



## Detrital and igneous zircon ages for supracrustal rocks of the Kyrgyz Tianshan and palaeogeographic implications



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### ABSTRACT

We report detrital zircon ages for Precambrian and early Palaeozoic metasediments from the Tianshan orogen in Kyrgyzstan, an important component of the Central Asian Orogenic Belt and compare these with published ages from the Chinese Tianshan and the Tarim craton. These data provide information on possible source terrains and suggest that Precambrian basement is widespread in the Tianshan and may, at least in part, represent continental fragments rifted off the Tarim craton during the early history of the Central Asian Orogenic Belt. Distinct differences in the Precambrian zircon age distribution between the North and Middle Tianshan of Kyrgyzstan support earlier ideas that these two terranes had different crustal histories prior to their amalgamation in the early Palaeozoic. We envisage an archipelago-type scenario for the Palaeo-Asian Ocean south of the Siberian craton in the late Neoproterozoic to early Palaeozoic in which numerous island arcs and Precambrian crustal fragments derived from Tarim drifted northwards (in present coordinates) and were amalgamated and tectonically stacked together during several ocean closure and accretion–collision events. This is surprisingly similar to what has been envisaged for the evolution of Indonesia where Mesozoic rifting of fragments from the Australian margin was followed by Cretaceous collisions and Cenozoic collision of Australia with the SE Asian margin. In both Central Asia and Indonesia continental crust has arrived in the region in multiple episodes and has been fragmented and juxtaposed by subduction-related processes. Continental growth during this process was minimal.

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### 1. Introduction

The Tianshan orogen of Kyrgyzstan, southern Kazakhstan and north-west China is part of the southern Central Asian Orogenic Belt (CAOB) and consists of late Neoproterozoic to Palaeozoic volcano-sedimentary and plutonic arc assemblages that are tectonically interlayered with metamorphic domains, often named complexes. Many of the latter were previously considered to be Archaean or Palaeoproterozoic in age but were shown to be much younger and document high-grade events associated with terrane accretion and subduction during the

Palaeozoic (Hegner et al., 2010; Alexeiev et al., 2011; Kröner et al., 2012, 2013). Nevertheless, some Precambrian basement terranes remain and in the Kyrgyz Tianshan were partly characterized by Kröner et al. (2012, 2013) and Konopelko et al. (2008, 2012). There is some speculation on the origin of these Precambrian crustal fragments in the CAOB, and most authors have assumed a Gondwana derivation without being more specific (e.g. Buslov et al., 2001; Dobretsov and Buslov, 2007), whereas Kröner et al. (2012, 2013, 2014) from work in the Kyrgyz Tianshan and Rojas-Agramonte et al. (2011) from work in Mongolia concluded that the most likely source is the Tarim craton that now borders the South Tianshan but may originally have been situated close to the northeastern margin of Gondwana (Li et al., 1996; Metcalfe, 2011). This conclusion was primarily based on age similarities of magmatic rocks in the Tianshan, Mongolia and Tarim, notably early Neoproterozoic to late Mesoproterozoic (Grenvillian) ages, as well as

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detrital and xenocrystic zircon age patterns that closely fit the pattern for available zircon ages of the Tarim craton.

In order to further test the hypothesis whether tectonic fragmentation and erosion of the Tarim craton have provided continental material and detritus to build up the accretionary domain of the Tianshan orogen we applied the U–Pb and Lu–Hf methods on detrital zircon grains from sandstones and other metasedimentary rocks in the Kyrgyz Tianshan that are either associated with early Palaeozoic arc terranes or belong to Precambrian tectonic slivers interlayered with the Palaeozoic rocks.

## 2. Geological outline and tectonic setting of the Kyrgyz Tianshan

The Tianshan thrust-and-fold belt extends for about 2000 km from Uzbekistan to eastern Xinjiang Province of NW China within the southern CAOB (Fig. 1). It represents a complex amalgamation of Palaeozoic island arcs, accretionary complexes and Precambrian micro-continental terranes (Kröner et al., 2012, 2013, 2014, and references therein). It evolved during several tectonic episodes from the Neoproterozoic to early Mesozoic, and was reactivated due to uplift and deformation in the late Tertiary and Quaternary (Glorie et al., 2011; De Grave et al., 2013). Tectonically, rocks in the western part of the belt within Uzbekistan and Kyrgyzstan have traditionally been grouped into three major fault-bounded tectonic zones named North Tianshan, Middle Tianshan and South Tianshan, which have distinctly different geological histories and structural patterns (Nikolaev, 1933; Popov, 1938; Bakirov and Maksumova, 2001), which we adopt in this paper.

There is some confusion in the literature on the tectonic nomenclature between the western (former USSR) part of the Tianshan as outlined above and its continuation in northwest China. The Kyrgyz and southern Kazakh North Tianshan is partly equivalent to the Chinese Central Tianshan and partly to what is known as Yili Block in China (Wang et al., 2008), whereas the Kyrgyz Middle Tianshan wedges out near the Kyrgyz–Chinese border and is not present in China (Fig. 1). However, the South Tianshan is equivalent in the west and east although some authors have recently included parts of the previously defined Chinese South Tianshan into the Central Tianshan (e.g., Charvet et al., 2007, 2011). Xiao et al. (2013) also follow the above subdivision and include the Yili Block in the North Tianshan but, like many other Chinese authors, they include into the northwestern part of their North Tianshan rocks that in eastern Kazakhstan are part of the Aktau–Junggar and Balkhash–Yili terranes (Alexeiev et al., 2011). The southern part of the Chinese North Tianshan consists predominantly of volcanic and sedimentary rocks, ranging in age between Early Devonian and early Carboniferous (An et al., in press).

The North Tianshan of Kyrgyzstan and southern Kazakhstan represents one of the oldest orogenic domains in the CAOB and contains large volumes of early Palaeozoic granitoids and is generally characterized by a regional pre-Devonian angular unconformity (Maksumova et al., 2001). On a large scale, it occupies the southern part of two major terranes, namely the Kokchetav–North Tianshan in the center and east, and the Karatau–Talas in the west (see Figs. 1 and 2).

The Kokchetav–North Tianshan consists of Precambrian micro-continental fragments, early Palaeozoic arcs and ophiolite-bearing sutures, as well as high-grade metamorphic domains including HP to UHP rocks, all welded together prior to the Middle Ordovician (see Kröner et al., 2012; Rojas-Agramonte et al., 2013, and references therein). In the Middle to early Late Ordovician the Kokchetav–North Tianshan was dominated by continental arc volcanism (De Grave et al., 2012; Degtyarev et al., 2012), followed by granitoid emplacement in the latest Ordovician and early Silurian (Mikolaichuk et al., 1997; Maksumova et al., 2001; Konopelko et al., 2008; Glorie et al., 2010; Kröner et al., 2012; De Grave et al., 2013).

The Karatau–Talas terrane (Fig. 2) consists of Neoproterozoic to early Palaeozoic low grade greenschists and phyllites, unmetamorphosed Neoproterozoic shallow marine and non-marine siliciclastic sediments with subordinate felsic tuffs, and Cambrian to Middle Ordovician carbonates (Cook et al., 1991; Maksumova et al., 2001; Meert et al., 2011). It may either represent an independent microcontinent, wedged between the Kokchetav–North Tianshan and the Middle Tianshan (Maksumova et al., 2001), or constitutes the marginal part of the Middle Tianshan microcontinent that was affected by deformation and intruded by granites in the Late Ordovician during collision with the Kokchetav–North Tianshan (Kröner et al., 2013 and references therein).

The Kyrgyz Middle Tianshan represents the southern part of the larger Ishim–Middle Tianshan microcontinent that extends from the Tianshan to the western part of northern Kazakhstan (Avdeev and Kovalev, 1989; see Fig. 6 in Windley et al., 2007). It most likely constitutes a single coherent continental block, about 2000 km long. The oldest rocks are amphibolite-facies metasediments and orthogneisses of the Kuilyu Complex in the Sarydzaj River basin in the far eastern part of the Middle Tianshan (Fig. 1), that yielded Palaeoproterozoic zircon ages of 2.3 to 1.7 Ga (Kiselev et al., 1982, 1993; Glorie et al., 2011; Kröner et al., 2013). Neoproterozoic granites and felsic volcanic rocks are common within the entire Ishim–Middle Tianshan microcontinent from eastern Kyrgyzstan to central Kazakhstan (Kiselev et al., 1993; Kröner et al., 2009; Glorie et al., 2011; Kröner et al., 2013). The Precambrian basement rocks are overlain unconformably by late Neoproterozoic

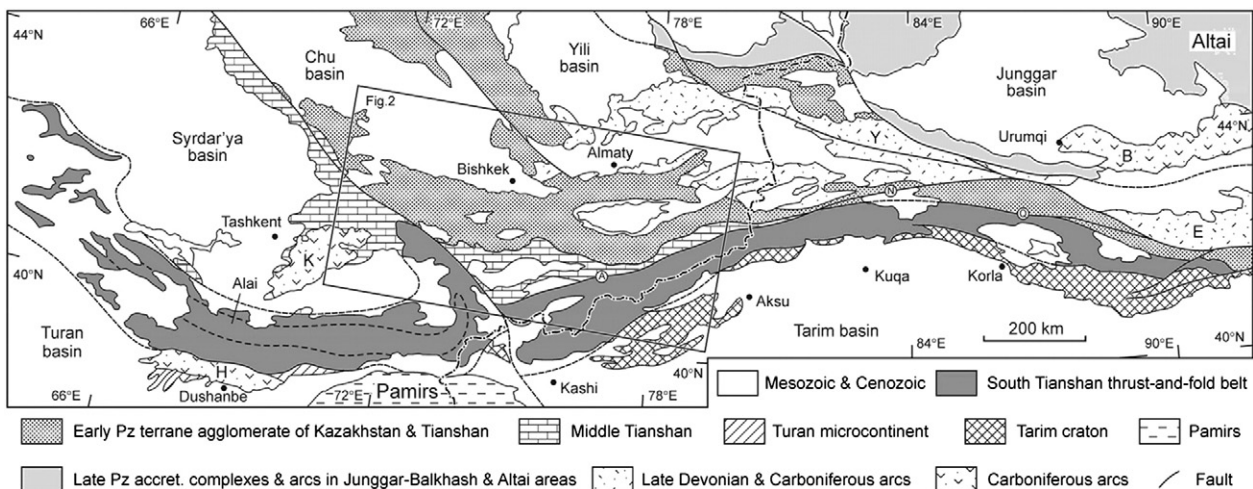


Fig. 1. Overview map of the Tianshan mountain range showing major tectonic subdivisions. Abbreviated names: Continental arcs: Y – Yili, E – East Tianshan, H – Hissar, K – Beltau-Kurama, B – Bogdoshan. Major faults: A – Atbashi – Enylchek, N – South Nalati, Q – Qavabulak. Dashed line is boundary between China and countries of the former Soviet Union. Modified after Biske et al. (2012).

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