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A Neoarchean subduction polarity reversal event in the North China Craton

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ABSTRACT

Subduction polarity reversal events following arc–continent, arc–arc or continent–continent collisions have been well-documented from Cenozoic, Mesozoic, and Paleozoic orogens, but not from the Archean. We here document a Neoarchean subduction reversal event after an arc–continent collision between the Eastern Block of the North China Craton (NCC) and the Fuping arc using field, geochemical and geochronological data. We focus our work on the Wangjiazhuang granite in the Zanhuang massif located along the eastern margin of the Central Orogenic Belt (COB) of the NCC, and a regional tectonic comparison with other granitic rocks with similar ages, geochemical and petrogenetic characteristics. The ca. 2.5 Ga A-type Wangjiazhuang granite intrudes the Neoarchean Zanhuang mélange belt and contains mafic and felsic inclusions. It has positive $\varepsilon_{Nd}(t)$ values (+0.12 to +1.13) and T_{DM2} ages between 2784 Ma and 2869 Ma. This work shows clearly, from field structural relationships, geochemistry and geochronology, that the Wangjiazhuang granite formed after an arc–continent collision between the Eastern Block which is defined as a continental block and the Fuping arc, after a subduction polarity reversal event placed a new slab beneath the collisionally modified margin of the Eastern Block and converted it to an Andean-type margin. The subduction polarity reversal event at ca. 2.5 Ga resulted in melting of the enriched mantle. Meanwhile, the rising magma induced partial melting of the old and thickened TTG crust leading to the intrusion of ca. 2.5 Ga Wangjiazhuang granite into the Neoarchean Zanhuang mélange. There are other granitic rocks with similar ages and geochemical and petrogenetic features in the Central Orogenic Belt and Eastern Block of the North China Craton, suggesting that they formed in a similar tectonic setting as the circa 2.5 Ga granites across the Eastern Block. The Neoarchean subduction polarity reversal event and prior arc–continent collision provide strong evidence that plate tectonics was operating by the end of the Neoarchean.

1. Introduction

Subduction polarity reversal events after arc–contintent, arc–arc or continent–continent collisions have been documented in Cenozoic and Mesozoic orogens in several places in the world, such as the Ligurian Alps, Italy (Vignaroli et al., 2008), Kamchatka (NE Russia) in the northwest Pacific (Konstantinovskaia, 2001), Taiwan-Luzon (Chemenda et al., 1997; Clift et al., 2003; Teng et al., 2000; Ustaszewski et al., 2012), Cretaceous Caribbean island arc (Draper et al., 1996; Lebron and Perfit, 1993), Solomon island arc (Copper and Taylor, 1985), Philippines (Pubellier et al., 1999), and northern New Guinea (Copper and Taylor, 1987; Dewey and Bird, 1970). However, subduction polarity reversal events have not been clearly documented from the Archean rock record. In this paper, based on the field structural, geochemical and geochronological studies on the Wangjiazhuang granite and a regional tectonic synthesis of geochemical and petrogenetic data from similar-aged plutons in the NCC, we propose a Neoarchean subduction polarity reversal event following an arc–continent collision between Eastern Block and the Fuping arc in the NCC.

In the past several decades, most workers have generally divided the NCC into the Eastern Block (EB) and Western Block (WB), separated by the intervening Central Orogenic Belt (Fig. 1; Kusky and Li, 2003; Zhao et al., 2001), or several smaller microblocks (Zhai and Santosh, 2011). Currently, the amalgamation mechanism of the Precambrian basement and formation age of the NCC are a hot topic (Deng et al., 2013, 2014; Kusky et al., 2014; Lu et al., 2014; Wang et al., 2013a, 2014a,b,c,d; Xiao et al., 2014; Yin et al., 2014; Zhang et al., 2007c, 2009, 2012; Zhao et al., 2012). Circa 2.5 Ga magmatic events within the North China Craton are strongly developed with the prominent characteristics of emplacement of the granitic rocks in the late stage of the Neoarchean

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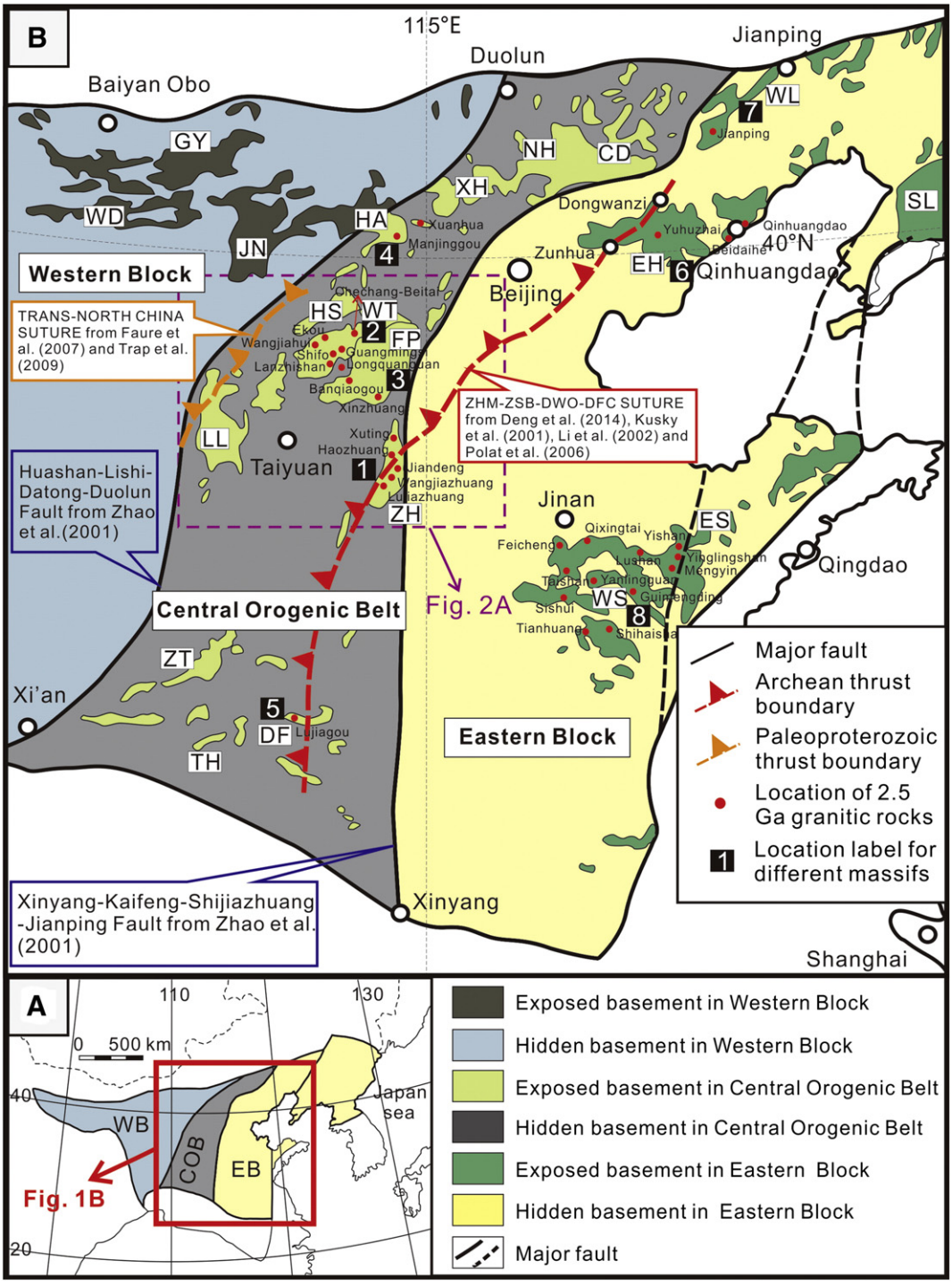

Fig. 1. A: Tectonic subdivision of the North China Craton (NCC) including Western Block (WB), Eastern Block (EB) and Central Orogenic Belt (COB). B: The distribution of the exposed basement of the central part of North China Craton with locations of Huashan–Lishi–Datong–Duolun and Xinyang–Kaifeng–Shijiazhuang–Jianping Faults from Zhao et al. (2001), Trans-North China suture from Faure et al. (2007) and Trap et al. (2009), and Zanhuang Melange (ZHM)–Zunhua Structural Belt (ZSB)–Dongwanzi Ophiolite (DWO)–Dengfeng Complex (DFC) suture from Deng et al. (2014), Kusky et al. (2001), Li et al. (2002) and Polat et al. (2006). Abbreviations of metamorphic complexes without exposure of 2.5 Ga granitic rocks: CD: Chengde; ES: Eastern Shandong Province; GY: Guyang; HS: Hengshan Complex; JN: Jining; LL: Lüliang; NH: Northern Hebei Province; SL: Southern Liaoning Province; TH: Taihua; WD: Wulashan–Daqingshan; XH: Xuanhua; and ZT: Zhongtiao Complex. Abbreviations of metamorphic complexes with exposure of 2.5 Ga granitic rocks: ZH (labeled as 1): Zanhuang Massif; WT (labeled as 2): Wutai Complex; FP (labeled as 3): Fuping Complex; HA (labeled as 4): Huai'an Complex; DF (labeled as 5): Dengfeng Complex; EH (labeled as 6): Eastern Hebei Province; WL (labeled as 7): Western Liaoning Province; and WS (labeled as 8): Western Shandong Province. Map modified from Zhao et al. (2005) and Kusky and Li (2003).

tectonic activity (Geng et al., 2010; Han et al., 2014; Ma et al., 2013; Nutman et al., 2011; Wilde et al., 2005; Zhang et al., 2013). However, the petrogenetic origin and geodynamic triggering mechanism for the 2.5 Ga magmatic event are poorly understood and controversial, with one group of thought arguing that they were related to the underplating by a mantle plume (Geng et al., 2012; Wu et al., 2014; Zhao, 2009; Zhao and Zhai, 2013; Zhao et al., 1999), whereas others favor magmatic arc models (Nutman et al., 2011; Peng et al., 2013; Wang et al., 2013b). Therefore, the study of 2.5 Ga magmatic activity in the NCC is very important and will undoubtedly provide key constraints on the early Precambrian tectonic evolution of the basement of the NCC. We previously reported that the ca. 2.5 Ga Wangjiazhuang granitic pluton intrudes the