Precambrian Research 231 (2013) 61–77

Contents lists available at SciVerse ScienceDirect

Precambrian Research

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

Late Paleoproterozoic sedimentary and mafic rocks in the Hekou area, SW China: Implication for the reconstruction of the Yangtze Block in Columbia

Wei Terry Chen [a], Mei-Fu Zhou [a,*], Xin-Fu Zhao [a,b]

[a] Department of Earth Sciences, University of Hong Kong, Pokfulam Road, Hong Kong, China
[b] Faculty of Earth Resources, China University of Geosciences, Wuhan 430074, China

ARTICLE INFO

Article history:
Received 17 September 2012
Received in revised form 3 February 2013
Accepted 19 March 2013

Keywords:
Hekou Group
Yangtze Block
Zircon
Continental rift
Columbia supercontinent

ABSTRACT

The Paleoproterozoic Hekou Group in the western Yangtze Block is a volcano-sedimentary succession that is intruded by gabbroic plutons. Sedimentary rocks in the group include slates, marble and meta-siltstones interlayered with felsic metavolcanic rocks, metabasalts and metatuffs. Both the volcanic rocks of the Hekou Group and gabbros have undergone upper greenschist to lower amphibolite facies metamorphism. Metatuff samples from different layers have average zircon U-Pb ages of ~1697 Ma, slightly older than the intruding gabbroic plutons with zircon U-Pb ages of ~1684 Ma. Both metabasalts and metagabbros have similar elemental and isotopic compositions, indicative of a co-magmatic origin. They are rich in TiO_2 (mostly >2.5 wt.%), Zr (94.5–347 ppm), Ta (0.48–3.00 ppm) and Th (1.05–7.61 ppm) with high Nb/Y ratios (mostly >0.6) and LREE-enriched chondrite-normalized REE patterns, resembling within-plate mafic rocks. Their positive whole-rock $\varepsilon Nd(t)$ (0.2 to +3.4) and zircon $\varepsilon Hf(t)$ values (−3.3 to +8.4) suggest contributions from a depleted mantle source. The large range of $\varepsilon Nd(t)$ and $\varepsilon Hf(t)$ values, and variable degrees of Nb-Ta anomalies (Ta/La_{PN} = 0.17–1.75) are indicative of crust contamination during magma ascending. Both the metabasalts and metagabbros are considered to have formed in a continental rift setting.

Detrital zircon grains from meta-siltstones in the Hekou Group have U-Pb age populations mainly at 2070–1880 Ma, 2330–2250 Ma and 2900–2700 Ma. These age populations are comparable to those of the North Australian and North China Cratons in the Columbia supercontinent. However, in terms of geochemical features, the ~1.7 Ga within-plate mafic rocks at Hekou are similar to those from the ~1.7 Ga Leichhardt and Calvert Superbasins of the North Australian Craton, but different from those from the 1.7–1.2 Ga Zhaertai-Bayan Obo rift zone of the North China Craton. It is thus suggested that the Yangtze Block was more likely linked with the North Australian Craton in Columbia during the Late Paleoproterozoic. These rifting basins and mafic rocks may record the initial break-up of the Columbia supercontinent.

1. Introduction

The Yangtze Block consists predominantly of Meso- to Neoproterozoic rocks with sparse Archean to Paleoproterozoic rocks (Wan, 2004). Although the only Archean rocks known in the block are the ~2.9 Ga Kongling Complex which was metamorphosed to granulites at 2.03–1.97 Ga and was intruded by ~1.85 Ga mafic dykes and A-type granites, a widespread Archean to Paleoproterozoic basement is inferred from detrital zircon U-Pb ages and Lu-Hf isotopic compositions (Gao et al., 2001; Zhang et al., 2006a, 2006b, 2011; Sun et al., 2008; Xiong et al., 2009; Peng et al., 2009). However, the Paleoproterozoic tectonic evolution of the Yangtze Block and its reconstruction in the Paleoproterozoic Columbia supercontinent are still poorly known. Recently, the Hekou, Dahongshan and Dongchuan Groups and some mafic plutons in the southwestern Yangtze Block have been dated at ~1700 Ma (Zhou, 2005; Greentree and Li, 2008; Zhao et al., 2010), but their implications for the reconstruction of the Yangtze Block in Columbia have not yet examined.

Sedimentary rocks are natural samples of eroded continental crust and may contain valuable information about their sources (Horton et al., 2010). Detrital zircon age spectra record various sources linked to eustatic, depositional and tectonic change (Wang et al., 2010, 2012a, 2012b), and thus can provide insights into the basin-orogen coupling and paleogeographic reconstructions (Horton et al., 2010; Myrow et al., 2010). On the other hand, mafic rocks directly derived from the mantle can be used for discriminating tectonic settings (Pearce and Cann, 1973). Therefore,

* Corresponding author. Tel.: +86 852 2857 8251.
E-mail address: mfzhou@hku.hk (M.-F. Zhou).

0301-9268/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.precamres.2013.03.011

studies combining sedimentary and interlayered mafic volcanic rocks can provide more reliable constraints tectonic environments and reconstruction of supercontinents in the earth's history.

In this contribution, we present new zircon U-Pb ages for metatuffs from the Hekou Group and for metagabbro from intruding mafic plutons, and detrital zircon ages of meta-siltstone. Whole-rock geochemistry and Nd-Hf isotopic compositions of mafic rocks are used to address their petrogenesis and tectonic settings. These new dataset are used to examine the Paleoproterozoic tectonic evolution of the western Yangtze Block, which is compared with other continents, and thus provide an excellent opportunity to explore the position of the Yangtze Block in Columbia.

2. Geological background

South China consists of the Yangtze Block in the northwest and the Cathaysia in the southeast. The Yangtze Block is bounded by the Songpan-Ganze Terrane of the Tibetan Plateau to the west and is separated from the North China Craton by the Qinlin-Dabie-Sulu Orogen to the north (Fig. 1). The southwestern Yangtze Block is marked by the Cenozoic Ailaoshan-Red River shear zone. Rare basement rocks are exposed in the Yangtze Block due to a thick Neoproterozoic (Sinian) to Cenozoic cover. The only known Archean rocks are the ~2.9 Ga Kongling Complex in the northern part of the block (Fig. 1) (Gao et al., 2001), consisting of tonalitic-trondhjemitic-granodioritic (TTG) gneisses, amphibolites, and meta-sedimentary rocks (Qiu et al., 2000). These Archean rocks were metamorphosed to granulites between 2.03 and 1.97 Ga (Qiu et al., 2000; Ling et al., 2001; Zhang et al., 2006b). The Kongling Complex was intruded by numerous ~1.85 Ga mafic dykes and granitic intrusions forming in a continental rift setting (Peng et al., 2009; Xiong et al., 2009; Zhang et al., 2011).

In the western Yangtze Block, late Paleoproterozoic to Neoproterozoic strata are widespread. Paleoproterozoic strata include the Dahongshan, Dongchuan and Hekou Groups, whereas Meso- to Neo-Proterozoic strata include the Kunyang, Huili, Julin and Yanbian Groups (Fig. 1). The Dahongshan and Dongchuan Groups contain tuffaceous layers with zircon U-Pb ages of ~1700 Ma (Hu et al., 1991; Greentree and Li, 2008; Zhao et al., 2010), whereas the Mesoproterozoic Kunyang and Huili Groups contain volcanic layers with zircon U-Pb ages of ~1100 to ~1000 Ma (Greentree et al., 2006; Geng et al., 2007; Sun et al., 2009). The Neoproterozoic Yanbian Group has detrital zircons as young as ~860 Ma (Zhou et al., 2006; Sun et al., 2009). The Paleoproterozoic Dahongshan, Dongchuan and Hekou Groups were metamorphosed to upper greenschist-lower amphibolite facies (Li et al., 1988), and were intruded by Paleoproterozoic gabbroic plutons (Zhao et al., 2010; Guan et al., 2011; Zhao and Zhou, 2011). In contrast, the Kunyang, Huili and Yanbian Groups underwent only lower greenschist facies metamorphism (Chen and Chen, 1987; Li et al., 1988).

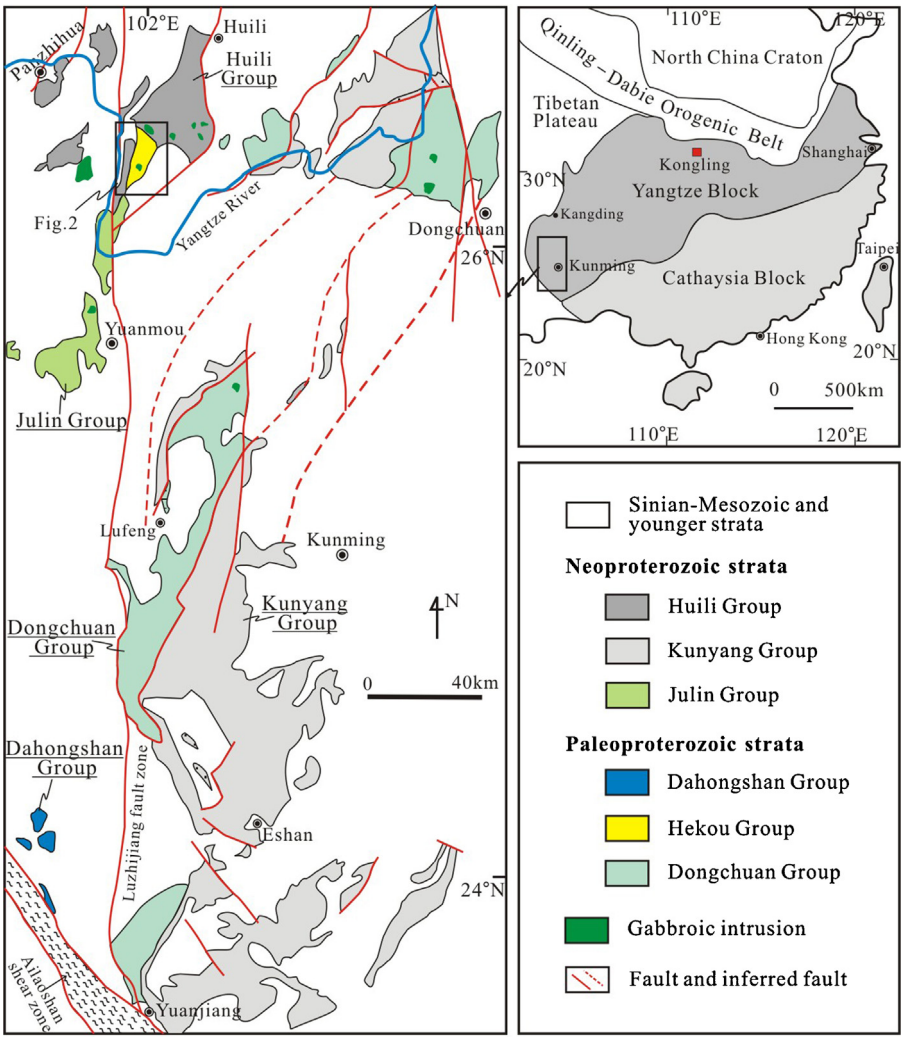

Fig. 1. Regional geological map of the western Yangtze Block showing the distribution of Precambrian strata and plutons (modified after Wu et al., 1990; Zhao et al., 2010).