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Growth and evolution of Precambrian continental crust in the southwestern Tarim terrane: New evidence from the ca. 1.4 Ga A-type granites and Paleoproterozoic intrusive complex

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ABSTRACT

The Precambrian tectonic evolution and growth of continental crust in the southwestern Tarim Craton in NW China remain enigmatic. In this contribution, we report petrography, zircon U–Pb ages, geochemistry and Nd–Hf–O isotope data on the ca. 1.4 Ga granitic pluton in southwestern Tarim Terrane. We also present zircon U–Pb ages and Hf isotope data on the Paleoproterozoic intrusive complex from this area, and use the combined data to evaluate Precambrian tectonic evolution of the region in relation to the Columbia supercontinent. The ca. 1.4 Ga Azibailedi pluton is mainly composed of biotite monzogranite with contents SiO_2 (72.8–75.1 wt.%). The major element chemistry of the pluton reveals alkali-calcic and ferroan affinities and metaluminous to peraluminous feature with A/CNK ranging from 0.86 to 1.15. The granite shows high total REE contents with variable enrichment in LREE ($(La/Yb)_N$ = 8.5–12.2). Both REE and other incompatible elements features define A-type affinities. The initial epsilon Nd values vary from −3.5 to −2.2 and zircon $\varepsilon_{Hf}(t)$ and $\delta^{18}O$ values range from −4.1 to +6.1 and 7.1‰ to 8.6‰. Integrating geological, geochemical and Nd–Hf–O isotope data, we suggest that the Azibailedi A-type granites were derived from pre-existing early Paleoproterozoic mafic lower crust with involvement of variable amount of Paleoproterozoic juvenile crust, possibly trigged by basaltic magma upwelling, during the breakup of the Columbia supercontinent.

U–Pb geochronology and Hf isotopic analyses of zircons from the Paleoproterozoic Heluositan intrusive complex show crustal growth episodes during 2.2–4.2 Ga with peaks at 2.3–2.5 Ga, 3.3 Ga and 3.6–3.8 Ga, distinct from the other Precambrian terranes of the Tarim Craton. A comprehensive synthesis of the records of assembly and breakup of Columbia supercontinent from different Precambrian terranes in the Tarim Craton show significant differences. The temporal distinction in tectonothermal events and the marked difference in the continental crust growth processes suggest that the early Precambrian basement of the Tarim Craton was possibly composed of discrete terranes which were fragmented from different ancient cratonic nuclei.

1. Introduction

The Tarim, North China and South China Cratons constitute the three major Precambrian cratons in China (Zhao and Cawood, 2012; Zhang et al., 2013a,b). The Tarim Craton is located within the Xinjiang Uygur Autonomous Region of NW China, and is largely covered by desert (more than 85%) (Xu et al., 2013). The Precambrian basement rocks in the craton are exposed only along its margins, including the Tikelike area in the southwestern margin, the Akesu and Quruqtagh (also spelled as Kuluketage) area along the northern margin, and the North Altyn Tagh Mountain and the Dunhuang area at the eastern margin (Fig. 1a).

Investigations focusing on the Neoproterozoic geology of the southwestern Tarim terrane have revealed two tectonothermal episodes, one during early Neoproterozoic (1.0–0.9 Ga) and the other during middle Neoproterozoic (~0.8 Ga), possibly

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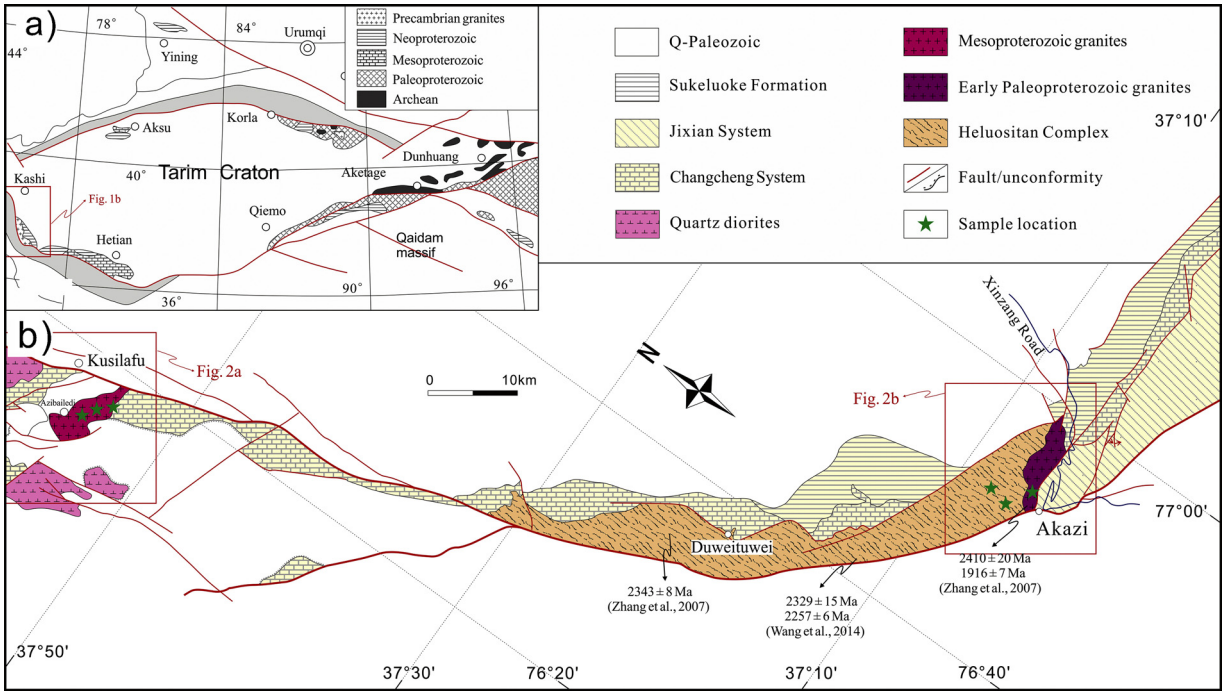

Fig. 1. (a) Tectonic framework of the Tarim Craton and its marginal area showing the Precambrian terranes along its margin. (b) Precambrian geology in the southwestern section of the Tarim Craton (modified after HNGS, 2004a,b).

corresponding to the assembly and breakup of the supercontinent Rodinia (Zhang et al., 2006a,b, 2010). However, despite the availability of some geochronological and geochemical data have been reported (Wang et al., 2014; Zhang et al., 2007a), continental growth processes and tectonic evolution are poorly understood.

In this contribution, we present detailed field observations, petrography, zircon U–Pb ages and Hf–O isotopes, whole-rock major and trace element geochemistry, and Sr–Nd isotopes of the Azibailedi A-type granites (ferroan granites) in the southwestern margin of Tarim Craton. We also report zircon U–Pb ages and Hf isotopes of the early Paleoproterozoic Heluositan intrusive complex, which findings, in combination with those from previous investigations provide new insights into: (1) the petrogenesis of the 1.4 Ga Azibailedi A-type granites, and their implications on the history of breakup of the Columbia supercontinent; (2) the Precambrian tectonic evolution and continental crustal growth and (3) the architecture of the early Precambrian basement of the Tarim Craton.

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., 2013a). The craton shows typical double-layered structure consisting of a Precambrian basement (pre-Neoproterozoic) and late Neoproterozoic to Cambrian cover series (Xinjiang BGMR, 1993; Feng et al., 1995). The Precambrian rocks in the Tarim Craton are mostly exposed along the northern, eastern and southwestern margins.

The Precambrian basement rocks of the Quruqtagh-Dunhuang area are composed of orthogneisses (tonalite-trondhjemite-granodiorite; TTG), amphibolite and metasedimentary rocks. Previous studies indicated that the TTG rocks were mainly emplaced at ca. 2.7–2.5 Ga. Metamorphism main at ca. 1.85–1.80 Ga has been identified in both Archean and the Paleoproterozoic paragneisses (Ge et al., 2014; Zhang et al., 2013b) and the Paleoproterozoic metamorphism has been correlated to the assembly of the Columbia supercontinent (Ge et al., 2013a; Zhang et al., 2012a, 2013b; Lei et al., 2012). A recent study on 1470 Ma metadiabase from this region correlates with the breakup of the Columbia supercontinent (Wu et al., 2014). In the Aketage area, Paleoproterozoic metamorphic events are recorded by the Archean Milan Group, mostly composed of TTG rocks, hypersthene granulite, and mafic granulite, metamorphosed at ~2.0 Ga (Zhang et al., 2014a), followed by 1.85 Ga post-orogenic extension represented by OIB-like mafic dykes and massive potassic granites (Lu et al., 2008; Zhang et al., 2014a). Detrital zircon U–Pb dating and field mapping indicate the absence of Archean basement in the Akesu area (Fig. 1a) (Xinjiang BGMR, 1993; Zhang et al., 2014b). Zircons from the Akesu Group have U–Pb age populations of ~0.82 Ga, 2.0–1.8 Ga, ~2.3 Ga and ~2.5 Ga (Zhang et al., 2014b; Zhu et al., 2011). The youngest group of these ages at ~820 Ma constrains the lower limit of the depositional time of the protoliths of Aksu blueschist (Zhang et al., 2014b). The age population of 2.0–1.8 Ga is coincident with the timing of the amalgamation of the Columbia supercontinent (Zhu et al., 2011). Based on zircon U–Pb ages and $^{39}Ar/^{40}Ar$ plateau age of glaucophane from the blueschist in Aksu terrane (Yong et al., 2013), Zhang et al. (2014a,b) argued that the Akesu terrane (AT) might represent an accretionary terrane amalgamated to the Tarim Craton during 820–780 Ma.

The major Precambrian units of the southwestern Tarim terrane (STT) are mainly composed of the Paleoproterozoic Heluositan complex, the Mesoproterozoic greenschist-facies metamorphosed and intensively folded sedimentary sequences and the Neoproterozoic volcanic-sedimentary sequences with no significant metamorphism and deformation (Zhang et al., 2007a,b, 2010) (Fig. 1b). The Heluositan Complex mainly consists of paragneisses, orthogneisses and migmatites which underwent ca. 1.9 Ga amphibolite to granulite facies metamorphism and were intruded by the 2.34 Ga Xuxugou and 2.41 Ga Akazi plutons (Zhang et al., 2007a; Guo et al., 2013). Furthermore, the ca. 1.9 Ga metamorphism event has also been recorded in the complex (Wang et al., 2014; Zhang et al., 2007a). The poorly exposed Mesoproterozoic magmatic rocks occur in the northern part of the Tikelike belt close to Kusilafu area