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Precambrian evolution of the Chinese Central Tianshan Block: Constraints on its tectonic affinity to the Tarim Craton and responses to supercontinental cycles

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ABSTRACT

As the southernmost continental fragment in the Central Asian Orogenic Belt (CAOB), the Chinese Central Tianshan Block (CTB) is essential for understanding the evolution of the CAOB. However, its tectonic affinity with the Tarim Craton and links with supercontinent cycles are not clear. Here, we present whole-rock geochemistry, zircon ages and Hf-in-zircon isotopic data for augen- and mylonitic granitic gneisses in the eastern Chinese Central Tianshan Block (ECTB). Zircon U-Pb dating reveals that the augen- and mylonitic gneisses formed at ca. 918 Ma and 896 Ma, respectively. The gneisses have REE and HFSEs patterns comparable to the upper continental crust. Their Cr and Ni contents are similar to those of the typical S-type granites in the Lachlan belt. These rocks exhibit evolved zircon $\varepsilon_{Hf}(t)$ values (−9.0 to +1.6), which are consistent with those values of coeval crustal-derived rocks within the CTB. Together with the occurrence of muscovite and the existences of Paleo- to Mesoproterozoic inherited zircons (2.21–1.25 Ga), the geochemical data indicate that protoliths of these gneisses are S-type granites. These results, compiled with published geochronological data, suggest that an Archean basement was most likely absent in the CTB. The basement rocks of the CTB were dominantly produced by crustal growth in the early Mesoproterozoic and then reworked at Neoproterozoic. We suggest that the Mesoproterozoic crustal growth and the early Neoproterozoic crustal reworking were likely related to the breakup of the Nuna (ca. 1.40 Ga) and the assembly of the Rodinia (1.00–0.88 Ga), respectively. Because the CTB displays different crustal evolution from the Tarim Craton, we conclude that these two blocks have no close tectonic affinity in the Precambrian.

1. Introduction

Accretionary orogens are major sites of amalgamation of continental fragments and growth of continental crust (e.g., Windley, 1993; Cawood et al., 2009). This kind of orogens has been generally considered to correlate with the supercontinental cycle (e.g., Cawood and Buchan, 2007; Nance et al., 2014; Cawood et al., 2016). As one of the largest Phanerozoic accretionary orogenic belts on the earth, the Central Asian Orogenic Belt (CAOB) was formed by continuous accretions of different continental fragments, island arcs, seamounts and oceanic plateaux with huge inputs of massive juvenile crustal materials (e.g., Mossakovskiy et al., 1993; Sengör et al., 1993; Jahn et al., 2000; Jahn, 2004; Xiao et al., 2004; Windley et al., 2007). Three models were proposed to interpret the formation of the CAOB, including subduction of the single Kipchak arc, multiple island arcs and an archipelago (Sengör et al., 1993; Yakubchuk, 2004; Xiao et al., 2015). The differences among these models lie in the interpretation of early history and tectonic affinities of various fragments dispersed within the orogenic belt. Thus, the origin and evolution of the accreted continental fragments provide an opportunity to better understand the evolution of the CAOB and to clarify their relationships with supercontinental cycles.

The CAOB is surrounding by the Siberian Craton to the north and the Tarim Craton as well as the North China Craton to the

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south (Fig. 1a). In the southern part of the CAOB, two continental fragments, namely the Chinese Central Tianshan Block (CTB) and the Yili Block (YB), were incorporated into this orogenic belt during the Paleozoic (Xiao et al., 2004; Gao et al., 2009; He et al., 2014a; Liu et al., 2014; Wang et al., 2014a; Huang et al., 2016). It was recently indicated that the Yili and Central Tianshan underwent distinct evolution since early Paleozoic and became unified until late Carboniferous (Wang et al., 2008a, 2011; Charvet et al., 2011), but some newly studies proposed that these two continental fragments once constituted a big continent in the Precambrian (Liu et al., 2014; Huang et al., 2015b, 2016). At present, the tectonic affinity of the CTB related to the Tarim Craton still remains controversial. Hu et al. (2000) first proposed that the CTB was an independent continental terrane with no affinities to the Tarim Craton. Recently, some researchers argued that the CTB was once a part of the Tarim Craton in the Precambrian because of their similar magmatism and age distributions of detrital zircon grains (Shu et al., 2011; Ma et al., 2012a,b, 2013; Lei et al., 2013; Wang et al., 2014a,b). However, neither is commonly accepted. Most recently, others favored an eastern European Craton derivation for the CTB due to an absence of Archean basement (He et al., 2014a; Huang et al., 2014, 2015a,b).

In the past twenty years, the formation of the basement and the Precambrian crustal evolution of the CTB have not been well constrained, although Paleoproterozoic ages were obtained for the oldest gneisses not only in the eastern CTB (ECTB) but also in the western CTB (WCTB) (ca. 1.80 and 2.47 Ga, respectively) (Chen et al., 1997; Hu et al., 1997, 2000; Wang et al., 2014a). The early Paleoproterozoic age (ca. 2.47 Ga) is an upper intercept age of zircon with a bad concordance. The late Paleoproterozoic ages (ca. 1.80 Ga) were obtained by the zircon dilution method and Sm-Nd isochron. Because zircons from the rocks have complex internal structure and samples for Sm-Nd isochron can hardly meet the assumptions that all the samples are cogenetic and have the same initial $^{143}Nd/^{144}Nd$ value at the same time, these Paleoproterozoic ages need further studies to prove. The geological significance of these Paleoproterozoic ages needs to be constrained by more evidence. Therefore, it still remains unknown whether an Archean to Paleoproterozoic basement exists in the CTB or not. Recently, some Mesoproterozoic and Neoproterozoic magmatic events were also documented both in the ECTB and the WCTB (Li et al., 2002a; Liu et al., 2004; Hu et al., 2006, 2010; Yang et al., 2008; Chen et al., 2009; Shi et al., 2010; Peng et al., 2012; Lei et al., 2013; He et al., 2014a, 2015a; Huang et al., 2014, 2015a; Wang et al., 2014b;

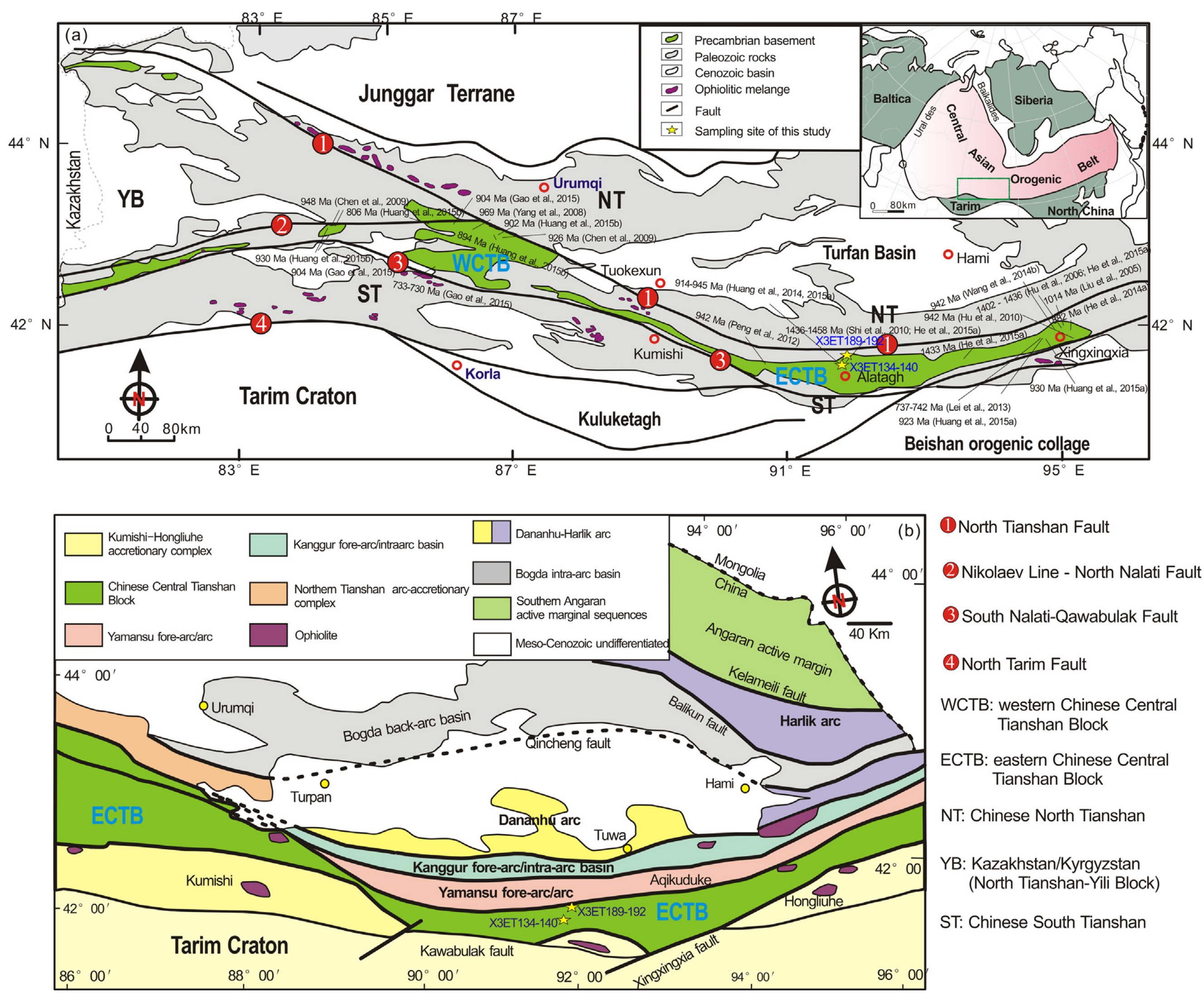

Fig. 1. (a) Sketch map of the Chinese Tianshan showing main tectonic boundaries and distribution of Precambrian rocks (modified after Gao et al., 2009; Charvet et al., 2011; He et al., 2014a; Wang et al., 2014c). (b) Sketch map of the eastern Tianshan Block showing the continental terranes (modified after Xiao et al., 2004). Inset is a simplified map of the Central Asian Orogenic Belt (modified after Xiao et al., 2012).