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A new Triassic shortening-extrusion tectonic model for Central-Eastern Asia: Structural, geochronological and paleomagnetic investigations in the Xilamulun Fault (North China)

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ABSTRACT

At the northern margin of the North China Block (NCB), the Xilamulun Fault (XMF) is a key belt to decipher the tectonic evolution of Central-Eastern Asia, as it records the Paleozoic final closure of the Paleo-Asian Ocean, and localizes a Late Triassic intracontinental deformation. In this study, structural analysis, ^{40}Ar–^{39}Ar dating, and paleomagnetic studies were performed to investigate the kinematics of the XMF and to further discuss its Triassic geodynamic significance in the Central-Eastern Asia framework after the Paleozoic Central Asian Orogenic evolution. The structural analyses reveal two phases of ductile deformation. The first one (D1), which displays N-verging and E–W trending folds, is related to the Early Paleozoic collisional event between the NCB and the Songliao–Hunshandake Block (SHB). The second phase (D2) displays a high-angle foliation and a pervasive sub-horizontal E–W stretching lineation with kinematic criteria indicative of dextral strike–slip shearing. The ^{40}Ar–^{39}Ar dating on mylonitic granite places the main shearing event around 227–209 Ma. This D2 shearing is coeval with that of the dextral strike–slip Bayan Obo–Chifeng Fault (BCF) and the Chicheng–Fengning–Longhua Fault to the south, which together constitute a dextral shearing fault system on the northern margin of the NCB during the Late Triassic. The paleomagnetic study performed on the Middle Permian Guangxingyuan pluton, located between the XMF and BCF, documents a local clockwise rotation of this pluton with respect to the NCB and SHB. Our multidisciplinary study suggests an NNW–SSE shortening and strike–slip shearing dominated tectonic setting on the northern margin of the NCB during the Late Triassic. Combining the contemporaneous dextral strike–slip movements of the XMF and BCF in northern China and the sinistral strike–slip movement of East Gobi Fault (EGF) in southeastern Mongolia with the large-scale tectonic framework, a Late Triassic NNW–SSE shortening-eastward extrusion tectonic model for Central-Eastern Asia is firstly proposed. The NNW–SSE shortening results in the eastward extrusion of the continental wedge bounded by the BCF and EGF, which is accommodated by the different kinematic patterns of the southern (XMF and BCF) and northwestern (EGF) bounding faults. This shortening-extrusion tectonic framework is tentatively interpreted as the result of the far field forces associated with three Late Triassic lithosphere-scale convergences in East Asia: i) northward intracontinental subduction between the NCB and South China Block, ii) collision of the Qiangtang Block with the Qaidam Block, and iii) southward subduction of the Mongol–Okhotsk Ocean beneath the Mongolia Block.

1. Introduction

Central-Eastern Asia, located between the North China Block (NCB) and Tarim Block in the south and the Siberian Block (SIB) in the north, recorded the Neoproterozoic to Paleozoic evolution of the Central Asian Orogenic Belt (CAOB; e.g. Sengör et al., 1993; Xiao et al., 2003; Xu et al., 2013). After the end of the CAOB formation that resulted in the amalgamation of the NCB, Tarim Block, SIB and several intervening microcontinents, intracontinental strike–slip faults were the prominent tectonic features of Central-Eastern Asia during the Early Mesozoic (Lamb et al., 1999; Johnson, 2004; Webb and Johnson, 2006; Webb et al., 2010; Zhao et al., 2013). The strike–slip faults can be ascribed to the consequence of several tectonic events, such as the Mesozoic

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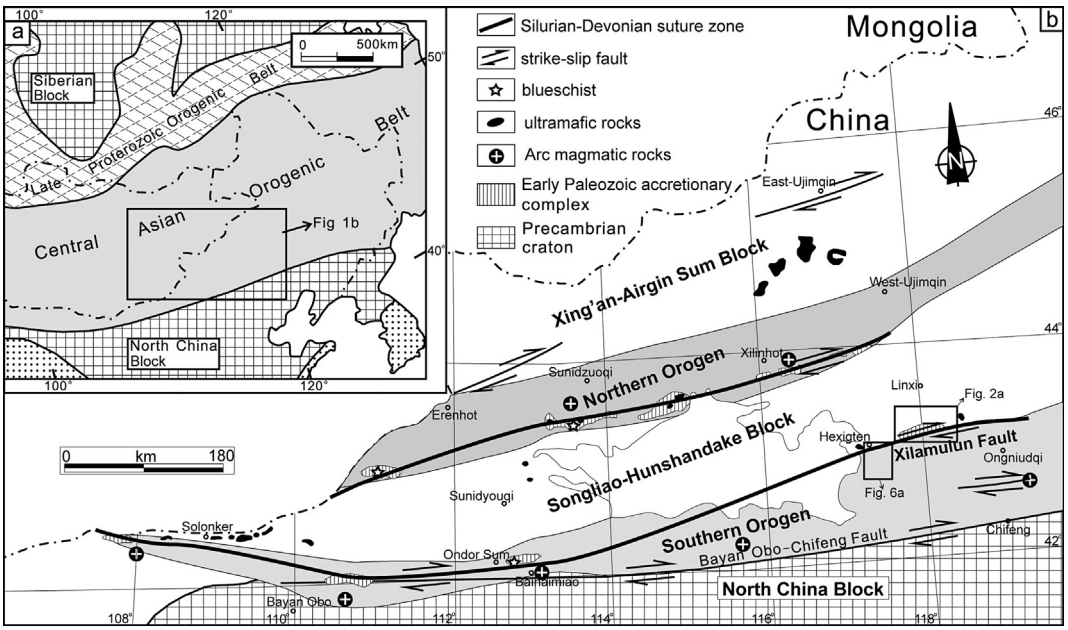

Fig. 1. (a) Schematic tectonic map of the Central Asian Orogenic Belt in Central-Eastern Asia (modified after Sengör et al., 1993 and Han et al., 2010) with the location of (b) in a box. (b) Tectonic map of Inner Mongolia showing the two Silurian–Devonian orogenic belts (Northern Orogen and Southern Orogen) that separated the three continental blocks of Xing'an–Airgin Sum Block, Songliao–Hunshandake Block and North China Block from north to south, respectively (modified after Jian et al., 2008 and Xu et al., 2013).

closure of the Mongol–Okhotsk Ocean (Zonenshain et al., 1990; Meng, 2003), the Meso-Cenozoic Pacific plate subduction (Wang et al., 2015), and the far-field effects of the Triassic NCB–South China Block (SCB) intracontinental convergence (Rowley et al., 1997; Liu et al., 2006). The strike–slip faults are critical structures in understanding the post-Paleozoic intracontinental deformation, especially for the evolution of the former tectonic sutures, which are potentially susceptible to reactivation if post-collisional intracontinental deformation occurs (Laurent-Charvet et al., 2003; Cogné et al., 2005; Choulet et al., 2013).

Inner Mongolia of China exposes both the northern margin of the NCB, and the southeastern part of the CAOB (Fig. 1a; Enkin et al., 1992; Xiao et al., 2003; Xu et al., 2013). Concerning its Phanerozoic tectonic evolution, three episodes are well recognized. (1) During the Early Paleozoic, these geological units experienced several N–S ductile shearing phases, corresponding to two orogenic events, namely i) the Late Silurian collision between the NCB and the Songliao–Hunshandake Block, and ii) the Late Devonian collision between the Songliao–Hunshandake Block and the Xing'an–Airgin Sum Blocks (Tang, 1990; Shi et al., 2013; Xu et al., 2013, 2015). (2) A Carboniferous–Permian post-orogenic extensional setting is documented by Carboniferous clastic–carbonate deposits, Permian intrusions and volcanic–sedimentary sequences (Tang, 1990; Zhang et al., 2008; Zhao et al., 2015). These rocks did not record any synmetamorphic ductile deformation, only tilting and folding. However, the significance of this episode is controversial, since some granitic intrusions present magmatic arc affinities and the mafic–ultramafic rocks are considered as ophiolite (Chen et al., 2000; Li, 2006; S.H. Zhang et al., 2009). (3) A Late Jurassic–Early Cretaceous episode is characterized by extensional tectonics with rift basins, metamorphic core complexes (MCC), and magmatism (Meng, 2003; Wu et al., 2005; Wang et al., 2012).

However, as few Triassic–Early Jurassic strata or magmatic rocks are exposed, the Early Mesozoic evolution is still not well understood. Meanwhile, the Early Mesozoic is a crucial period in deciphering the tectonic transition from Paleozoic evolution of the CAOB to the Late Mesozoic extension (Meng, 2003). An important Middle–Late Triassic thermal-tectonic event has been identified in southeastern Mongolia and Chinese Inner Mongolia (Daoudene et al., 2012); however, its geodynamic mechanism is not clear (Chen et al., 2000; Wang et al., 2004; Li et al., 2007; Liu et al., 2012). Nevertheless, the Triassic strike–slip faults that control the regional tectonics of this period are well recognized in the neighboring areas of the Southern Mongolia (Lamb et al., 1999; Webb et al., 2010) and Junggar (Laurent-Charvet et al., 2003; Choulet et al., 2013). Several Early Mesozoic strike–slip faults on the northern margin of the NCB were described preliminarily, e.g., Xilamulun Fault, Hongshan–Balihan Fault, and Chicheng–Fengning–Longhua Fault (Wang et al., 2013), giving us a good opportunity to study the Early Mesozoic kinematics in this area. Among these faults, the Xilamulun Fault was considered as the suture zone of the final closure of the Paleo-Asian Ocean during the Late Paleozoic (Li, 2006; Li et al., 2014). Furthermore, the Early Mesozoic reactivation and deformation along this fault can give important clues to decipher the Early Mesozoic tectonic evolution of the northern margin of NCB. Hence, in this study, a multi-disciplinary approach, involving structural analysis, ^{40}Ar–^{39}Ar dating, and paleomagnetic studies, was performed in order to investigate the kinematics and timing of the Xilamulun Fault and to discuss its place in the Early Mesozoic tectonic framework of Central-Eastern Asia.

2. Geological setting

2.1. Central-Eastern Inner Mongolia

The tectonic framework of Central-Eastern Inner Mongolia is characterized by two Early–Middle Paleozoic orogenic belts (Fig. 1b; Xu et al., 2013). The Southern Orogen (SO), from Bayan Obo via Ondor Sum to the Xilamulun Fault (Fig. 1b), is characterized from S to N by an Early Paleozoic magmatic arc (Jian et al., 2008) and a subduction-accretionary complex enclosing a ~450 Ma high pressure blueschist (De Jong et al., 2006). The subduction-accretionary complex experienced top-to-the-north ductile shearing along a flat-lying foliation (Shi et al., 2013). Late Silurian molassic deposits unconformably overlie these lithotectonic units (Tang, 1990). The Northern Orogen (NO), developing from Sunidzuoqi through Xilinhot to West-Ujimqin, is characterized from N to S by an Early Paleozoic magmatic arc