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Research paper

Apatite fission track thermochronology in the Kuluketage and Aksu areas, NW China: Implication for tectonic evolution of the northern Tarim

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ABSTRACT

Tarim Precambrian bedrocks are well exposed in the Kuluketage and Aksu areas, where twenty four samples were taken to reveal the denudation history of the northern Tarim Craton. Apatite fission track dating and thermal history modeling suggest that the northern Tarim experienced multi-stage cooling events which were assumed to be associated with the distant effects of the Cimmerian orogeny and India-Eurasia collision in the past. But the first episode of exhumation in the northern Tarim, occurring in the mid-Permian to Triassic, is here suggested to be induced by docking of the Tarim Craton and final amalgamation of the Central Asian Orogenic Belt. The cooling event at ca. 170 Ma may be triggered by the Qiangtang-Eurasia collision. Widespread Cretaceous exhumation could be linked with docking of the Lhasa terrane in the late Jurassic. Cenozoic reheating and recooling likely occurred because of the north-propagating stress, however, this has not affected the northern Tarim much because the Tarim is characterized by rigid block-like motion.

1. Introduction

The Tarim Craton in NW China is one of the major cratons of Asia (Fig. 1). To the north of the Tarim, a vast array of active intracontinental mountain belts, extending into the interior of the Eurasian continent, comprise the Central Asian Orogenic Belt (CAOB) (Şengör et al., 1993; Charvet et al., 2007; Windley et al., 2007; Xiao et al., 2009, 2015). The Tarim Craton consists of Precambrian bedrocks, which are overlain by Phanerozoic sediments in the south and centre, but are well exposed in the north.

The Kuluketage area (Fig. 2), in the north-eastern Tarim Craton, provides an excellent geological exposure with an area of ca. 100–250 km N–S and ca. 500 km E–W extension, suitable for studying Precambrian bedrocks of the craton by means of geochronology (Zhang et al., 2009a; Zhu et al., 2011a; Cao et al., 2011a, b; Long et al., 2011a, b). (U-Th)/He and fission track thermochronometries also have been applied to reveal the tectono-thermal evolution history (Qiu et al., 2009; Zhu et al., 2010; Xiao et al., 2011; Zhang et al., 2011).

The Aksu area is located along the northwestern margin of the Tarim Craton, NW China (Fig. 1). With a well-preserved late Precambrian blueschist (Fig. 3a), many geochemical, geochronologic and paleomagnetic studies have been performed in recent decades (Liou et al., 1989; Nakajima et al., 1990; Liou et al., 1996; Chen et al., 2004; Zhan et al., 2007). The exhumation history has previously been determined by apatite fission track (AFT) dating (Dumitru et al., 2001; Zhang et al., 2009b). The major erosion was proposed to initiate in middle Permian time (Dumitru et al., 2001). And the Neogene sample was suggested to have a local source, since it yielded an AFT age essentially identical with the ca. 214 Ma age from Sinian to Permian section (Dumitru et al., 2001). This deduction was consistent with the detrital mineralogy of the Neogene rocks in the area (Graham et al., 1993). Cretaceous exhumation in the Aksu area was also documented by AFT dating of Precambrian bedrock (Zhang et al., 2009b).

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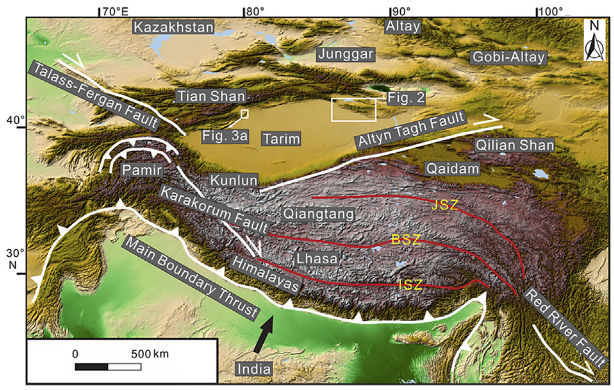

Figure 1. Tectonic setting of the Tarim, Tibetan Plateau and Tianshan (modified after DeCelles et al., 2007). The background image is from ETOPO1 Global Relief Model (NOAA, National Geophysical Data Center) (Amante and Eakins, 2009). White rectangles show the study areas. White solid lines indicate major faults, while red lines present suture zones in the Tibetan Plateau. ISZ: Indus-Yarlung suture zone, BSZ: Bangong suture zone, JSZ: Jinsha suture zone.

However, compared with the large Precambrian outcrops, only limited locations have been studied. Meanwhile, questions still remain about reactivations of Precambrian faults and tectonic implications of multi-stage cooling events. In this study, nineteen additional AFT samples from Kuluketage and five more from Aksu are analyzed to generate more representative results. Combined with previously published dataset, we discuss the linkage between the cooling events and regional tectonic activities, all the information leads to a better understanding of thermo-tectonic evolution history of the northern Tarim.

2. Geological setting

2.1. The Kuluketage area

Situated between the southern Tianshan and Tarim Basin, the Kuluketage area contains widespread Precambrian bedrock and Palaeozoic stable platform sediments (Fig. 2). The term "bedrock" used here means all kinds of Precambrian rocks including magmatic, sedimentary and metamorphic rocks (Hu et al., 2000; Lu et al., 2008). The Kuluketage area refers to the region between the Xinger fault and the Kongquehe fault. The Xingdi fault extends from east to west and divides the area into two parts. In addition to the Xinger and Xingdi faults extending from east to west, numerous sub-faults extend in various directions (Zhang et al., 2011). Abundant Neoarchean TTG (tonalite-trondhjemite-granodiorite) gneisses are well exposed along the Xinger and Xingdi faults. The Proterozoic rocks, mainly occurring on both sides of the Xingdi fault, are unconformably overlain by early Palaeozoic sedimentary strata. Ordovician strata crop out to the south of the Xingdi fault, whereas Cambrian to Lower Ordovician strata crop out between the Xingdi and Xinger faults. To the north of the Xinger fault, Devonian to Lower Carboniferous strata are exposed together with minor Jurassic sandstones (XJBGMR, 1993).

A simple tectonic evolution of the Xingdi fault zone is summarized into four periods by previous studies. The first period is characterized by strong folding, ductile shearing and the magmatism dated at the interval of 900–1100 Ma (Deng et al., 2008; Shu et al., 2011); the second period is recorded by extensive bimodal magmatism and diabase dyke swarm dated at 830–740 Ma, indicating rifting during the breakup of Rodinia (Xu et al., 2005; Lu et al., 2008; Zhu et al., 2008b; Zhang et al., 2009a; Zhu et al., 2011a); the third period is suggested to be formed likely in the mid–late Paleozoic, producing two anticlines of Neoproterozoic Kuluketage Group and one syncline of Cambrian system (Shu et al.,

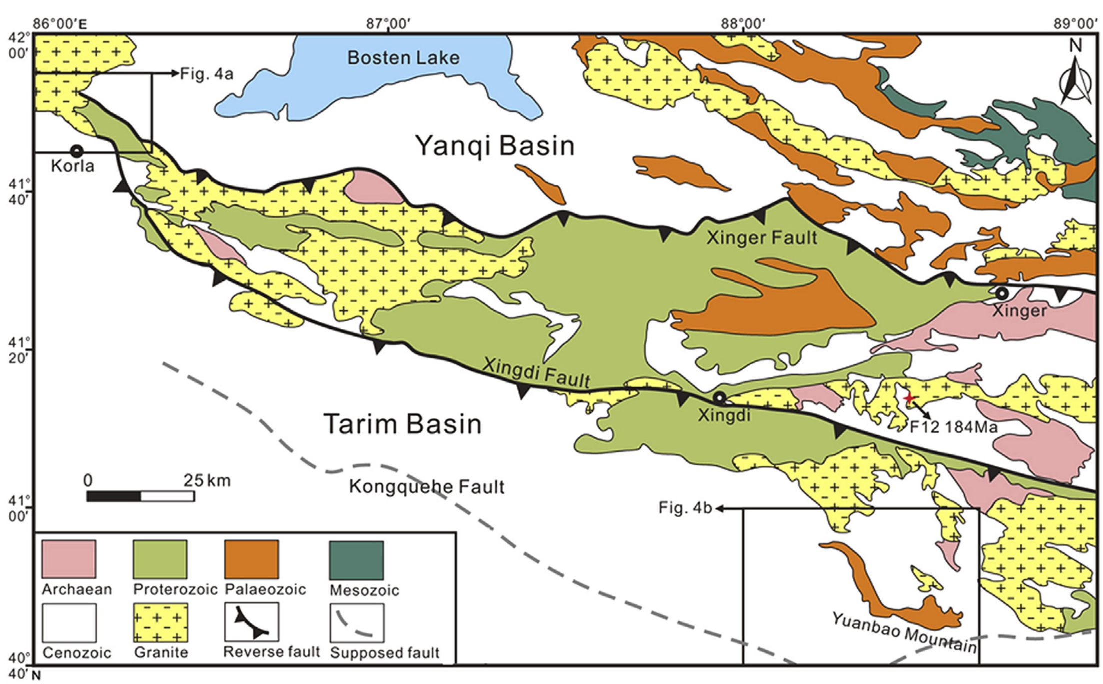

Figure 2. Simplified geological map of the Kuluketage area, NE Tarim Craton (modified after XJBGMR, 1993). The samples were collected from Precambrian outcrop near Korla and Ordovician sandstone in Yuanbao Mountain except sample F12. See Fig. 4 for more detailed geological information.