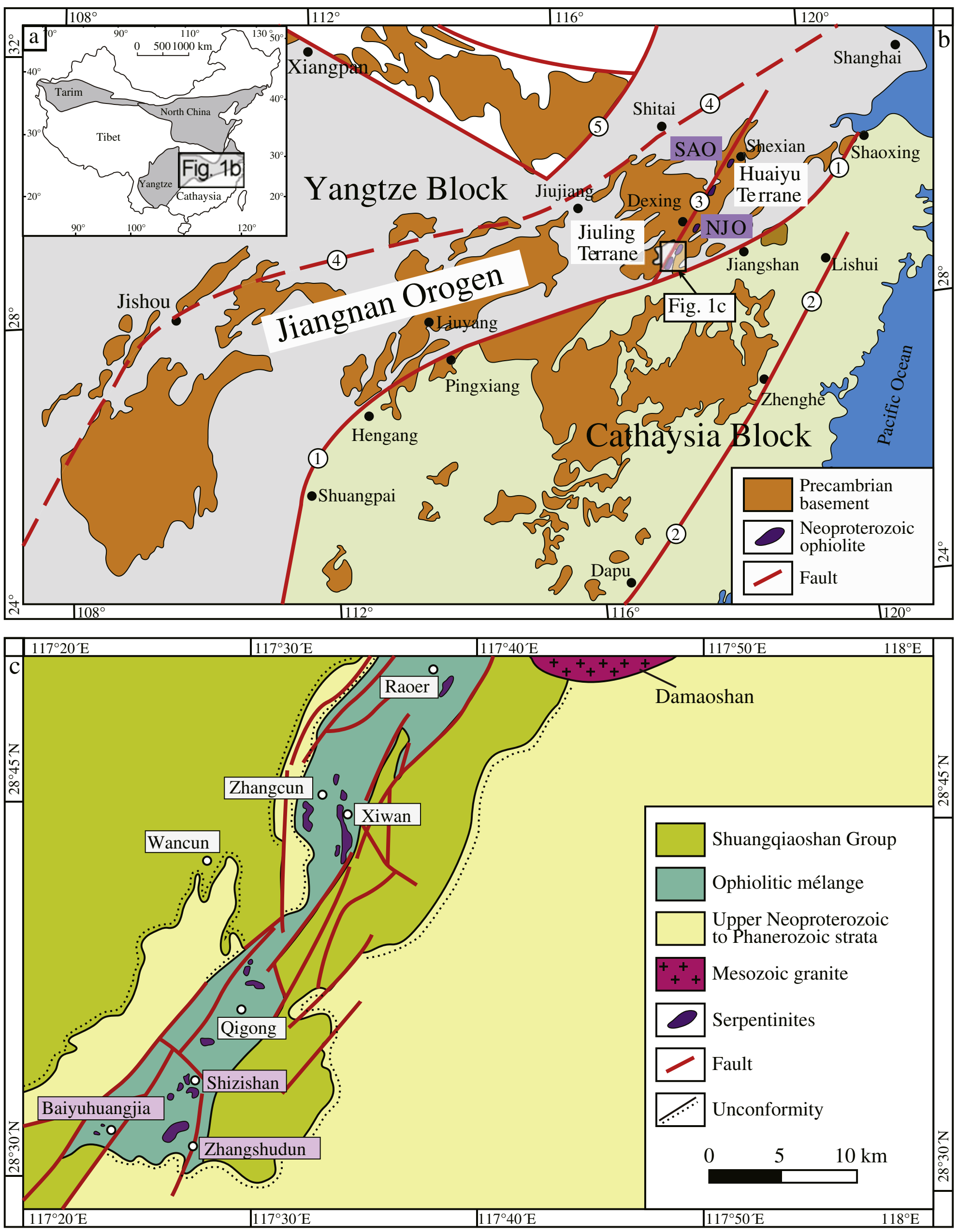


**Fig. 1.** (a) Sketch tectonic map illustrating the location of the Yangtze and Cathaysia blocks in China. (b) Schematic tectonic map of the South China craton showing the eastern Jiangnan Orogen between the Yangtze and Cathaysia blocks (modified after Yao et al.(2014a)). The fault 1: Shaoxing–Jiangshan fault; 2: Zhenghe–Dapu fault; 3: NE Jiangxi fault; 4: Shitai–Jiujiang fault; 5: Tanlu fault. Abbreviations: SAO = South Anhui ophiolite; NJO = NE Jiangxi ophiolite. (c) Simplified geological map showing the southern segment of the NE Jiangxi ophiolite (modified after Li et al.(2008a)) and the locations of the study areas, i.e., Zhangshudun, Shizishan and Baiyuhuangjia.