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Neoproterozoic sedimentary basin evolution in southwestern Tarim, NW China: New evidence from field observations, detrital zircon U–Pb ages and Hf isotope compositions

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ABSTRACT

Sedimentary basin evolution is intimately related to tectonic background and thus can serve as one of the most important indicators in deciphering the regional tectonic evolution process. Neoproterozoic volcanic-sedimentary sequences are well preserved along the southwestern margin of the Tarim Block in NW China and provide new insights into the Neoproterozoic tectonic evolution of the Tarim. In this contribution, we report the metamorphic deformation features and systematic detrital zircon U–Pb ages and Hf isotope compositions of the Neoproterozoic strata in SW Tarim. Geochronological data reveal that the greenschist-facies metamorphic and tightly folded Sailajiazitage Group (SG) volcanic-sedimentary sequence deposited during 860–830 Ma, the Ailiankate Group (AG) clastic rocks of low greenschist – facies metamorphism and intensive deformation deposited during 820–800 Ma, and the unmetamorphosed and undeformed late Neoproterozoic carbonate–clastic–tillite sequences, including the Silu Group (SLG) and the Qiakemakelieke Group (QG), deposited after 760 Ma. Two phases of glaciations from the QG in SW Tarim could be equivalent to the Beiyixi glaciation and the Altungol–Tereeken glaciation in north Tarim, respectively. Rock assemblages coupled with geochemistry of the SG bimodal volcanic rocks indicate its deposition in a back-arc basin. Rock assemblages, detrital zircon age spectra and its metamorphism and deformation features suggest that the AG clastic sequence most likely deposited at a foreland basin on the back-arc basin sedimentary package while the middle to late Neoproterozoic SLG and QG carbonate–clastic–tillite sequences deposited at a passive marginal and/or rift basins. The Neoproterozoic evolution process of the southwestern Tarim demonstrates that (1) the Neoproterozoic assemblage of the Tarim basement could have lasted till 760 Ma as evidenced by the Aksu blueschist-facies metamorphism and (2) its Pre-Nanhuaian basement could be composed of independent continental terranes. Furthermore, positive $\varepsilon Hf(t)$ deviations in these detrital zircons suggest that the Rodinia plume could have effects on the Neoproterozoic igneous activities.

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1. Introduction

Detrital zircon geochronology and geochemistry is becoming a powerful method in deciphering sedimentary provenance and in crustal evolution (e.g., Kemp et al. (2006), Cawood et al. (2007a, b), Grove et al. (2008a,b), Hawkesworth et al. (2010), Li et al. (2014), Gehrels (2014), Spencer et al. (2015)), owing to zircon's refractory characteristics during metamorphic and weathering processes (Zheng et al., 2007), and the availability of large numbers of in situ, high precision analyses of their ages, trace elements, oxygen and Lu–Hf isotope compositions using modern microbeam techniques (ion probe and LA-MC/Q-ICPMS, e.g., Liu et al. (2008), Li et al. (2014)). Detrital zircon spectra have distinctive age distribution patterns that reflect the tectonic setting of the basin in which they are deposited, and could provide a framework that can be used to constrain the tectonic setting of sedimentary packages (Cawood et al., 2012). In addition, systematic in situ zircon Lu–Hf isotope compositions, coupled with in situ U–Pb ages, have been widely used to discuss regional tectonic evolution and the continental growth process (e.g., Kemp et al. (2006), Condie et al. (2009a,b); Sun et al., 2009; Li et al., 2014).

The Tarim Craton in the Xinjiang Uygur Autonomous Region of northwestern China, covering an area of more than 600,000 km^2, is

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one of the main three Precambrian nuclei in China (i.e., Tarim, North China and South China) (Zhao and Cawood, 2012; Zheng et al., 2013; Zhang et al., 2013). The craton is surrounded by the Phanerozoic orogenic belts of Tienshan Mountains to the north, the western Kunlun Mountains to the south, and the Central-Southern Altyn Tagh Mountains to the southeast (Fig. 1a). In recent years, many studies focusing on the Neoproterozoic geology of Tarim illustrated that the craton was assembled within the Rodinia supercontinent during late Mesoproterozoic to early-middle Neoproterozoic (Zhang et al., 2003a, 2012a; Zhan et al., 2007; Lu et al., 2008; Shu et al., 2011; He et al., 2012). The two main pulses of Neoproterozoic magmatism at 820–800 Ma and 780–760 Ma were considered to be related to the Rodinian plume (Zhang et al., 2007a,b, 2009, 2011, 2012b; Xu et al., 2005, 2009, 2013; Zhu et al., 2008). Several studies on the early Precambrian history of this craton show 2.0–1.8 Ga metamorphism overprinted on the Archean and Paleoproterozoic outcropping along the northern margin (the Quruqtagh terrane), the southwestern Tarim terrane and the Altyn terrane in the east, which was considered to be correlated to the assembly of the Columbia supercontinent (Lu et al., 2008; Shu et al., 2011; Long et al., 2010, 2011; Zhang et al., 2011; Ge et al., 2013a, 2013b). Recently, Zhang et al. (2014a) and Ye et al. (2016) suggested that the Precambrian basement of the Tarim possibly composed of discrete terranes drifted from different Precambrian nuclei and these terranes did not assemble until the early to middle Neoproterozoic during the assemblage of the Rodinia supercontinent.

Although many studies have been carried on the Neoproterozoic igneous activities in Tarim, little attention has been paid to the tectonic settings of the Neoproterozoic sedimentary basins (Turner, 2010). In order to evaluate the coupling between Neoproterozoic tectonic evolution process and the development of sedimentary basins along the southwestern margin of the Tarim, in this contribution, we analyzed U–Pb ages and Hf isotope compositions of the detrital zircons from different Neoproterozoic members outcropping in southwestern Tarim. Using these data, in combination with metamorphic and deformation features of these members observed in the field, we aim to: (1) decipher the tectonic settings of the Neoproterozoic basin and the possible tectonic system transformation from early to late Neoproterozoic in southwestern Tarim; (2) describe a more detailed late Mesoproterozoic to Neoproterozoic tectonic evolution process of the southwestern Tarim terrane; and (3) constrain the Neoproterozoic glaciation age for a better correlation of the glaciation at the different terranes of the Tarim.

2. Regional geology

The Tarim Craton is bound by the Tianshan, western Kunlun and Central-Southern Altyn-Tagh Mountain belts to the north, south and southeast, respectively (Fig. 1a) (Lu et al., 2008; Zhang et al., 2013). The craton shows typical double-layered structure sequence consisting of a Precambrian basement (pre-Neoproterozoic or Pre-Nanhuaian) and a late Neoproterozoic to Cambrian cover (Lu, 1992; Xinjiang, 1993; Feng et al., 1995; Gao and Chen, 2003). The Precambrian rocks in the Tarim Craton are mostly exposed along the northern, eastern and southwestern margins. In central Tarim, Precambrian igneous and metamorphic rocks were obtained in the drilling holes (Li et al., 2005; Guo et al., 2005; Xu et al., 2013a,b).

The major Precambrian rock series of the southwestern Tarim terrane (STT) are mainly composed of the Paleoproterozoic Heluositan complex and the 2.41 Ga Akazi pluton (Zhang et al., 2007c; Wang et al., 2014; Ye et al., 2016) (Fig. 2), the Mesoproterozoic greenschist- to amphibolite- facies metamorphosed and intensively folded sedimentary sequences, and the Neoproterozoic volcanic-sedimentary sequences and carbonate–clastic–tillite

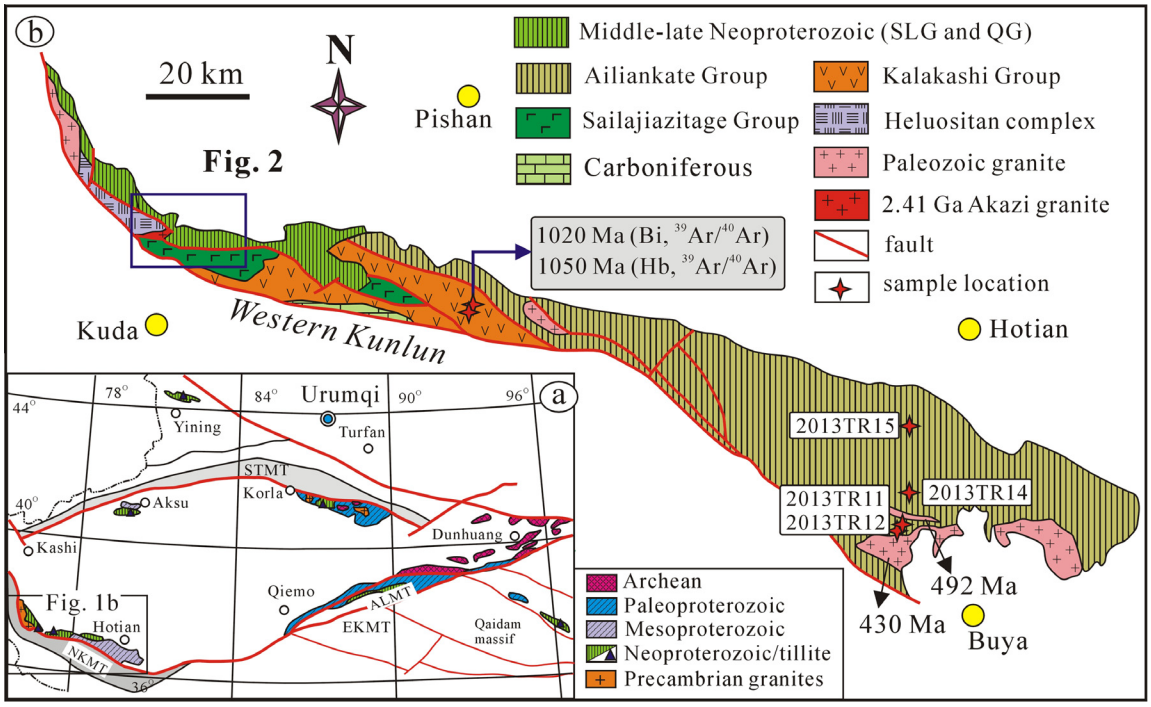

Fig. 1. (a) Tectonic framework of the Tarim Craton and its adjacent areas showing the Precambrian terranes along its margin. (b) Main Precambrian unites in the southwestern section of the Tarim Craton. Hornblende and biotite $^{39}Ar/^{40}Ar$ plateau ages are marked for the high greenschist to amphibolite facies metamorphic Mesoproterozoic Kalakashi Group (modified after Xinjiang (1993)). The Neoproterozoic sequences could be divided into main three members, i.e., member 1, the Sailajiazitage group; member 2, the Ailiankate Group and member 3, the Silu Group (SLG) and Qiakemakelieke Group (QG). Both member 1 and member 2 underwent low greenschist-facies metamorphism and intensive deformation while member 3, of no deformation and metamorphism.

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