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Triassic diorites and granitoids in the Foping area: Constraints on the conversion from subduction to collision in the Qinling orogen, China

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ABSTRACT

The western Qinling is characterized by Triassic granitic plutons, which are keys to constrain the timing of subduction and collisional processes between the North China and South China Blocks. This paper presents a set of new LA-ICPMS U–Pb zircon geochronology, major and trace element geochemistry for several representative diorite and granitoid plutons in the Foping area. The diorites are characterized by high MgO, Al_2O_3, Y and Yb contents, but low SiO_2, Sr/Y and La/Yb ratios, as well as depletion of Nb, Ta, P and Ti, suggesting derived from a subduction related setting. LA-ICPMS zircon U–Pb age of 216.9 ± 1.5 Ma (MSWD = 0.69) from the diorite constrains the time of the subduction event. The medium- and fine-grained monzogranites as well as the biotite granites exhibit relative high SiO_2, MgO and Rb, low Y and Yb contents, and low Sr/Y and La/Yb ratios, as well as various depletions of Nb, Ta, P and Ti. These features indicate a derivation from lower continental crust but had been influenced by slab released fluids in a syn-collisional setting. The medium-grained monzogranite and biotite granite yield LA-ICPMS zircon U–Pb ages of 207.3 ± 2.1 Ma (MSWD = 1.8) and 201.6 ± 1.2 Ma (MSWD = 1.04), respectively, proposing the syn-collision during ca. 207–201 Ma. Geochemical and geological evidences suggest that the granodiorites intruding in the syn-collisional monzogranites were related to the post-orogenic collapse after the collision between the North China and South China Blocks. The LA-ICPMS U–Pb zircon age of 189.3 ± 2.9 Ma (MSWD = 5.6) for the granodiorite constrains the time of the post-orogenic collapse. Our geochronological and geochemical data provide important constraints on the Triassic evolution from subduction to collision then up to post-collisional collapse along the Qinling orogen.

1. Introduction

The Qinling–Dabie orogenic belt is well documented that it was formed by the collision of the North China Block (NCB) and South China Block (SCB) (e.g. Ames et al., 1996; Dong et al., 2011a,b,c; Enkin et al., 1992; Faure et al., 2001; Hacker et al., 1998; Hsü et al., 1987; Kröner et al., 1993; Li et al., 1993, 1994; Mattauer et al., 1985; Meng and Zhang, 1999; Okay, 1993; Ratschbacher et al., 2003, 2006; Xu et al., 1988; Zhai et al., 1998; Zhang et al., 1991, 2001; Zhao and Coe, 1987). However, the timing of the collision was disputed for decades due to the distinctive geological records in the Qinling Mountains to the west and the Dabie to the east. In the Qinling Mountains, the Shangdan suture zone represents the major tectonic boundary between the NCB and SCB (Fig. 1). Even though there still exist debates about the definite time of collision and orogenic process along the Shangdan suture, the closure of the Shangdan ocean was mostly suggested to have occurred in Paleozoic times depending on the detailed investigations of geology, geochemistry and geochronology of ophiolite and related volcanic rocks as well as metamorphism (e.g. Dong et al., 1997, 2011a,b and c; Gao et al., 1995; Hacker et al., 2004; Liu et al., 2003; Ratschbacher et al., 2003, 2006; Sun et al., 2002b; Xue et al., 1996a,b; Zhang et al., 1994, 1995a,b, 2001; Zhang and Zhang, 1995). However, the predominantly HP/UHP metamorphic rocks exposed in the Dabie terrane favoured a Triassic collision between the NCB and SCB (e.g. Ames et al., 1996; Enkin et al., 1992; Hacker et al., 1998; Hsü et al., 1987; Li et al., 1993, 1994; Okay, 1993; Wang et al., 1989; Zhao and Coe, 1987).

During the last decades, extensive studies revealed the existence of a Triassic suture zone, termed the Mianlue suture, along the southern margin of the Qinling orogenic belt (Dong et al., 1999, 2004; Lai et al., 2004; Li et al., 1996, 2007a; Liu et al., 2001; Xu et al., 2002; Zhang et al., 1995a,b, 1996, 2001). This suture zone is a key to promote reconsidering the timing and mode of collision between the NCB and SCB, as well as the formation and exhumation of the Dabie HP/UHP terrane. To the northern side of the Mianlue suture, the widespread Triassic granitoids intruded into the Western Qinling region. These intrusions provide the

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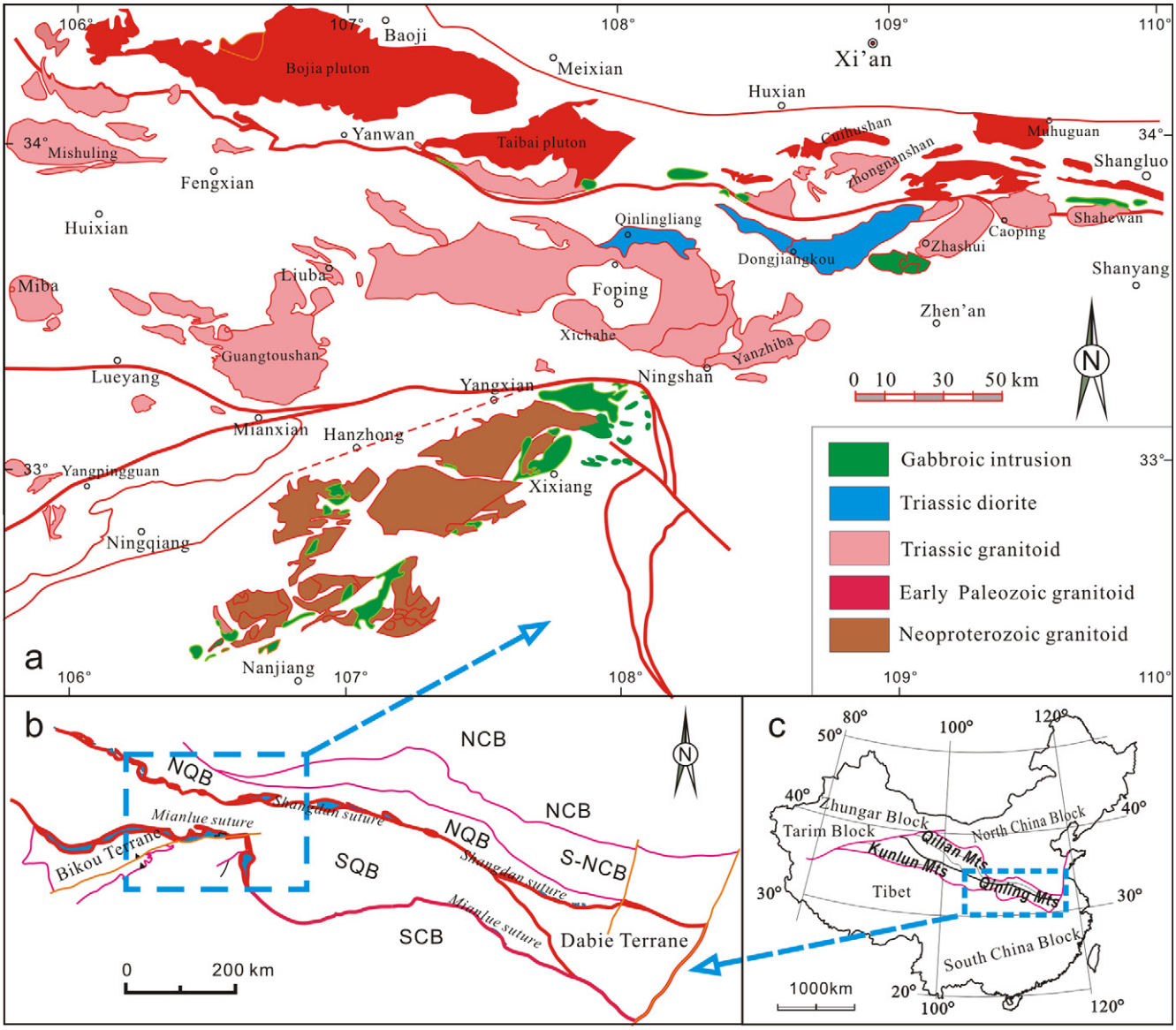

Fig. 1. Simplified maps showing (a) the tectonic division of the Qinling orogenic belt, (b) the distribution of granitoids in the Western Qinling, and (c) the location of the Qinling orogenic belt in China. NCB: North China Block; S-NCB: southern margin of the North China Block; NQB: North Qinling Belt; SQB: South Qinling Belt; SCB: South China Block.

important clues on the detailed orogenic process, and thus were intensively studied during the last decades (Hu et al., 2004; Jiang et al., 2010; Qin et al., 2008a,b, 2010b; Sun et al., 2002b; Zhang et al., 2001, 2005). However, controversy still exists on the petrogenesis and tectonic implication about these rocks. Although Zhang et al. (2001) suggested that these Triassic granite are mostly related to the subduction and collision along the Mianlue suture zone whereas the rapakivi granite is believed to be formed by post-collision collapse, the other researchers (Gong et al., 2009; Hu et al., 2004; Jiang et al., 2010; Jin et al., 2005; Qin et al., 2007a,b, 2009; Sun et al., 2000, 2002a; Zhang et al., 2008) argued that granitoids were formed in collision stage and can be divided into syn-collisional and post-collisional granite groups (Zhang et al., 2005).

In this paper, we present a set of new geochemical and geochronological data of the diorite and granite intrusions in the Foping area, which are located in the transitional position of the West and East Qinling Mountains, and undertake an attempt to constrain the time of the subduction to collision of the Qinling orogen.

2. Geological setting

The Qinling orogenic belt is bounded by the Lingbao–Lushan–Wuyang fault (LWF) to the north and the Mianlue–Bashan–Xiangguang Faults (MBXF) to the south (Fig. 1a), along which the Qinling orogenic belt overthrusted onto the southern of the NCB and northern of the SCB, respectively.

Based on the comprehensive investigations of geology, geochemistry and geophysics, the existence of two sutures is well documented, i.e. the Shangdan suture in the north and the Mianlue suture in the south (Zhang et al., 2001; Dong et al., 2011c). With these two sutures and the Luonan–Luanchuan fault (LLF), the Qinling orogenic belt is divided into, from north to south, the southern margin of the NCB (S-NCB), North Qinling Belt (NQB), South Qinling Belt (SQB) and the northern margin of the South China Block (N-SCB) (Fig. 1a).

The Shangdan suture zone is defined by a linear, patchy distribution of tectonic and ophiolitic melanges and arc-related volcanic rocks (Dong et al., 1997, 2011b; Sun et al., 1995; Zhang et al., 1994,