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Research Paper

Meso-Cenozoic tectonic evolution of the Talas-Fergana region of the Kyrgyz Tien Shan revealed by low-temperature basement and detrital thermochronology

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ABSTRACT

This study provides new low-temperature thermochronometric data, mainly apatite fission track data on the basement rocks in and adjacent to the Talas-Fergana Fault, in the Kyrgyz Tien Shan in the first place. In the second place, we also present new detrital apatite fission track data on the Meso-Cenozoic sediments from fault related basins and surrounding intramontane basins. Our results confirm multi-staged Meso-Cenozoic tectonic activity, possibly induced by the accretion of the so-called Cimmerian blocks to the Eurasian margin. New evidence for this multi-staged thermo-tectonic activity is found in the data of both basement and Meso–Cenozoic sediment samples in or close to the Talas-Fergana Fault. Zircon (U–Th)/He and apatite fission track data constrain rapid Late Triassic–Early Jurassic and Late Jurassic–Early Cretaceous basement cooling in the Kyrgyz Tien Shan around 200 Ma and 130–100 Ma respectively. Detrital apatite fission track results indicate a different burial history on both sides of the Talas-Fergana Fault. The apatite fission track system of the Jurassic sediments in the Middle Tien Shan unit east of the Talas-Fergana Fault is not reset, while the Jurassic sediments in the Fergana Basin and Yarkand-Fergana Basin, west of the fault zone, are partially and in some cases even totally reset. The totally reset samples exhibit Oligocene and Miocene ages and evidence the Cenozoic reactivation of the western Kyrgyz Tien Shan as a consequence of the India-Eurasia convergence.

1. Introduction

The Tien Shan (or Tian Shan) is a 2500 km long intracontinental mountain belt located in northwest China, Kyrgyzstan, Kazakhstan, Tajikistan and Uzbekistan and forms the southwest part of the Central Asian Orogenic Belt (CAOB) (Fig. 1). The CAOB represents a mosaic of Precambrian and Palaeozoic blocks, accreted during the closure of the Paleo-Asian ocean (Sengör et al., 1993; Filippova et al., 2002; Khain et al., 2003; Konopelko et al., 2007; Windley et al., 2007; Xiao et al., 2008; Glorie et al., 2011; De Grave et al., 2012; Wilhem et al., 2012). During the Mesozoic and Cenozoic, parts of the CAOB were reactivated in response to far-field accretion-collision events along the (Eur)Asian margin, with a final and still active late Cenozoic phase related to the India-Eurasia collision (Molnar and Tapponier, 1975; Watson et al., 1987; Dumitru et al., 2001; De Grave et al., 2007; Jolivet et al., 2010; De Pelsmaeker et al., 2015; Glorie and De Grave, 2016; Käßner et al., 2016, 2017). During these reactivation phases, deformation is often partitioned along inherited, weak crustal structures (Yin and Harrison, 2000; Dumitru et al., 2001; Aitchison et al., 2007; Kapp et al., 2007; Glorie et al., 2010; Wack et al., 2014; Jolivet, 2015). In this context, the currently active 500 km long NW–SE oriented intracontinental dextral strike-slip Talas-Fergana Fault (TFF) is an important inherited Palaeozoic structure and has generated an

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estimated accumulated offset of more than 100 km since the end of the Palaeozoic (Burtman et al., 1996; Konopelko et al., 2013; Rolland et al., 2013; Bande et al., 2015b; Burtman, 2015; Alexeiev et al., 2017) (Figs. 1 and 2). The fault represents the southern part of the larger Karatau– Talas–Fergana Fault that extends from southern Turgay in Kazakhstan to western Tarim in China. The TFF has evolved in three discrete phases of deformation, during three stages: (1) in the late Permian and Early Triassic; (2) in the Early and Middle Jurassic; and (3) in the late Cenozoic (Thomas et al., 1993; Burtman et al., 1996; Sobel, 1999; Allen et al., 2001; Konopelko et al., 2013; Rolland et al., 2013; Bande et al., 2015b; Alexeiev et al., 2017), but the timing of the associated crustal exhumation is still poorly understood. This study aims to better constrain the Meso-Cenozoic tectonic evolution of the TFF and the tectonic response of the adjacent basement blocks in terms of exhumation and associated mountain building, erosion and sediment accumulation in the nearby intramontane basins.

The first part of this study presents new low-temperature thermochronological data from basement blocks along and near the TFF, i.e. 20 apatite fission track (AFT) ages, 2 zircon (U–Th)/He ages, 1 apatite U–Pb age and the associated thermal history models. The second part of this study presents 17 new detrital AFT ages and confined track length data of 5 samples from Mesozoic and early Cenozoic sediments, obtained from the surrounding intramontane Tien Shan basins: Fergana, Yarkand-Fergana and Ming-Kush-Kökömeren basins (Figs. 1 and 2). The analysed sediment samples fit in detailed sedimentary logs of De Pelsmaeker et al. (2018) and for 11 of the 17 analysed samples it was possible to compare the obtained AFT results with the zircon U–Pb results from the same detrital sample. Hence, we present this new multi-method chronological data and integrate them with existing results for the Tien Shan (Dumitru et al., 2001; Sobel et al., 2006a,b; De Grave et al., 2007, 2011a, 2012, 2013; Glorie et al., 2010, 2011; Jolivet et al., 2010; Macaulay et al., 2014; Bande et al., 2015b, 2017; Glorie and De Grave, 2016) to gain more insights in the Meso-Cenozoic reactivation and burial history of the region.

2. Geological setting

2.1. Pre-Mesozoic evolution

Paleozoic complexes in the Kyrgyz Tien Shan are traditionally divided into three major tectonic units: Northern Tien Shan (NTS), Middle Tien Shan (MTS) and Southern Tien Shan (STS) (e.g. Windley et al., 2007; Konopelko et al., 2008; Seltmann et al., 2011; Alexeiev et al., 2016) (Fig. 2). The NTS mainly consists of Precambrian continental fragments related to the Kazakhstan paleocontinent (e.g. Kröner et al., 2013). The basement is extensively intruded by Cambrian to Silurian granitoids related to major collisions

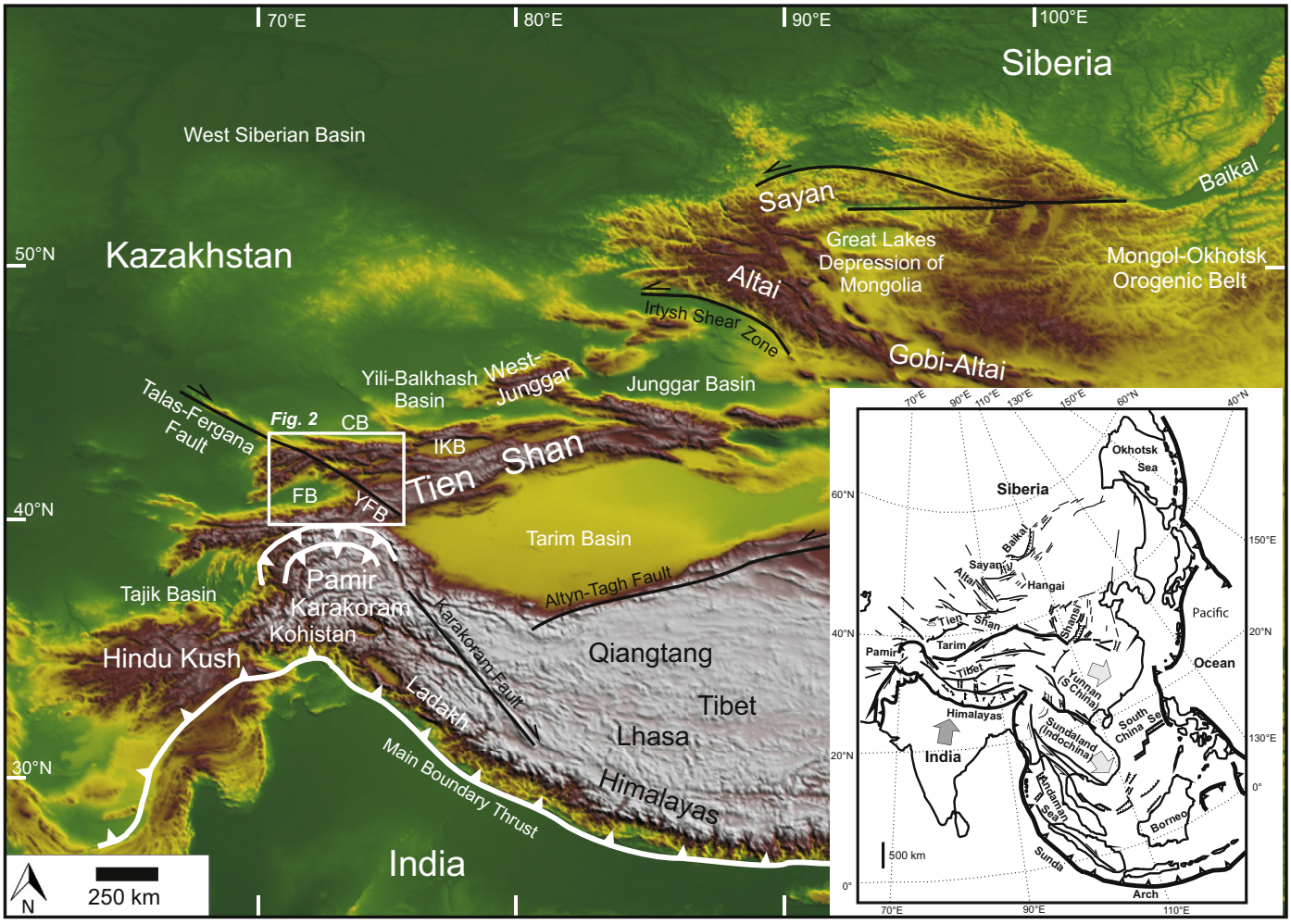

Figure 1. General topographic and tectonic map of Central Asia with indication of the study area (white box detailed in Fig. 2). CB = Chu Basin, FB = Fergana Basin, IKB = Issyk-Kul Basin, YFB = Yarkand-Fergana Basin (adapted from De Grave et al., 2007; De Pelsmaeker et al., 2015).

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