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The late Paleozoic to Mesozoic evolution of the eastern margin of the Central Asian Orogenic Belt in China

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ABSTRACT

The north-east Central Asian Orogenic Belt (CAOB) in China records terminal closure of the Paleo-Asian Ocean in the mid- to late Permian along the Solonker–Xar Moron–Changchun suture. This marks the end of the overall northward movement of the Chinese blocks from a peri-Gondwana position toward Siberia and a switch in tectonic processes to those dominated by activity associated with the Paleo-Pacific plate to the east. Four distinct changes in tectonic regime can be recognised here in the late Paleozoic to early Mesozoic: (i) north–south compression resulted in orogenesis and gave way to post-collisional extension at ~260–250 Ma with the emplacement of A-type granites; (ii) almost coeval with this, there was an the onset of east–west extension from 250 to 225 Ma along the extreme eastern margin of the CAOB, when a seaway opened between the Songliao and Jiamusi/Khanka blocks; (iii) the onset of westerly-directed compression, associated with subduction of the Paleo-Pacific plate from ~210 Ma, resulted in re-amalgamation of the Jiamusi/Khanka block with the CAOB by ~190–180 Ma and the massive generation of Jurassic I-type granitoids throughout the region; finally (iv) a change to east–west extension from ~140 Ma onward resulted from roll-back of the Paleo-Pacific plate. This latter event was accompanied by the emplacement of S-type granitoids and the development of sedimentary basins and core complexes. It also accompanied a more widespread thinning or delamination of the lithosphere across most of north-east China during the Cretaceous.

1. Introduction

The Central Asian Orogenic Belt (CAOB) (Fig. 1) has been recognised as the world's largest Phanerozoic orogen (Jahn et al., 2000a,b,c). Referred to as the Altaids by Sengor et al. (1993, 2014) and as the Central Asian Foldbelt in Russia (Sorokin et al., 2011), its evolution commenced in the Proterozoic and continued into the Cenozoic (Windley et al., 2007; Xiao et al., 2010). The recognition, based on Nd systematics and more recently confirmed by hafnium-in-zircon data, that most of the Phanerozoic rocks are juvenile (Jahn et al., 2000b,2000c; Wu et al., 2000; Wang et al., 2015a,b) has led to questioning the commonly held tenet that crustal growth during the Phanerozoic was minimal. However, this premise has itself been questioned recently, with Kröner et al. (2014) arguing that significant variations in zircon εHf values at any given magmatic age suggest that the granitoid magmas were derived from compositionally and chronologically heterogeneous crustal sources. Hence crustal evolution in the CAOB involved both juvenile material and reworking of older crust, reflecting the earlier Meso- to Neoproterozoic history of the belt. In this regard, Kröner et al. (2014) suggested a tectonic setting similar to the SW Pacific and the Tasmanides of eastern Australia.

In China, the southeast segment of the CAOB is commonly referred to as the Xing'an–Mongolia (or Xing-Meng) Orogenic Belt (see Xu et al., 2015 for a recent review). Only a few Proterozoic rocks have been recorded from this part of the CAOB, although there is widespread evidence in detrital zircon populations of both Mesoproterozoic and Neoproterozoic material (Zhou et al., 2010a,c): a few Archean and Paleoproterozoic zircons have also been recorded (Wang et al., 2006; Zhou et al., 2010a, 2012). The oldest rocks so far identified are in drill core from the basement of the southeast part of the Songliao Block, where zircons from a granodiorite yield a magmatic age of 1839 + 7 Ma (Wang et al., 2006). However, no surface outcrops of Precambrian rocks have so far been identified. There are also local outcrops of Neoproterozoic rocks in both the Erguna Block (Zhou et al., 2011a; Wu et al., 2011; Tang et al., 2013) and in the Xing'an Block in the Xinghuadulou area (Zhou et al., 2011b) (Fig. 2).

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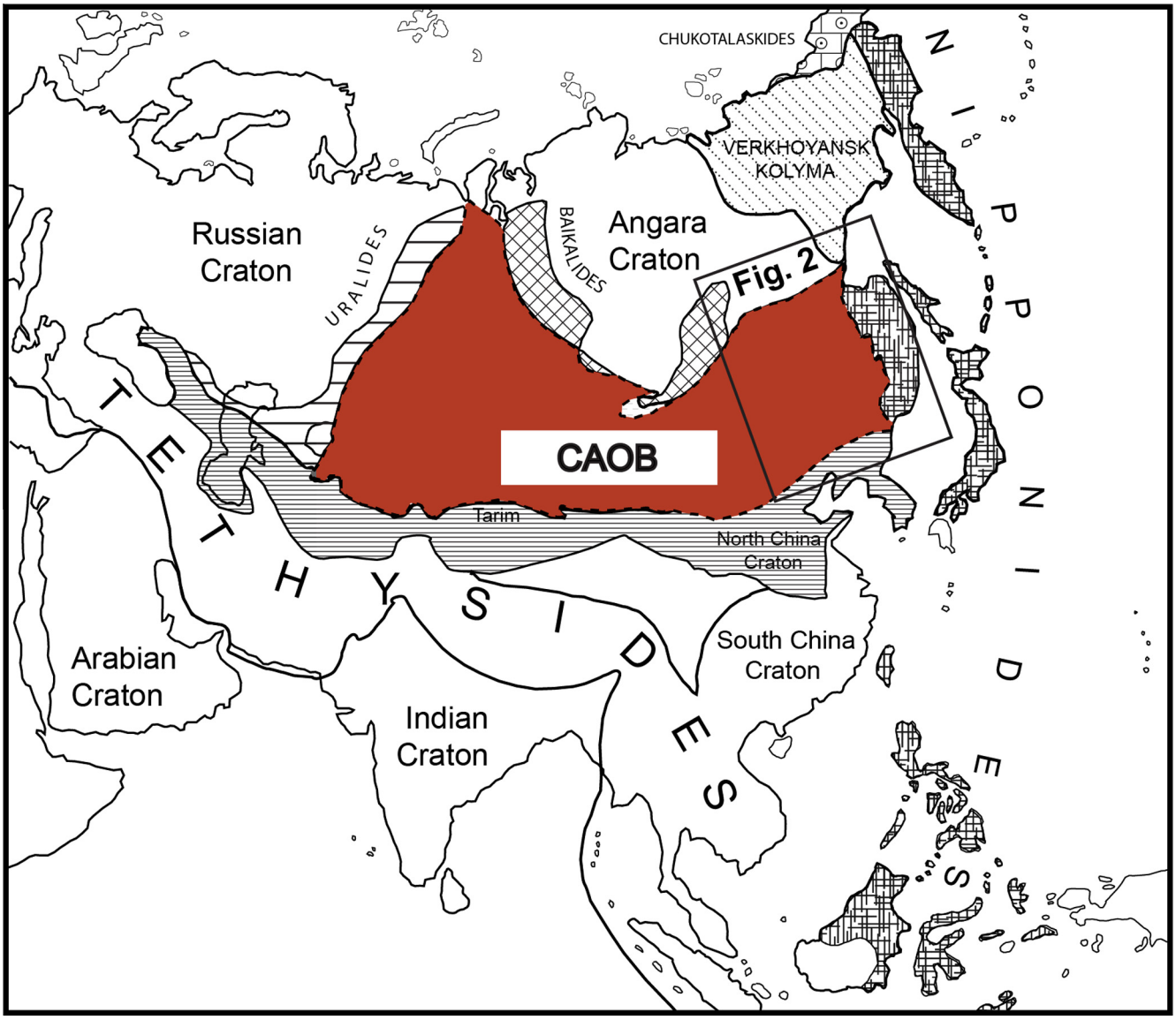

Fig. 1. Location of the Central Asian Orogenic Belt (CAOB) with respect to the main tectonic units of Asia, as interpreted by Şengör and Natal'in (1996). Re-drawn and modified from Şengör and Natal'in (1996) and Wilde et al. (in press).

Furthermore, Meso- to Neoproterozoic basement has also been reported in the Xilinhot complex (Sun et al., 2013b) within the Xing'an Block. Indeed, there has been considerable controversy as to whether the Xilinhot complex really is Proterozoic in age. Initial Rb–Sr and Sm–Nd work by Xu et al. (1996) favoured an age of 1225 ± 41 Ma for the protolith of hornblende–plagioclase gneiss. However, subsequent work (Shi et al., 2003) failed to find evidence of any Precambrian rocks. Likewise, although (Chen et al., 2009) found evidence for Archean and Proterozoic detrital and inherited zircons, they concluded that the rocks formed over an extended period from 530 to 296 Ma. However, the study by Sun et al. (2013b) found that granitic gneisses recorded Mesoproterozoic protolith ages of ~1390 Ma, and that these were cut by gabbros previously dated at ~740 Ma (Ge et al., 2011). In the Xinghuadukou area, Zhou et al. (2011b) identified mafic rocks with a magmatic crystallization age of 783 ± 8 Ma that had subsequently undergone metamorphism at 496 ± 7 Ma. However, such Proterozoic rocks occupy only small areas of the various blocks and it is unclear at present whether this reflects the true distribution or is a consequence of insufficient geochronological data.

This general lack of Precambrian rocks in the Chinese portion of the CAOB brings into question the presence of major microcontinental blocks within the southern part of the belt. These have been widely recognised in both the Mongolian (Badarch et al., 2002; Rojas-Agramonte et al., 2011; Kröner et al., 2014) and Russian (Buslov et al., 2002; Kozakov et al., 2007; Turkina et al., 2007; Rytsk et al., 2011) segments of the CAOB, so it is perhaps surprising that they appear to be generally lacking in China. Previous workers have suggested that the Erguna, Xing'an, Songliao, Jiamusi and Khanka blocks are themselves microcontinents (Wu et al., 2002). However, ongoing work since the early 1990s has failed to find significant evidence (other than that stated above) for the presence of an extensive Precambrian basement to any of these blocks (Wilde et al., in press).

One explanation for the lack of a Precambrian crystalline basement in the Chinese CAOB may be the manner in which the orogen developed. It is widely recognised that the bulk of the CAOB either grew out from the margins of the Siberia Craton (Xiao et al., 2003, 2009) or within the Paleo-Asian Ocean at some distance from the northern and southern margins of the ocean (Kröner et al., 2014). The southern margin of the ocean, defined by the Precambrian