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Detrital zircon ages of Proterozoic meta-sedimentary rocks and Paleozoic sedimentary cover of the northern Yili Block: Implications for the tectonics of microcontinents in the Central Asian Orogenic Belt

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ABSTRACT

The Central Asian Orogenic Belt (CAOB) is one of the largest accretionary orogens in the world. It was formed mainly by amalgamation of island arcs, accretionary wedges and microcontinents. Revealing the origins of the Precambrian continental blocks is essential for the understanding of the tectonic framework and geodynamic evolution of the CAOB. In this paper we present detrital zircon U–Pb ages of Precambrian meta-sedimentary rocks and late Paleozoic undeformed sandstone from the northern Yili Block, Chinese North Tianshan, in order to better understand the regional tectonic evolution. Two mica-schist samples from the Wenquan Metamorphic Complex (WMC) show similar zircon age distribution patterns with peaks at ~0.43 Ga, ~0.54 Ga, ~0.65–0.68 Ga, ~0.74–0.79 Ga, ~0.89–0.92 Ga, ~1.3–1.55 Ga and ~1.69–1.70 Ga, respectively. Minor age peaks of ~1.1 and ~2.2 Ga are also separately recognized in individual samples. A phyllite from the Mesoproterozoic Changcheng System yielded detrital zircon ages mainly ranging from 855 to ~1500 Ma with a single peak at ~906 Ma. According to the analysis of age data and corresponding CL images of the dated zircon grains, protoliths of the mica-schists and phyllite should have deposited later than 645 Ma and 850 Ma, respectively, and were subjected to medium- to low-grade metamorphism during mid-late Silurian time. The good agreement between the age patterns of the meta-sediments and those of the nearby granitic and high-grade metamorphic rocks of the WMC indicates that the detrital zircon grains were mainly derived from the local metamorphic/crystalline basement. Occurrence of much older zircons (~1.0–2.2 Ga) in the mica-schists and absence of such zircon populations in the phyllite suggest that (1) the protoliths of the mica-schists and phyllite had distinct sources and were deposited at different time, and (2) Mesoproterozoic to Paleoproterozoic rocks probably existed in the northern Yili Block. Three undeformed sandstone samples yielded consistent single age peak at ~368–376 Ma and contain only a few Proterozoic detrital zircon grains. The peak age is in agreement with ages of neighboring late Paleozoic arc magmatic rocks in the Chinese North Tianshan. Thus, the sandstone was probably deposited during latest Devonian to earliest Carboniferous time in a forearc or interarc basin, around which Proterozoic basement was not exposed or completely isolated. A comparison between the zircon age patterns of the northern Yili Block and the surrounding cratons and microcontinents leads us to conclude that (1) the northern Yili Block had a Proterozoic basement similar to that of the Chinese Central Tianshan and Kyrgyz North Tianshan, and (2) these microcontinental blocks share the same origin as the Tarim Craton, but are distinguished from the Siberian Craton.

1. Introduction

Continental fragments are main constituents of accretion and collisional orogenic belts. The origin and crustal evolution of the continental units play an important role in the understanding of the tectonics and geodynamic processes of orogenic belts. The Central Asian Orogenic Belt (CAOB; Fig. 1A; Jahn et al., 2000; Jahn,

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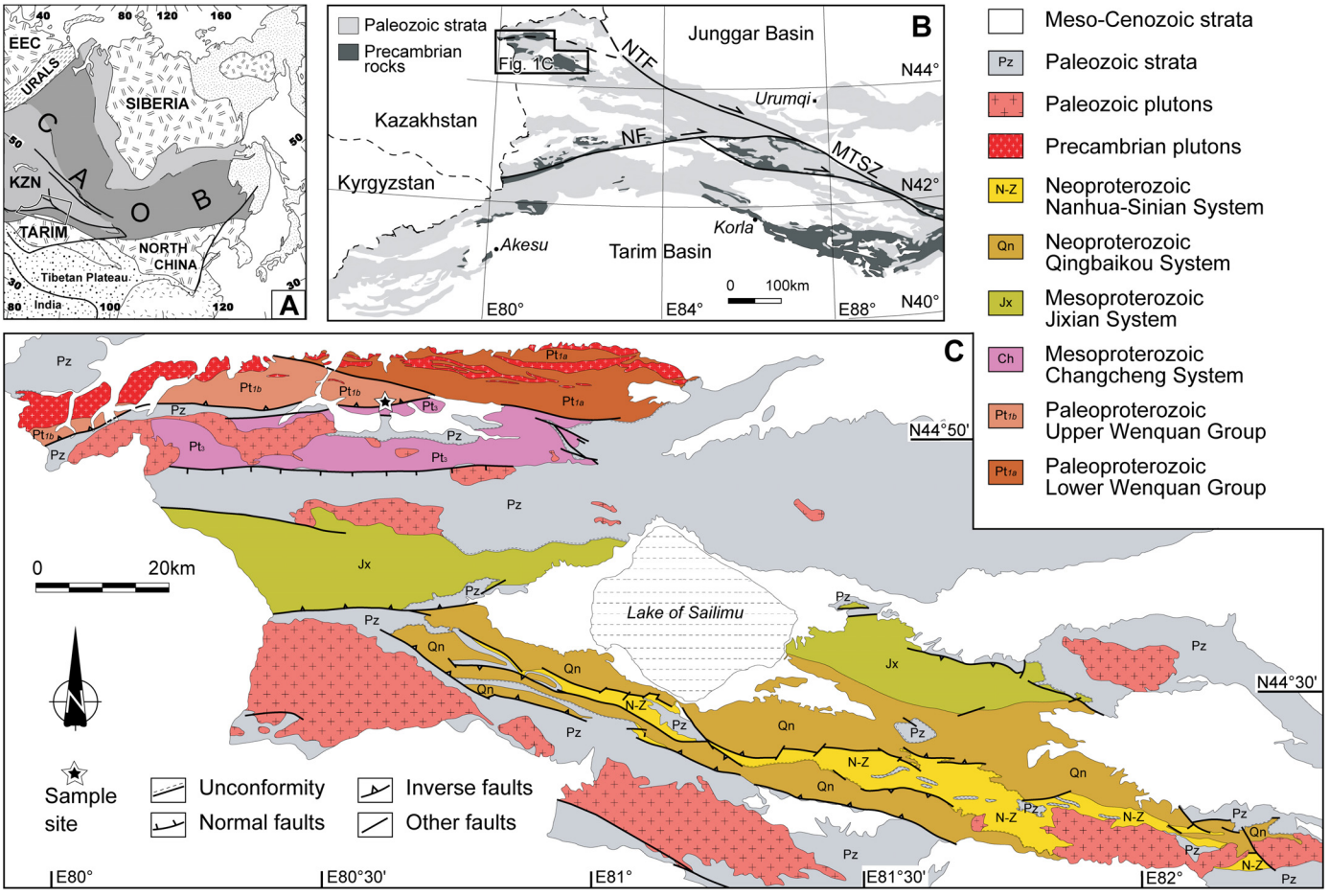

Fig. 1. (A) The sketch map of Eastern Asian showing the tectonic position of the Central Asia (after Jahn, 2004). CAOB, Central Asian Orogenic Belt; EEC, East European Craton; KZN, Kazakhstan. (B) Simplified geological map of the western Chinese Tianshan Belt showing the distribution of Proterozoic rocks (Modified from Wang et al., 2009). NTF, North Tianshan Fault; MTSZ, Main Tianshan Shear Zone; NF, Nalati Fault. (C) Simplified geological map of the Salimu area, northern part of the Yili Block (modified from XBGMR, 1988a, 1988b, 1993). The location of the sampling is shown with a star.

2004) is a result of long-lasting accretion orogenic processes, and its formation have become one of the most attractive issues in the international geologic community. Numerous studies have been conducted in the past decades, but many disputed issues still remain and have hindered understanding of the paleogeographic reconstruction and tectonic evolution of the CAOB. The controversies mainly focus on three aspects: (1) accretion process and its mechanism, including two competitive models, of which one is a single arc-trench system with continuous subduction and accretion of oceanic components (including oceanic plateaus, island arcs, seamounts and ophiolites) (Sengör et al., 1993; Sengör and Natal'in, 1996), and the other is an archipelago model with multiple arc/back-arc basin systems and different oceanic subduction polarities and ages (Mossakovsky et al., 1993; Windley et al., 2007; Geng et al., 2009, 2011; Jiang et al., 2010, 2012; Levashova et al., 2009; Long et al., 2010a; Glorie et al., 2011; Yuan et al., 2011; Xiao et al., 2010, 2013; Eizenhöfer et al., 2014); (2) time-space patterns of accretion orogeny, namely, the timing of the collision and the locations of suture zones (e.g., Gao et al., 1998, 2009; Shu et al., 2002, 2004, 2011; Xiao et al., 2004, 2008, 2013; Wang et al., 2008, 2011a; Cai et al., 2010, 2011a, 2011b, 2012a, 2012b, 2014; Charvet et al., 2011; Han et al., 2010; Hegner et al., 2010; Yin et al., 2010; Wang et al., 2011d; Zhang et al., 2011a; Kröner et al., 2012; Wilhem et al., 2012; Choulet et al., 2012, 2013); and (3) the nature and evolution of the continental blocks with Precambrian basement, that is, whether continental blocks belong to independent microcontinents (Allen et al., 1993; Windley et al., 2007) or where continental fragments separated from and re-amalgmated with various cratonic plates (Sengör and Natal'in, 1996; Kheraskova et al., 2003; Turkina et al., 2007; Shu et al., 2002, 2004, 2013; Zhou et al., 2010; Charvet et al., 2007, 2011; Wang et al., 2008, 2011a; Levashova et al., 2011)?

Recently, an increasing amount of geochronological, geochemical and isotopic data have been published to constrain the Paleozoic accretion and amalgamation tectonics of the CAOB, but studies on the nature and evolution of the continental basements within the CAOB are relatively minor (Hu et al., 2006, 2010; Kröner et al., 2007, 2013; Chen et al., 2009, 2012; Sun et al., 2009; Wang et al., 2014). On the basis of U–Pb ages and Hf isotopic compositions of detrital zircon grains from the late Paleozoic sedimentary rocks, some authors recognized evidence of contamination or reworking of Precambrian crust during the Paleozoic magmatism that occurred during the building of the CAOB (Rojas-Agramonte et al., 2011, 2013; Ma et al., 2012a, 2012b). However, the limited and discrete outcrops of Precambrian rocks cannot afford comprehensive cognition of the continental blocks and their correlation with sources of detrital zircon grains in Paleozoic sediments.

In the past few years, our research group has carried out extensive investigations on the Wenquan Metamorphic Complex (WMC; Wang et al., 2011b, 2012, 2014) that is located in the northern Yili Block, Chinese North Tianshan (Fig. 1B and C). The WMC is composed mainly of high-grade metamorphic rocks and low-grade meta-sedimentary rocks that were previously assigned to the Paleo- to Mesoproterozoic basement rocks (XBGMR, 1993).