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SHRIMP U–Pb zircon dating of the Neoproterozoic Penglai Group and Archean gneisses from the Jiaobei Terrane, North China, and their tectonic implications

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Abstract

Archean basement gneisses and supracrustal rocks, together with Neoproterozoic (Sinian) metasedimentary rocks (the Penglai Group) occur in the Jiaobei Terrane at the southeastern margin of the North China Craton. SHRIMP U–Pb zircon dating of an Archean TTG gneiss gave an age of 2541 ± 5 Ma, whereas metasedimentary rocks from the Neoproterozoic Penglai Group yielded a range in zircon ages from 2.9 to 1.8 Ga. The zircons can be broadly divided into three age populations, at: 2.0–1.8 Ga, 2.45–2.1 Ga and >2.5 Ga. Detrital zircon grains with ages >2.6 Ga are few in number and there are none with ages <1.8 Ga. These results indicate that most of the detrital material comes from a Paleoproterozoic source, most likely from the Jianshan and Fenzishan groups, with some material coming from Archean gneisses in the Jiaobei Terrane. An age of 1866 ± 4 Ma for amphibolite-facies hornblende–plagioclase gneiss, forming part of a supracrustal sequence within the Archean TTG gneiss, indicates Late Paleoproterozoic metamorphism. Both the Archean gneiss complex and Penglai metasedimentary rocks resemble previously described components of the Jiao-Liao-Ji orogenic belt and suggest that the Jiaobei Terrane has a North China Craton affinity; they also suggest that the time of collision along the Jiao-Liao-Ji Belt was at ~1865 Ma.

Keywords: SHRIMP U–Pb Zircon dating; Archean; Neoproterozoic Penglai Group; North China Craton; Sulu Orogen

1. Introduction

The Sulu Orogen (Fig. 1) is the eastern extension of the Qingling-Dabie-Sulu Orogenic Belt and was one of the first ultrahigh-pressure (UHP) belts shown to contain microdiamond, requiring pressures in excess of 3.2 GPa at >130 km depth (Xu et al., 1992; Wang et al., 1995). UHP metamorphism occurred during northward subduction of the South China Craton (SCC) beneath the North China Craton (NCC) in the Triassic (Liou et al., 1996; Hacker et al., 1995, 1998, 2000; Li et al., 1993, 2000; Zheng et al., 2003, 2005). The Jiaobei Terrane is separated from the Sulu Orogen by the Wulian–Yantai Fault and consists predominantly of Archean gneisses, Paleoproterozoic metasedimentary rocks named the Fenzishan and Jingshan groups, and Neoproterozoic metasedimentary rocks named the Penglai Group. The Fenzishan and Jingshan groups experienced amphibolite- to granulite-facies metamorphism (Cong and Wang, 1999; Zhai et al., 2000, 2005; Zhai and Liu, 2003; Zhao et al., 2005; Wan et al., 2006; Tang et al., 2007), whereas the Penglai Group underwent only greenschist-facies metamorphism (SBGMR, 1987, 1997; Zhu et al., 1994).

The Jiaobei Terrane is generally considered to be the southern extension of the Jiao-Liao-Ji Belt (Fig. 1a) in the eastern part of the NCC (Zhao et al., 2002, 2005; Zhai, 2002). Recently, however, Faure et al. (2001, 2002, 2003) suggested that the Jiaobei Terrane probably belongs to the SCC and that the Wulian–Yantai Fault does not mark the suture between the NCC and SCC. Based on field observations that both the Jiaobei and Sulu rocks under-

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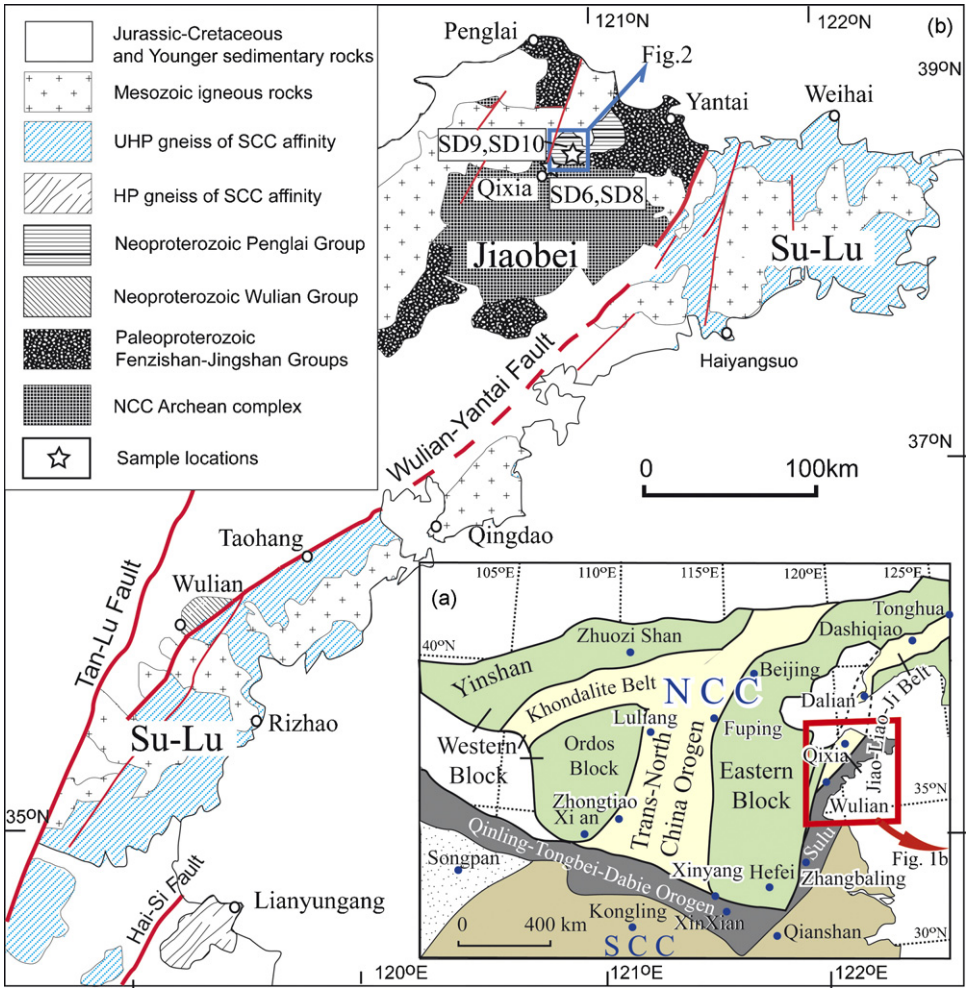

Fig. 1. (a) Subdivisions of the North China Craton (after Zhao et al., 2005), showing location of the Qinling-Dabie-Sulu Orogenic Belt. Rectangle shows location of the study area. (b) Geological sketch map of the Sulu Orogenic Belt of central-eastern China (after Faure et al., 2001; Hacker et al., 2006). NCC: North China Craton; SCC: South China Craton.

went similar deformational histories, granulite-facies restites in migmatites of the Jiaobei Terrane are considered to be granulitized eclogites derived from the UHP rocks in the Sulu Orogen (Faure et al., 2001). The similarities in petrological and structural features between the Jiaobei Terrane and Sulu Orogen further suggest that the boundary between the NCC and SCC should be placed north of the Jiaobei Terrane (Faure et al., 2001). Wu et al. (2004) and Zheng et al. (2005) likewise suggest that the suture lies below, or north of, the Wulian and Penglai groups (Fig. 1b), based on their interpretation that the Wulian Group is a subduction complex containing Neoproterozoic intrusives of SCC affinity, and the similarities in sedimentary style between the Wulian and Penglai groups (see also Li et al., 2007). Furthermore, Tang et al. (2006) reported that some rocks of the Fenzishan Group belong to the SCC, based on two samples of impure marble, which yielded SHRIMP zircon U–Pb ages of 786 ± 67 and 240 ± 44 Ma for igneous and metamorphic zircon, respectively. This suggests that the protolith of the marble was a limestone that was deposited synchronously with volcaniclastic rocks in a Meso-Neoproterozoic rift basin within the SCC, which was then thrust northward over the NCC due to crustal detachment during continental subduction (Tang et al., 2006). However, some recent studies suggest that the Jiaobei Terrane has affinities to the NCC, but that it behaved as a microcontinental block during Triassic continental collision (Tang et al., 2007; Wan et al., 2007).

The controversy over the tectonic affinity of the Jiaobei Terrane and the location of the suture between the NCC and SCC has thus attracted much attention (Faure et al., 2001, 2002, 2003; Zhai, 2002; Zhou et al., 2003; Zheng et al., 2005; Wu et al., 2004; Tang et al., 2006, 2007; Li et al., 2007; Wan et al., 2007). However due to a lack of high-quality geochronological data, the nature of the protoliths and the timing of metamorphism in the Jiaobei Terrane are poorly constrained. In particular, the lack of data on the Penglai Group means there is little constraint on the origin, provenance and tectonic affinity of these sediments (Faure et al., 2001, 2002, 2003). Various workers have also examined the Archean basement rocks in order to establish their protolith age and the timing of metamorphism, but there are still insufficient data to determine this.