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Late Paleoproterozoic multiple metamorphic events in the Quanji Massif: Links with Tarim and North China Cratons and implications for assembly of the Columbia supercontinent

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ABSTRACT

The Quanji Massif preserves important records of late Paleoproterozoic metamorphic events that provide insights into the tectonic history of the Tarim Craton and its relation with the North China Craton. Here we investigate amphibolites from two regions in the Quanji Massif. U–Pb ages from metamorphic zircons in the amphibolites, combined with previously published ages from this region, define distinct metamorphic events during Paleoproterozoic. The earlier medium-*P*/*T* type upper amphibolite-facies metamorphic event occurred at ca. 1.90–1.96 Ga in a collisional setting. The second event took place with low-*P*/*T* type amphibolite-facies metamorphism in an arc setting at ca. 1.82–1.85 Ga, with a subsequent medium-*P*/*T* type metamorphism during arc–continental collision at ca. 1.80–1.82 Ga. Our data reveal for the first time that the late Paleoproterozoic metamorphic events in the Quanji Massif are closely comparable with those documented from the Khondalite Belt within the Inner Mongolia Suture Zone and the Trans-North China Orogen in the North China Craton. We therefore propose that the Quanji Massif and Tarim Craton probably shared similar tectonic histories with those of the North China Craton in the late Paleoproterozoic, coinciding with the global assembly of the Columbia supercontinent.

1. Introduction

The Paleoproterozoic coherent supercontinent, Columbia, was assembled at ~2.2–1.8 Ga (Rogers et al., 2000; Rogers and Santosh, 2002, 2003, 2004, 2009; Zhao et al., 2002a, 2004; Meert, 2012; Mohanty, 2012; Rogers, 2012). Recent studies have revealed that at least three Archean microcontinental blocks of the North China Craton were amalgamated in a period from ca. 1.95 to 1.80 Ga, possibly related to the assembly of the Columbia supercontinent (Lu, 2002; Zhao et al., 2000, 2002a,b, 2004, 2005; Lu et al., 2002b, 2006, 2008a,b; Ge et al., 2003; Kusky and Li, 2003; Zhai and Liu, 2003; Xia et al., 2006a; Kusky et al., 2007; Kusky and Santosh, 2009; Santosh, 2010; Kusky, 2011; Li et al., 2011a; Nutman et al., 2011; Tsunogae et al., 2011; Wan et al., 2011, 2012; Zhai and Santosh, 2011; Dan et al., 2012; Jian et al., 2012; Li et al., 2012; Liu et al., 2012b,c,d; Lü et al., 2012; Sun et al., 2012; Zheng et al., 2012; Zhao and Zhai, 2013). The NCC together with the Tarim and South China Cratons constitute the tectonic framework of China. However, little is known about the tectonic history of the Tarim Craton (TC), because of its thick desert cover. Sparse data from recent studies suggest that this craton was also possibly involved in the assembly of the Columbia supercontinent (e.g. Long et al., 2010a,b, 2011a,b; Zhang et al., 2012a). The late Paleoproterozoic history of the TC and its relationship with the NCC are emerging as a focus theme in understanding the Precambrian history of China and adjacent fragments.

In the domain between southwest NCC and southeast TC, a number of micro-blocks and/or micro-massifs have been identified including the Alashan Massif, Mid-Qilian Block, Quanji Massif (also named as Oulongbuluke Massif) and the Qaidam Block (see

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inset in Fig. 1) (Lu, 2002; Lu et al., 2002c). Among these, the Quanji Massif (QM) is composed of a medium- to high-grade metamorphosed crystalline basement, similar to the units in the NCC and TC, and is unconformably overlain by unmetamorphosed cover, thus representing a cratonic continental remnant (Lu, 2002; Lu et al., 2002c; Chen et al., 2009, 2012; Gong et al., 2012). Recent studies on the tectonic history of the QM have revealed many similarities with the TC in terms of stratigraphic sequences, as well as magmatic and metamorphic histories (Lu et al., 2006, 2008a), leading to a number of models for the correlation of the QM and the TC (Chen et al., 2012; Gong et al., 2012). Also, the QM and its inherited components from the TC have many similarities with the NCC, including the early crustal growth history and magmatic intrusions during the Neoarchean to Paleoproterozoic times (Chen et al., 2012; Gong et al., 2012). On the other hand, since Mid-Neoproterozoic, the QM and TC show similar stratigraphic units including tillite horizons, suggesting a common history with the Yangtze Craton (YC) (Lu et al., 2006). The metamorphic units of the QM, particularly of the paragneisses, show petrographic evidence for two discrete metamorphic events (Wang, 2009; Wang et al., 2009). Zircon U–Pb ages for anatectic leucosomes in paragneisses and lenticular amphibolite enclaves within granitic gneisses from the QM reveal that the first regional metamorphic event occurred in 1.90–1.96 Ga, associated with the assembly of the Columbia supercontinent (Lu, 2002; Lu et al., 2002a, 2006, 2008a; Hao et al., 2004; Wang et al., 2008; Chen et al., 2009; Wang, 2009; Zhang et al., 2011). However, the available data are insufficient to place precise constraints on the second regional metamorphic event (e.g. Zhang et al., 2001; Wang, 2009; Wang et al., 2009).

In this study, we report geochronological data on metamorphosed amphibolites from the QM which clearly reveal two distinct thermal events during the late Paleoproterozoic. We evaluate the results in understanding the correlation between the QM and TC, and the broader connection with the NCC and Columbia supercontinent.

2. Geological background

The QM is WNW-ESE oriented and exposed for nearly 500 km on the southeastern side of the Altyn-Tagh fault (Fig. 1). It is bounded by the Da-Qaidam – Qinghai Lake Fault which separates the massif from the Paleozoic South Qilian belt (Song et al., 2006, 2012) in the north. To the south, the QM is bordered by the early Paleozoic north Qaidam high- to ultrahigh-pressure belt. The Precambrian metamorphic basement of the QM is composed of the Delingha Complex, Dakendaban Group and Wandonggou Group (Lu, 2002). The Delingha Complex is composed mainly of ~2.20–2.39 Ga Paleoproterozoic granitic gneisses (Lu, 2002; Lu et al., 2002a, 2006, 2008a; Ba et al., 2012; Gong et al., 2012). Enclaves of amphibolite and mafic granulite are commonly present within the granitic gneisses. Some of the amphibolite enclaves yielded TIMS U–Pb zircon ages of 2410 Ma (Lu, 2002; Lu et al., 2002a). The Dakendaban Group can be divided into lower and upper sub-groups and is in fault contact with the Delingha Complex. The lower Dakendaban sub-group is distributed in the northeastern part of Wulan and is a set of upper amphibolite-facies volcano-sedimentary rock units formed during ~2.20–2.32 Ga (Chen et al., 2012). The upper Dakendaban subgroup which is mainly exposed in the Delingha region comprises polymetamorphosed supracrustal rocks possessing features similar to the khondalites formed during ~2.2–1.95 Ga (Wan et al., 2001, 2006; Lu, 2002; Huang et al., 2011; Chen et al., 2012). In the western portion of the QM, ca. 1.80 Ga rapakivi granite pluton is exposed (Xiao et al., 2004; Lu et al., 2006; Chen et al., 2013) which is in fault contact with the undivided Dakendaban and Wandonggou Groups (Lu et al., 2006). The Wandonggou Group is composed of a suite of low grade clastic-carbonate sedimentary rocks with minor volumes of mafic metavolcanic rocks. The basement rocks are unconformably covered by the Nanhua-Sinian Quanji Group and other early Paleozoic to Mesozoic strata.

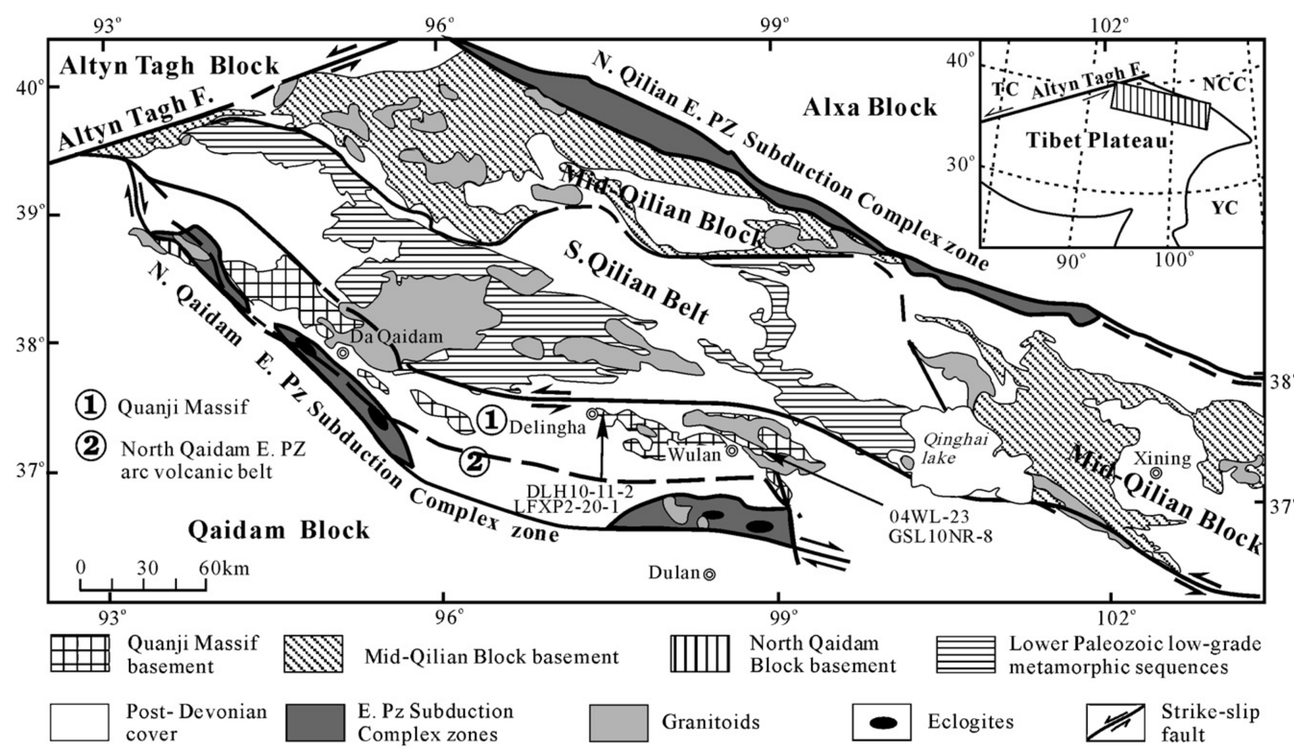

Fig. 1. Geological sketch map of the Quanji Massif (modified from Xu et al., 2006; Chen et al., 2009, 2012) and sample locality of amphibolites. YC, Yangtze Craton; NCC, North China Craton; TC, Tarim Craton.