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Sources and provenance of the Neoproterozoic placer deposits of the Northern Kazakhstan: Implication for continental growth of the western Central Asian Orogenic Belt

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ABSTRACT

We present results of in situ analysis of zircon U-Pb ages, Hf isotopic compositions for detrital zircons combined with whole-rock Nd isotopic data for the Neoproterozoic quartzites and zircon-rutile placer deposits in quartzite-schist sequences of the Kokchetav, Ishkeol'mes and Erementau-Niyaz terranes of the Northern Kazakhstan and discuss possible provenances and position of these terranes in Mesoproterozoic. Concordia ages of detrital zircons from the Northern Kazakhstan part of the Central Asian Orogenic Belt (CAOB) demonstrate age peaks in intervals ca. 1.13–1.46, 1.65–1.78, 1.86–1.92, 2.70 and 2.84 Ga. Obtained data indicate that Mesoproterozoic, latest Paleoproterozoic (Staterian), late Paleoproterozoic '(Orosinian) and Neoarchean rocks were the sources of these metasediments. Hf-in-zircon and Nd whole rock data show that the Mesoproterozoic and latest Paleoproterozoic rock complexes were originated from mainly short-lived juvenile and mixed crustal-juvenile sources that imply their derivation in subduction-related oceanic and continental arc setting or from mafic underplating. Rocks with ages of ca 1.65–1.78, 1.86–1.92, 2.70 and 2.84 Ga have not been recognised previously in the western CAOB. It is possible that these rocks were completely eroded or overlapped by younger sequences and composed the buried basement of Precambrian terranes of the western CAOB. Comparison of Meso-Paleoproterozoic age patterns for the Northern Kazakhstan, Tian Shan and Tarim craton demonstrate that the crustal basement of the Northern Kazakhstan is similar to the Chinese Central Tian Shan terrane and different from the Archean basement formation of the Tarim Craton. Age peaks at ca. 1.92–1.86, 1.78–1.65 and 1.46–1.13 Ga, identified for detrital zircons from Neoproterozoic zircon-rutile placer deposits of the Northern Kazakhstan correspond to the formation and breakup of the Columbia/Nuna supercontinent and assembly of the Rodinia supercontinent or large continental domain.

1. Introduction

Central Asian Orogenic Belt or Central Asian Fold belt (Zonenshain et al., 1990) is situated between the Siberian craton in the north and the North China and Tarim cratons in the south (Fig. 1) and represent one of the largest accretionary orogen in the World (e.g., Şengör et al., 1993; Cawood et al., 2009; Wilhem et al., 2012). The CAOB is characterised by extensive Phanerozoic juvenile continental crust growth (e.g., Şengör et al., 1993; Kovalenko et al., 1996; Jahn et al., 2000, 2004; Kovalenko et al., 2004; Windley et al., 2007; Xiao and Santosh, 2014) started at the end of Ediacaran (Kovach et al., 2011). At the same time, numerous Precambrian terranes, often considered as microcontinents (e.g., Belichenko and Boos, 1988; Mossakovsky et al., 1993; Kuzmichev, 2004; Kröner et al., 2008; Kheraskova et al., 2010; He et al., 2014a, 2014b, 2015), played important role in formation and evolution of the CAOB crust (Kröner et al., 2014). There are different opinions on the origin and evolution of the CAOB microcontinents, including their derivation from Gondwana (Mossakovsky et al., 1993; Didenko et al., 1994; Kheraskova et al., 2003; Dobretsov and Buslov, 2007; Glorie et al., 2011), from the Siberia (Berzin et al., 1994; Kuzmichev, 2004), Baltica (He et al., 2014a, 2014b) or Tarim (Kheraskova et al., 2010; Rojas-Agramonte et al., 2011; Kröner et al., 2012; Ma et al., 2012a, 2012b; Kröner et al., 2013) cratons, or from shelf of the Rodinia supercontinent (Yarmolyuk and Kovalenko, 2001; Yarmolyuk et al., 2005, 2006).

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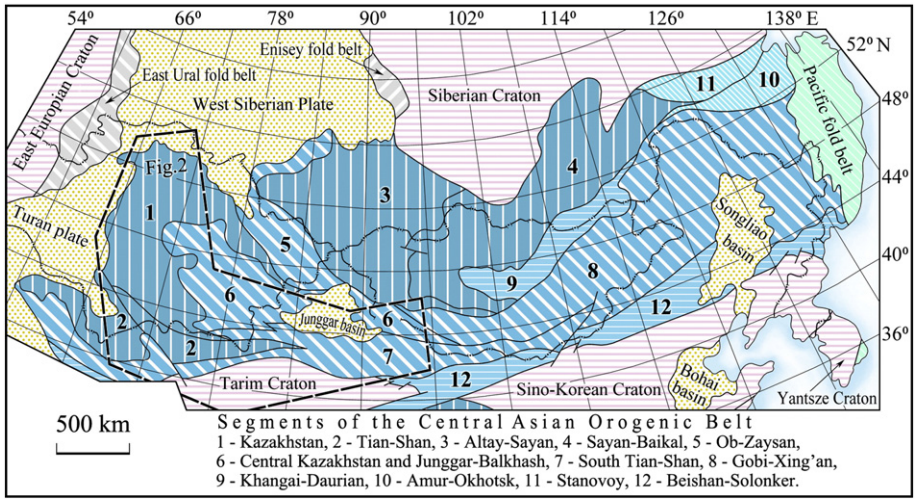

Fig. 1. Sketch map showing position and tectonic units of the Central Asian Orogenic Belt. Modified from (Tectonic map of Central Asia and adjacent areas, 2008). Structures with consolidated crust formed: 1–3 – by the Middle Devonian; 5–8 – by the Late Carboniferous; 9, 12 – by the Middle Triassic; 10, 11 – by the beginning of Cretacerous.

Precambrian terranes (sialic massifs in the Russian literature) are widespread in the western part of the CAOB including Kazakhstan upland and Tian Shan (Fig. 2) where they occupy about 50% of territory (Degtyarev et al., 2017-in this issue). Prominent feature of these terranes in Northern Kazakhstan is extensive distribution of Precambrian metamorphosed terrigenous formations, where they are mainly represented by quartzite-schist sequences.

Detrital zircon dating allows obtain information on the age of sedimentary source material and therefore constrains the maximum age of sediment deposition, age of main stages of acid magmatism and

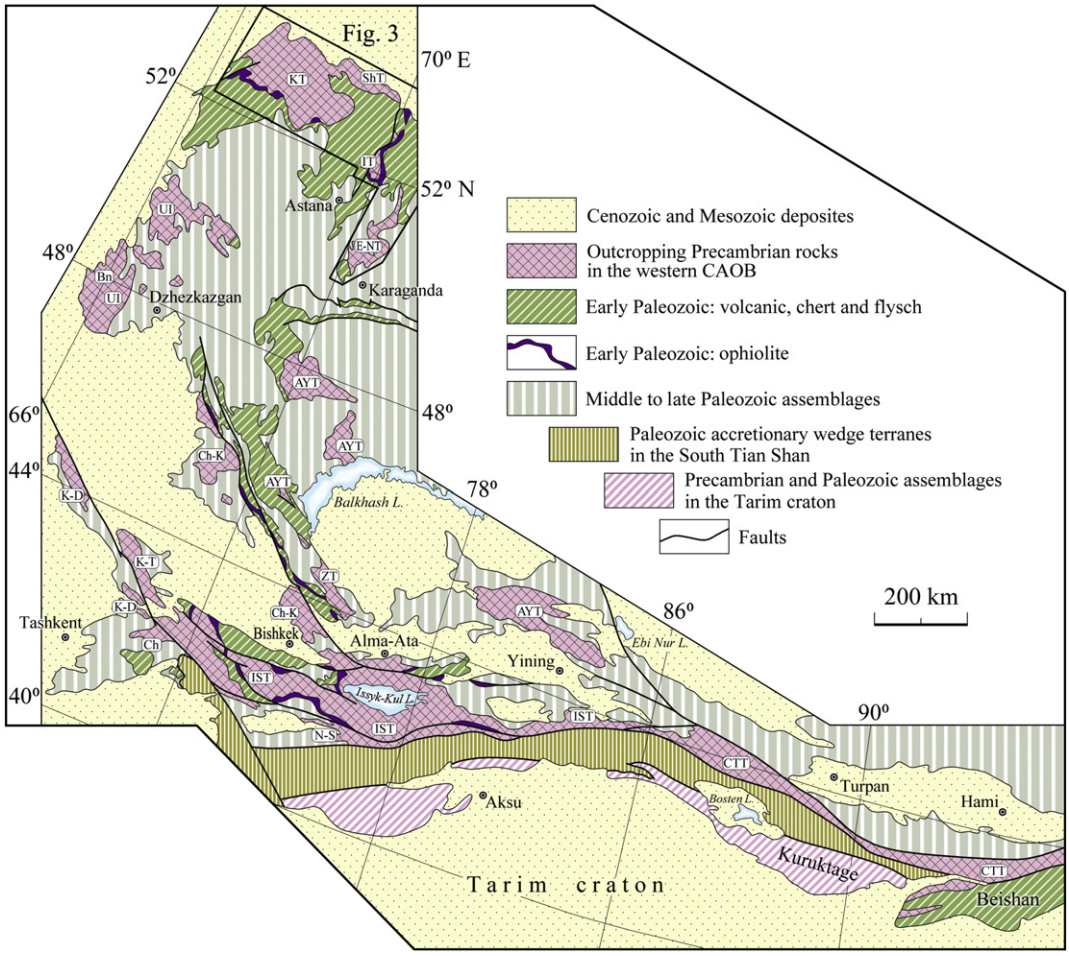

Fig. 2. Principal outcrops of Precambrian rocks in relation to early Paleozoic, middle to late Paleozoic and Mesozoic-Cenozoic assemblages in the western part CAOB. After Degtyarev et al. (in this issue). Terranes: AYT – Aktau-Yili, CTT – Chinese Central Tien Shan, E-NT – Erementau-Niyaz, IST – Issyk-Kul, KT – Kokchetav, ShT – Shatskiy, IT – Ishkeol'mes, ZT – Zheltau. Subterranes in the Ulutau-Sarudzhaz terrane: Bn – Baikonur, Ch – Chatkal, Ch-K – Chu-Kendyktas, K-D – Karatau-Dzhebagly, K-T – Karatau-Talas, N-S – Naryn-Sarydzhaz, Ul – Ulutau.