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Revisiting of the Yanshanian basins in western and northern Beijing, North China

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ABSTRACT

We present new laser ablation–inductively coupled plasma–mass spectrometry (LA–ICP–MS) zircon U–Pb ages and provenance data for the Yanshanian basins in western and northern Beijing, North China, with the aims of demonstrating the relationship between basin evolution and “Yanshanian tectonism” and constraining the Late Jurassic–Early Cretaceous tectonic evolution of the region. The inherited Yanshanian basin in western Beijing has a Late Jurassic–Early Cretaceous tectonic history similar to that of typical Yanshanian basins in the Yanshan Fold–Thrust belt (YFTB), and it became inactive at ~138 Ma. The Qianjiadian basin (QJB) in northern Beijing is only infilled by the sediments of the Tuchengzi Formation. Our new zircon U–Pb ages (160–156 Ma) for the pyroclastic and volcanic rocks of the Tuchengzi Formation suggest that formation of the QJB commenced at ~160 Ma, consistent with the main episode of “Yanshanian tectonism”. The QJB developed in the footwall of the Pingquan–Gubeikou thrust fault (PGF), and records the syn-tectonic unroofing and erosion of the hanging wall of that fault. It was later reformed by the post-depositional Qianjiadian thrust fault (QJF) along the western margin. The formation and development of the QJB in northern Beijing and the inherited Yanshanian basin in western Beijing were related to the “Yanshanian tectonism”, especially at ca. 160 Ma, when the intense deformation and large-scale magmatism occurred. The tectonic transition from N–S to NW–SE shortening is attributed to the northwest-ward subduction of the Paleo-Pacific Plate, and is constrained to ~156–135 Ma in the YFTB and eastern China.

1. Introduction

The Yanshan Fold–Thrust belt (YFTB), located at the northern margin of the North China Craton (NCC), was subjected to intense intraplate deformation during the Mesozoic (Ge, 1989; Song, 1999; Davis et al., 2001) following collision between the NCC and the Mongolian arc terranes during the late Permian to earliest Triassic (e.g., Davis et al., 2001; Xiao and Brian, 2003; Xiao et al., 2009; Li et al., 2007a). Mesozoic tectonic deformation in the NCC is known as the “Yanshanian Movement” (Yanshanian tectonism), and significant lithospheric thinning and cratonic destruction (descratonization) owing to the roll-back of the subducted Paleo-Pacific Plate and consequent upwelling of asthenospheric mantle (Deng et al., 2006; Li et al., 2007b, 2012; Wu et al., 2008; Zhu et al., 2011, 2012; Li and Huang, 2013; Zhang et al., 2014). Thus, the tectonic setting of the YFTB and eastern China changed from intraplate contraction to extension. Prior to the period of extension, a tectonic transition occurred from N–S convergence

between the Paleo-Asian and Paleo-Tethys oceans to the northwest-ward subduction of the Paleo-Pacific Plate beneath the eastern Asian continent during the late Mesozoic, which resulted in large-scale magmatism, structural deformation (with tectonic trends changing from E–W to NE–SW and NNE–SSW), and the development of NE-trending terrestrial basins in the YFTB and eastern China (Davis et al., 2001, 2005; Cope et al., 2007; Wang et al., 2011; Zhang et al., 2014; Liu et al., 2015b).

The timing of this transition in Mesozoic tectono-magmatic activity and crustal deformation processes is crucial in understanding the tectonic history of the YFTB and eastern China, which is closely linked to the initial subduction of the Paleo-Pacific Plate beneath the eastern Asian continent. However, the timing of this transition is controversial, having been assigned to the Late Jurassic–Early Cretaceous (He et al., 1998; Ma et al., 2002; Li et al., 2003; Zhai et al., 2004; Zhao et al., 2004a) and Early Cretaceous (Ren et al., 1999; Niu et al., 2003).

The Yanshanian tectonism was originally considered to occur during

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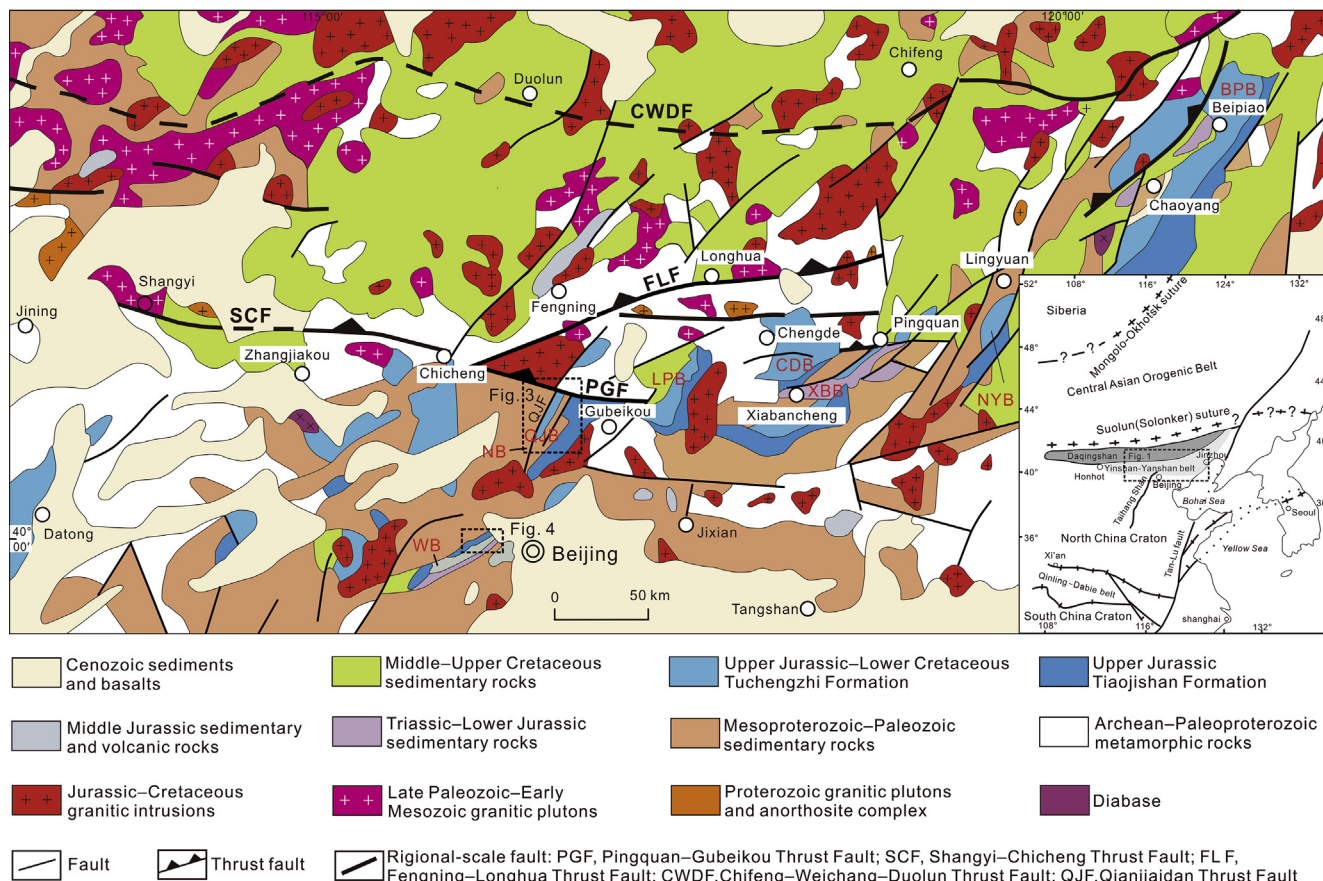


Fig. 1. Simplified geological map of the northern margin of the NCC. Modified from Zhang et al. (2007) and Liu et al. (2015a). Abbreviations are as follows: WB = western Beijing; NB = northern Beijing; QJB = Qianjiadian Basin; LPB = Luanping Basin; CDB = Chengde Basin; XBB = Xiabancheng Basin; NYB = Niuyingzi Basin; and BP = Beipiao Basin. Dashed rectangles mark the areas shown in Figs. 3 and 4. Inset map shows the main features of the wider tectonic setting of the NCC and the Central Asian Orogenic Belt.

the Late Jurassic–Early Cretaceous (Wong, 1927, 1929) based on the widespread angular unconformity between the Late Jurassic Tiao-jishan/Lanqi volcanic rocks and the underlying Jiulongshan Formation or older strata in the YFTB and eastern China. The Yanshanian basins are valuable for studying the tectono-sedimentary response to the regional tectonic events, despite the obscuring effects of the intense deformation in the YFTB (Wong, 1927; Bao et al., 1983; Zhao, 1990; Zhao et al., 2002, 2004b; BBGMR, 1991; Cope et al., 2007; Zhang et al., 2013; Li et al., 2014; Li et al., 2016).

The syn-tectonic sediments in fold–thrust belts can be used to constrain the timing of thrust-related deformation and paleogeography of provenance. In combination with structural and geochronological data, the basin sediments provide valuable information for understanding tectonic events and geological history. Therefore, the Late Jurassic–Early Cretaceous sequences of the Tiao-jishan and Tuchengzi formations in Yanshanian basins may provide important constraints on regional tectonic events.

The Beijing area is located in the western YFTB (Fig. 1) and is a significant area for studying Yanshanian deformation and the evolution of Yanshanian basins (Bao et al., 1983; Zhao et al., 2002; Zhang et al., 2013). Two Yanshanian basins were selected in this study based on their well-preserved Mesozoic terrestrial sediments, magmatic activity, and abundance of E–W-trending and NE–SW- to NNE–SSW-trending

tectonic structures: the newly formed Qianjiadian Basin (QJB) in northern Beijing and a typical inherited basin in western Beijing (Fig. 1). The infilling Upper Jurassic Tiao-jishan Formation marks the final phase of evolution of the basin in western Beijing. The Upper Jurassic–Lower Cretaceous Tuchengzi Formation is absent from this basin, whereas it is widespread in the QJB in northern Beijing and the YFTB (Figs. 1 and 2) (Bao et al., 1983; Ma and Liu, 1986; BBGMR, 1991; Zhao et al., 2002). The different stratigraphic sequences in these basins may reveal significant differences in basin evolution and sedimentary response to tectonic events. We present new LA–ICP–MS zircon U–Pb ages and provenance data in these basins, enabling comparison of the stratigraphic sequences and evolutionary histories between western and northern Beijing, and thereby enhancing our understanding of Yanshanian tectonism and the late Mesozoic tectonic evolution of the YFTB and eastern China.

2. Geological background

The YFTB is located in the northern margin of the NCC (Fig. 1) and records a long geological history from the Archean to the Mesozoic (Zhai and Peng, 2007; Zhao et al., 2010; Wang et al., 2011). Most parts of the NCC remained relatively stable after its final cratonization at ~1.8 Ga through to the Triassic (Zhai and Santosh, 2011; Zhai, 2014;

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