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Neoproterozoic subduction-accretionary tectonics of the South Qinling Belt, China

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ABSTRACT

The Neoproterozoic magmatism in the South Qinling Belt and northern margin of the South China Block is important key to understanding the tectonic evolutionary history of the South China Block, and to reconstruct the tectonics of the supercontinent Rodinia. The Xiaomoling magmatic complex in the South Qinling Belt consists mainly of basalts in the Mogouxia area, gabbros and diorites in the Chishuigou, Lengshuigou and Qianyouhe areas. The basalts in the Mogouxia are characterized by depletion of LREEs and LILEs, and non- differentiation of HFSEs, suggesting their deviation from a slightly depleted MORB mantle source. Taken together with geochemical and geological data, the basalt in the Mogouxia area is interpreted to have derived from a subduction-related back-arc basin setting. The gabbros from both Chishuigou and Lengshuigou sections display clear LREE, Th, and LILEs enrichment, and depletion of Nb, Ta and Ti, and highly differentiation in HFSEs, which are similar to that of a typical Island Arc Basalts. The diorites from both Chishuigou and Qianyouhe areas display strong LREE enrichment, depletion of Nb, Ta, P and Ti, enrichment of LILEs, and flat distribution pattern of HFSEs in the primitive mantle-normalized trace element pattern. According to their geochemistry, both gabbros and diorites from different localities of the Xiaomoling magmatic complex were mostly likely formed in an island-arc tectonic setting. The zircons concentrated from the gabbro and diorite yield LA-ICPMS U-Pb ages of 753 ± 4 Ma and 843 ± 5 Ma, respectively, representing their formation ages. Integrated all the available geological, geochemical and geochronological data, we propose that the Xiaomoling magmatic complex represents the northernmost of the accretionary belt to the north of the South China Block, while the Hannan-Huangling Neoproterozoic intrusions mark the southernmost of the accretionary belt. Therefore, the most of southern Qinling represents a wide subduction and accretionary tectonic belt in Neoproterozoic times. Our new geochronology and previously published reliable ages estimate a long-lived subduction during ca. 850–700 Ma at the present South Qinling area, to the north of the South China Block.

1. Introduction

The Qinling Orogenic Belt (QOB), extending from east to west in the center of China and eastern Asian continent, has been well documented as formed by the collision between the North China Block (NCB) and South China Block (SCB) along the Paleozoic Shangdan suture (Zhang, 1988; Xu et al., 1988; Hsu et al., 1987; Mattauer et al., 1985; Kröner et al., 1993) or along both the Shangdan suture (SDS) and Mianlue suture (MLS) in Paleozoic and Triassic times, respectively (Zhang et al., 1995, 2001; Li et al., 1996; Meng and Zhang, 1999; Dong et al., 2011, 2013; Dong and Santosh, 2016). The QOB, bound by the Lingbao-Lushan-Wuyang fault (LWF) to the north and Mianlue-Bashan-Xiangguang fault (MBXF) to the south, can be divided into North and South Qinling Belts by the SDS (Fig. 1). The North Qinling Belt has been traditionally proposed to be a southern sector of the NCB which evolved into an active continental margin during Early Paleozoic time (Zhang et al., 2001; Xu et al., 1988; Hsu et al., 1987; Kröner et al., 1993; Li et al., 1996; Xue et al., 1996; Meng and Zhang, 1999). However, recent investigations of geology, geochemistry and geochronology

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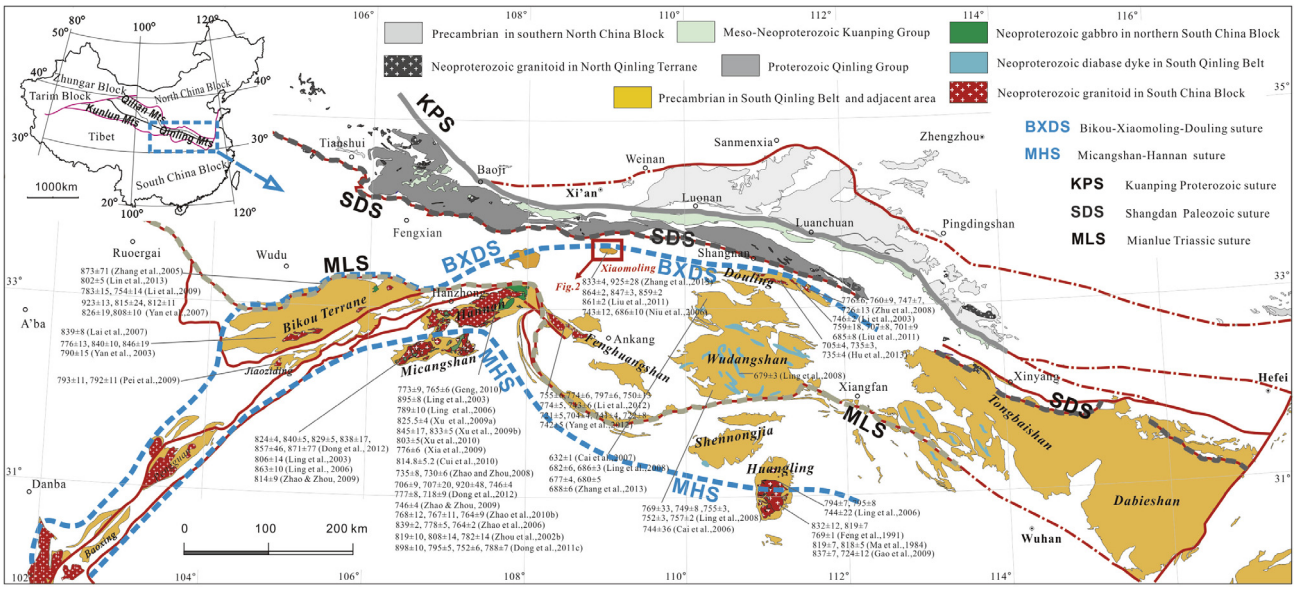

Fig. 1. Simplified tectonic maps of the Qinling Orogenic Belt and adjacent areas (modified after Dong and Santosh, 2016) showing the tectonic subdivision, distribution of the Precambrian rocks and the ages of Neoproterozoic igneous rocks. Inset map in the upper-lift corner shows the location of the Qinling Orogenic Belt within China.

indicate that the North Qinling Belt had been involved into a Mesoproterozoic southward subduction zone between the North Qinling Terrane to the south and the NCB to the north along the Kuanping suture and Luonan-Luanchuan fault (LLF) (Fig. 1) (Dong et al., 2014; Dong and Santosh, 2016).

The South Qinling Belt (SQB) is argued to be the northern part of the SCB or Yangtze Block (YB) according to their similar latest Neoproterozoic and Lower Paleozoic successions (Zhang et al., 2001). The SCB was formed by the Neoproterozoic collision between the Yangtze Block to the north and the Cathaysia Block to the south along the Jiangnan orogenic belt (Chen et al., 1991; Zhou and Zhu, 1993; Charvet et al., 1996; Li et al., 1997; Li and Mooney, 1998; Zhao and Cawood, 1999; Wang et al., 2007, 2008; Yu et al., 2010). Detailed geological, geochemical and geochronological investigations reveal that the SQB was split from the SCB as a discrete micro-continent due to the opening of the Mianlue ocean in Paleozoic time (Zhang et al., 1995, 2001; Li et al., 1996; Dong et al., 1999, 2011c), and amalgamated to the North Qinling Belt and NCB during early Devonian (Dong et al., 2011a, 2013; Dong and Santosh, 2016). Up to Late Triassic, the ongoing northward subduction of the Mianlue oceanic crust resulted a collision along the Mianlue suture between the SCB and the SQB which had been amalgamated to the North Qinling Belt (Zhang et al., 1995, 2001; Li et al., 1996, 2004; Dong et al., 1999, 2011b, 2013; Xu et al., 2000, 2002; Duan et al., 2011; Dong and Santosh, 2016). Comparing to the well documented Phanerozoic tectonics and evolutionary history, the Precambrian tectonic evolution of the SQB is still controversial due to its Precambrian tectono-stratigraphic associations are distinct from that of the Yangtze Block (Northern part of the SCB) (Dong and Santosh, 2016). For instance, Mesoproterozoic strata are not exposed in the SQB, however, they are widely occurred in the Yangtze Block (e.g., Shennongjia and Dagushi Groups). Particularly, the SQB is characterized by wide exposure of the Neoproterozoic volcanic-sedimentary successions (e.g., Wudang, Yunxi, Suixian, Bikou, Yaolinghe and Xixiang Groups), whereas the Yangtze Block has no record of these strata. These clues imply that the SQB evolved into a very different Meso- Neoproterozoic tectonic history from that of the Yangtze Block.

In this study, we present zircon U-Pb ages and whole-rock geochemical data on the mafic rocks from the SQB to better constrain the timing and tectonic setting of the SQB to the north of the Yangtze Block and SCB. Together with the previous investigations, these new data will shed light on the Neoproterozoic tectonic framework of the northern margin of the Rodinia supercontinent.

2. Geological setting

The Southern Qinling Belt, located between the SDS and the MLS, is separated from the YB by the MLS which marks the closure of the Paleo-Tethys Ocean between the YB and the South Qinling microplate during Late Paleozoic to Early Triassic times (Zhang et al., 1995, 2001; Li et al., 1996, 2004, 2009, 2010a,b; Dong et al., 1999, 2011c; Xu et al., 2000, 2002; Dong and Santosh, 2016). The SQB consists of sporadic highly metamorphic Neo-Archean basement in the Douling terrane, widespread greenschist-facies metamorphosed Neoproterozoic clastic and volcanic rock association, and a thick pile of Sinian (uppermost of Neoproterozoic) to Devonian successions, as well as minor Carboniferous to Middle Triassic strata outcrop sporadically in the northern SQB.

The Neo-Archean basement represented by the Douling complex consists of granitic gneiss, amphibolite and marble occurring in the northern margin of the SQB (Fig. 1). The protolith of the granitic gneiss yields formation ages of ca. 2.51–2.47 Ga with Hf model ages of ca. 3.30–2.95 Ga (Hu et al., 2013). These basement rocks were intruded by the granitic plutons at ca. 759–705 Ma (Wang et al., 2013; Hu, 2013), and are unconformably covered by the greenschist facies metamorphosed Neoproterozoic clastic and volcanic associations (Zhang et al., 2000, 2001).

The Neoproterozoic volcanic-clastic association is typically represented by the Wudang Group in the middle part of the SQB, the Yunxi Group in the northern SQB, the Suixian Group in the eastern SQB, and the Bikou Group in the western SQB (Fig. 1). The petrology, geochemistry and geochronology indicate that these four groups are equivalent, which represent the oldest rock association in the SQB except the Douling complex scattered in the northern margin of the SQB. The Wudang, Yunxi and Suixian Groups in the neighbouring areas are unconformably covered by the widespread Yaolinghe Group, and intruded by synchronous mafic swarms and granitic intrusions (Fig. 1).