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Geochronology and geochemistry of metamorphic rocks in the Jiaobei terrane: Constraints on its tectonic affinity in the Sulu orogen

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Abstract

Tectonic affinity of tectono-lithological units close to ultrahigh-pressure metamorphic belt is a key issue for understanding the geodynamics of continental collision. This is particularly so for the Jiaobei terrane northeast of the Dabie-Sulu orogenic belt in China. New data from LA-ICPMS zircon U–Pb dating, whole-rock elements and Nd–Sr isotopes, and mineral O isotopes are presented for metamorphic rocks from this terrane. The results place geochronological and geochemical constraints on their protolith nature and metamorphic timing and thus on its tectonic affinity to one of the two Triassic collided continents, the North and the South China Blocks. Protolith ages for TTG gneiss, amphibolite and mafic granulite are ~2.7, ~2.5 and ~2.4 Ga, respectively; regional metamorphism took place extensively at ~1.76 Ga. Protolith of the TTG gneiss was generated by partial melting of mantle-derived rocks at the root of a thickened crust. Protolith of the amphibolite was probably a product of arc-like magmatism; protolith of the mafic granulite was derived from a depleted mantle source. Both of them were locally contaminated by supracrustal materials. Protoliths of paragneiss and schist in the Fenzishan Group were mostly derived from supracrustal sources, but protolith of amphibolite in the Fenzishan Group is of mantle-derived signature. Unlike the UHP metaigneous rocks in the Dabie-Sulu orogenic belt that show unusual ^{18}O-depletion, the Jiaobei metamorphic rocks have basically preserved their original mantle-like O isotope compositions. In general, the nature and timing of geological events recorded in the metamorphic rocks from the Jiaobei terrane are comparable with those from the North China Block rather than the South China Block. Thus, the Jiaobei terrane is concluded to have tectonic affinity to the former, but behave like a micro-continent during the Triassic continental collision. The ~1.76 Ga regional metamorphism in the Jiaobei terrane is likely related to reworking of the arc-continent collisional orogen in the periphery of the North China Block rather than the ~1.85 Ga collision event between the eastern and western North China Blocks. The present study lends support to the common assumption that the suture boundary between the North and South China Blocks in the Sulu orogen is located along the Wulian-Yantai fault. Tectonic mingling along the Wulian-Yantai fault is probably related to subduction erosion during the continental collision.

Keywords: Zircon; U–Pb age; Isotope; Element; Metamorphic rocks; Protolith nature; Tectonic affinity; Subduction erosion; Continental collision; Sulu orogen

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1. Introduction

The Dabie-Sulu orogenic belt in east-central China becomes well-known due to widespread occurrence of ultrahigh-pressure (UHP) metamorphic rocks. Tectonic affinity of petrotectonic units adjacent to this UHP metamorphic belt is an important issue with respect to the geodynamics of continental collision between the North China Block (NCB) and the South China Block (SCB). The Jiaobei terrane has become such a hot-object because resolution of its tectonic affinity involves positioning of the suture boundary between the two Triassic collided continents (Fig. 1). This terrane was normally considered to be situated along the southern margin of NCB, and its basement rocks were predominated by Archean TTG gneiss and Paleoproterozoic metasedimentary rocks that experienced amphibolite-facies to granulite-facies metamorphism (Cong and Wang, 1999; Zhai et al., 2000). Recently, however, an integrated examination of lithology, structural geology, and geochronology argued that the Jiaobei terrane probably belongs to SCB and the Wulian-Yantai fault is not the suture location between NCB and SCB (e.g., Faure et al., 2001, 2002, 2003).

Because of its importance in studying the geodynamics of a collision orogenic belt, debates concerning the tectonic affinity of the Jiaobei terrane and the suture location in the Sulu orogen has attracted much attention (e.g., Zhai et al., 2000; Zhai, 2002; Wu et al., 2004; Zheng et al., 2005a). Due to lacking of high-quality geochronological data, protolith nature and metamorphic timing of Precambrian basement in the Jiaobei terrane are poorly understood. For example, it was generally assumed that the TTG gneiss has a protolith age of about 2.5 Ga, coeval with most of TTG suits in the other areas of NCB (Zhao et al., 2001). Since previously published poor-quality geochronological data by zircon evaporation method for the TTG gneiss gave an age range of 2.4–2.8 Ga with large uncertainties (e.g., An, 1990; Wang and Yan, 1992; Zhao et al., 2001), it is unclear whether the TTG rocks in the Jiaobei terrane was generated in a single episode or not. Furthermore, there are no geochronological data reported for protolith of amphibolite lenses and mafic granulite enclaves within the Jiaobei TTG gneiss, hampering the full understanding of the relationship between the mafic bodies and the host TTG gneiss.

Because crystalline zircon has very slow rate of O diffusion (Watson and Cherniak, 1997; Zheng and Fu, 1998), it can preserve the O isotope composition of its

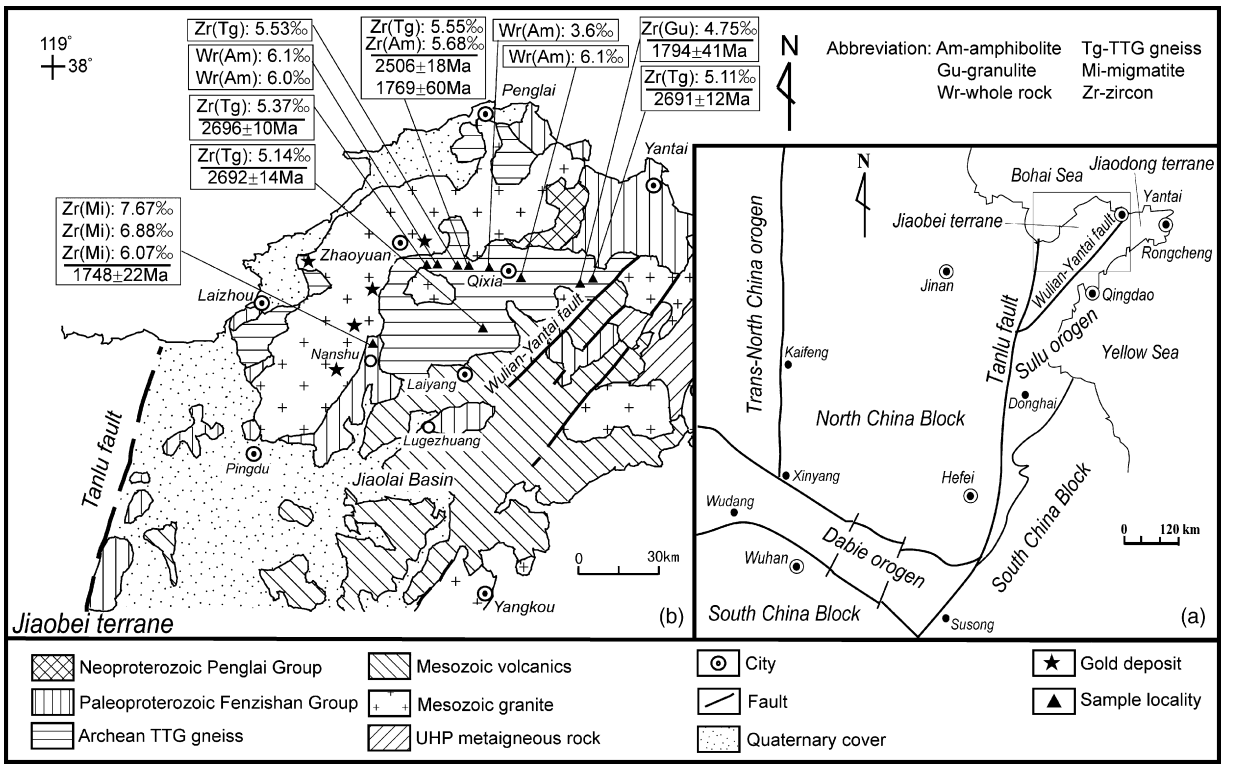

Fig. 1. A sketch map of tectonic division for the Shandong Peninsula (a) and simplified geology in the Jiaobei terrane with sample locality (b).