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The Paleoproterozoic magmatic–metamorphic events and cover sediments of the Tiekelik Belt and their tectonic implications for the southern margin of the Tarim Craton, northwestern China

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ABSTRACT

The Tiekelik Belt in the southwestern part of the Tarim Craton, NW China, consists of Archean–Paleoproterozoic orthogneisses, and granitoids, and younger sedimentary successions. U–Pb dating of Paleoproterozoic rocks in the Tiekelik Belt has provided new information on the southwestern margin of the Tarim Craton. Two orthogneisses from the Heluositan Complex yielded crystallization ages in the interval 2310–2260 Ma and metamorphic ages of 2040–2007 Ma and 1830 Ma, respectively. Two syenogranites from the Buweituwei pluton yielded crystallization ages of 1900 and 1795 Ma. Detrital zircon analyses from sedimentary rocks nonconformably overlying the Buweituwei and Akazi plutons indicate maximum depositional ages between 1950 Ma and 1780 Ma. Major detrital inputs are from the basement in the region and form prominent peaks at 1900–1800 Ma and 2300–2200 Ma. Our new data, combined with previous results, allow us to summarize the Archean–Paleoproterozoic tectonic evolution of the Tiekelik Belt as follows: (1) Emplacement of Archean-aged TTG magmas during the 3.14–2.76 Ga interval; (2) A series of 2.41–2.26 Ga magmatic events that represent an important period of crustal reworking within the Tarim craton; (3) 2.03–1.80 Ga magmatic and metamorphic events that include the emplacement of a 1.9 Ga mafic dyke suite into the Heluositan Complex along with several episodes of intraplate magmatism. The late magmatic events are coeval with metamorphism and may support an orogenic extensional model for the Tiekelik Belt during the 1.9–1.8 Ga interval; (4) post-1.8 Ga subsidence and formation of a Changcheng sequence in the Tiekelik Belt. The Paleoproterozoic ages of major tectonothermal events within the Tiekelik, North Altyn–Dunhuang block and Alashan block are almost identical and it is argued that they were connected at that time as North China and Tarim were part of the larger Columbia supercontinent.

1. Introduction

There is now broad consensus that the global distribution of continental collisions documented between 2.1 and 1.8 Ga record the amalgamation of supercontinent Columbia (aka Nuna; Rogers and Santosh, 2002; Zhao et al., 2002, 2004; Meert, 2002, 2012). In some configurations of Columbia, the Tarim Craton was not included (Rogers and Santosh, 2002; Meert, 2002; Hou et al., 2008; Zhang et al., 2012a). Recent data suggest that the Tarim Craton was part of Columbia although its exact position within that continent is somewhat variable (Zhang et al., 2007, 2012b,c, 2013a,b; Shu et al., 2011; Long et al., 2012; Ma et al., 2013; Ge et al., 2013; He et al., 2013; Meert, 2014). As an example, in some models the Tarim Craton (TC) and the North China Craton (NCC) were separated (Zhao et al., 2002, 2004; Yakubchuk, 2010) whereas in others they remained connected (Rogers and Santosh, 2009; Ge et al., 2013; Zhang et al., 2012c, 2013b).

Situated in northwest China, the Tarim Craton is bounded by the Tianshan, Western Kunlun and Central–Southern Altyn Tagh mountain belts to the north, south and southeast, respectively

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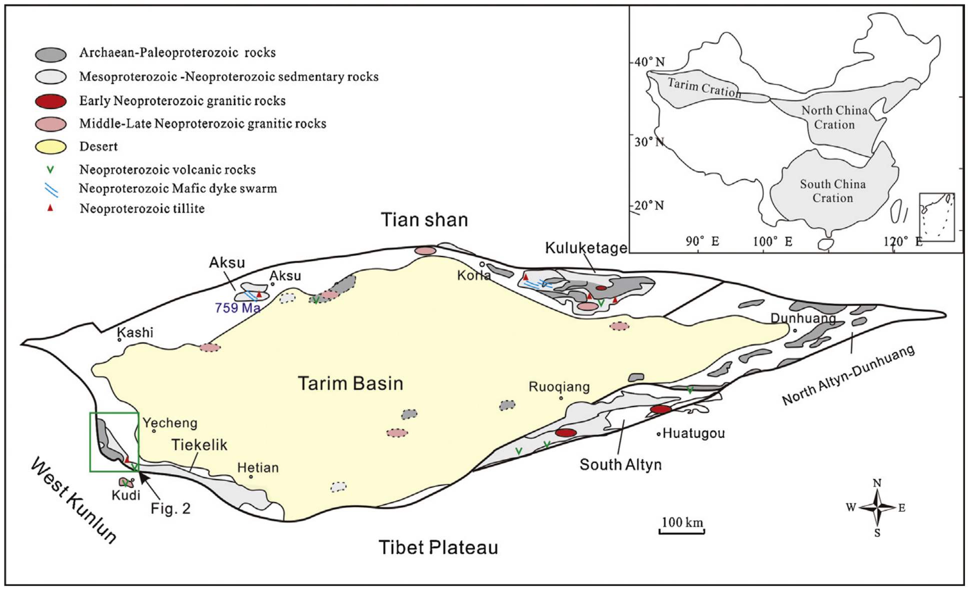

Fig. 1. Map of the Precambrian basement of the Tarim Craton. The dashed circles show the distribution of Precambrian rocks inferred from drill hole data. Inset shows location of the Tarim Craton within China.

(Fig. 1; Zhao and Cawood, 2012). Due to the extensive younger cover of the Taklamakan desert in the central part of the craton, the basement of the Tarim Craton is only exposed along the margins of the main basin (Fig. 1). These exposures include two regions along the southern margin of Tarim (Tiekelik and North Altyn–Dunhuang) and the Aksu and Kuluketage areas at the northern margin. The Archean–Paleoproterozoic aged basement rocks of the Tarim Craton are mainly exposed in the Kuruketage, North Altyn–Dunhuang and Tiekelik areas (Fig. 1; Gao and Zhu, 1984; Hu and Rogers, 1992; Lu and Yuan, 2003; Guo et al., 2003, 2013; Zhang et al., 2007, 2012b,c, 2013b; Lu et al., 2008; Long et al., 2010, 2012; Wang, 2011; Zong et al., 2013). Previously published data indicate that two major Paleoproterozoic 'events' took place at 2.45–2.25 Ga (magmatism) and 2.0–1.8 Ga (magmatism and metamorphism; Lu et al., 2008; Wang et al., 2009; Long et al., 2010; Shu et al., 2011; Wang, 2011; Zhang et al., 2012b,c,d, 2013b; Ge et al., 2013; He et al., 2013). Recently, new geochronological data were obtained from a deep drillhole into the basement of the Tarim craton. These data indicate that magmatic activity may have continued intermittently until c. 1.7 Ga and consisted of major reworking of the older Paleoproterozoic and Archean crust (Wu et al., 2012; Xu et al., 2013; Han et al., 2014).

The Tiekelik Belt is a narrow, but important, NW–SE-trending region along the southwestern margin of the Tarim Craton (Fig. 1). Rocks exposed in the Tiekelik Belt mainly consist of Paleoproterozoic and Neoproterozoic greenschist to amphibolite facies gneisses, schists, migmatites, amphibolites, quartzites, volcanic rocks and conglomerates that are overlain by late Palaeozoic to Cenozoic terrigenous sedimentary rocks (e.g. RGXR, 1993). The oldest rocks in the region are represented by a c. 3.14 Ga granitic gneiss (Guo et al., 2013). Zhang et al. (2007) argued that two Paleoproterozoic phases of high-K intrusions were emplaced at 2.41 and 2.34 Ga and were metamorphosed at 1.9 Ga. However, the sparse geochronological data do not fully constrain the Archean to Paleoproterozoic development of the Tiekelik Belt. In this paper, we present new zircon U–Pb geochronological data and whole rock geochemistry from different rock units within the region in order to unravel the architecture and evolution of the Tiekelik Belt during the Paleoproterozoic. Furthermore, a comparison of tectonothermal events from the Tiekelik and North Altyn–Dunhuang block and Alashan block are presented to evaluate the relationship between the Tarim Craton and North China Craton in the Columbia supercontinent.

2. Geological setting

The Tiekelik Belt is located in the southwestern part of the Tarim Craton between the Taklamakan desert and the West Kunlun Mountains (Fig. 1). The geological evolution of the Tiekelik Belt began with Archean to Paleoproterozoic thermo-magmatic episodes (of uncertain age) followed by the emplacement of c. 1.4 Ga anorogenic granitoids (Xu and Zhang, 1996; Zhang et al., 2007; Wang et al., 2009; Guo et al., 2013; Huang et al., 2012). The Archean and Paleoproterozoic geologic units within the belt (Fig. 2) are traditionally divided into (1) the Heluositan Group; (2) the Buweituwei and Akazi plutons; and (3) the Changcheng sedimentary sequence (1.8–1.6 Ga). The overlying Mesoproterozoic and Neoproterozoic sequences include continental rift volcano-sedimentary deposits (Ma et al., 1991; Wang et al., 2004, 2009, 2014). A detailed discussion of the Neoproterozoic evolution of the Tiekelik Belt can be found in Wang et al. (2014 and references therein).

The Heluositan Group outcrops in the western part of the Tiekelek Belt and consists of paragneisses, orthogneisses and migmatites (Figs. 2 and 3a), most of which have been metamorphosed under upper amphibolite- to granulite-facies conditions (RGXR, 1993; Guo et al., 2013). Since it is composed of magmatic and high-grade metamorphic rocks, it is not a group in the stratigraphic sense, and we will refer to it as the Heluositan Complex. It is intruded by the c. 2.34 Ga Buweiduwei and c. 2.41 Ga Akazi granitoids (Xu and Zhang, 1996; Zhang et al., 2007) and 1.8 Ga mafic dykes (unpublished data; Fig. 3b). Recently, a protolith age of 3.14 Ga was obtained on a sample of granitic gneiss within the Heluositan Complex (Guo et al., 2013). Collectively, the available geochronology suggests that the protoliths of the Heluositan Complex formed in the Archean and early Paleoproterozoic; however, no metamorphic ages from the Heluositan Complex have yet been published.

The Buweituwei and Akazi plutons intrude the Heluositan Complex gneissic suite. The Buweituwei pluton (BP) is a polyphase pluton composed of gneissic granodiorite, monzogranite and syenogranite along with minor amphibolite (Fig. 4a; HNGS, 2004).