ARTICLE IN PRESS

GR-01210; No of Pages 15

Gondwana Research xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Gondwana Research

journal homepage: www.elsevier.com/locate/gr

Late Triassic granitic magmatism in the Eastern Qiangtang, Eastern Tibetan Plateau: Geochronology, petrogenesis and implications for the tectonic evolution of the Paleo-Tethys

Touping Peng [a,*], Guochun Zhao [b], Weiming Fan [a], Bingxia Peng [a], Yongsheng Mao [a,c]

[a] State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China
[b] Department of Earth Sciences, The University of Hong Kong, Pokfulam Road, Hong Kong
[c] Graduate University of Chinese Academy of Sciences, Beijing 100049, China

ARTICLE INFO

Article history:
Received 18 September 2013
Received in revised form 29 December 2013
Accepted 2 January 2014
Available online xxxx

Handling Editor: Z.M. Zhang

Keywords:
Dongdashan batholith
Eastern Tibetan Plateau
Granite
Post-collisional magmatism
Paleo-Tethys

ABSTRACT

Triassic granites are widely exposed in the central Qiangtang, northern Tibetan Plateau. They, therefore, made an important contribution to the growth of the Tibetan Plateau. In this paper, we present zircon U–Pb dating and Hf isotopic results, and whole-rock elemental and Sr–Nd isotopic analyses of the Dongdashan (DDS) batholith in the central Qiangtang in order to understand their petrogenesis and tectonic setting. LA-MC-ICP-MS zircon U–Pb results show that the DDS batholith was emplaced at 220.3 ± 0.7 Ma. All the granites in the DDS possess high A/CNK values (>1.0) and display peraluminous characteristics, similar to S-type granite. Their strongly fractionated REE patterns ($(La/Yb)_N = 6.98$–13.9) with conspicuous negative Eu anomalies ($Eu^*/Eu = 0.51$–0.67), together with negative $\varepsilon_{Nd}(t)$ and $\varepsilon_{Nd}(t)$ values, and depleted Nd and Hf model ages, suggest that the DDS granitic magma had a dominantly crustal source, likely the Paleoproterozoic basement (i.e., the Ningduo and Caoqu group metasediments) in the area.

In combination with regional studies, our new geochemical data and geochronological results demonstrate that the Late Triassic magmatism was generated in a post-collisional tectonic setting. The spatial distribution pattern of the Mesozoic igneous rocks, coupled with the exhumation of high-pressure metamorphic rocks in the central Qiangtang, favors a slab breakoff model, which resulted in post-collisional extension and asthenospheric upwelling that induced large-scale partial melting of the middle-lower crust to produce voluminous amounts of felsic magma. Therefore, the occurrence of the Late Triassic post-collisional magmatism, and particularly the exhumation of high-pressure eclogites and blueschists as well as their presence in the lowermost portion of the Late Triassic volcanoclastics in the Qiangtang basin, clearly indicate that the final closure of the of Paleo-Tethys Ocean and associated continent–continent collision between the Gondwana-derived Western Qiangtang and Eastern Qiangtang terranes had not been completed until the early mid-Triassic.

1. Introduction

Granitoids are the important component of the upper crust, and are found in all plate tectonic environments, especially orogenic settings. Their magmas may be derived from different source regions, producing distinct granitoid types (e.g., Chappell and White, 1974; Sylvester, 1989; Eby, 1992; Moyen et al., 2001), such as S-, I- and A-type granites. Accordingly, they provide petrogenetic 'windows' into the evolution of deeper crustal sources, as well as clues to the overall tectonic setting (e.g., Pitcher, 1983; Pearce et al., 1984; Condie and Kröner, 2013). Moreover, different types of granitoid magmatism usually take place in different tectonic regimes during the evolution of orogeny, including subduction, and syn- to post-collisional and post-orogenic extensional settings (e.g., Chappell and White, 1974; Sylvester, 1989; Chappell and White, 1992; Brown, 1994; Barbarin, 1999; Bonin, 2007). For example, many peralkaline and alkaline granites are associated with post-tectonic within-plate extension (e.g., Bonin, 2007), whereas subduction-related granites tend to be metaluminous, although some metaluminous granites are collision-related (e.g., Martin, 1987; Wedepohl, 1991). In addition, granites related to continent–continent collision tend to be peraluminous (e.g., Wedepohl, 1991; Chappell and White, 1992, 2001). However, several studies have demonstrated that the majority of collision-related, strongly peraluminous granites were emplaced in post-collisional settings after the peak of crustal thickening (e.g., Sylvester, 1998). Furthermore, the resultant magmas could have involved the melt and heat input from mantle (Sylvester, 1998; Wang et al., 2010; Peng et al., 2013). In fact, an increasing number of studies have revealed that crustal anatexis during syn-collisional or syn-orogenic settings generally produces leucogranites, which are peraluminous, such as those along the Alpine-Himalayan

* Corresponding author at: Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, P.O. Box 1131, Guangzhou 510640, People's Republic of China. Tel.: +86 20 85292410; fax: +86 20 85291510.
E-mail address: tppeng08@126.com (T. Peng).

1342-937X/$ – see front matter © 2014 International Association for Gondwana Research. Published by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.gr.2014.01.009

Mountain chain (e.g., Harrison et al., 1998; Ciancaleoni and Marquer, 2004; Gaillard et al., 2004).

The Qiangtang block lies to the north of the Lhasa terrane and is the most important part of the Tibetan Plateau (Fig. 1a). The discovery of an early Mesozoic high-pressure (HP) to ultrahigh-pressure (UHP) metamorphic belt in the central Qiangtang (Li et al., 2006; Pullen et al., 2008; Liu et al., 2011; Zhai et al., 2011) and the recent identification of the Carboniferous oceanic ophiolites (Zhai et al., 2013c) indicate that the Paleo-Tethys Ocean was most likely situated between the Eastern and Western Qiantang terranes during the late Paleozoic, and its subduction and final closure led to collision between the two terranes (Li and Zheng, 1993; Yang et al., 2011; Zhai et al., 2011, 2013a). It is quite noticeable that the tectono-magmatism related to the evolution of the Paleo-Tethys Ocean made an important contribution to the growth of the Tibetan Plateau. In recent years, many studies have been carried out in this belt in order to decipher the evolution of the Paleo-Tethys Ocean, especially the correlation between the magmatism, metamorphism and sedimentation, and the tectonic regime transition from subduction to collision in the area (e.g., Pullen et al., 2008; Liu et al., 2011; Yang et al., 2011; Zhai et al., 2011, 2013a). Nonetheless, the tectonic setting of the middle–late Triassic tectono-magmatism, especially for the late Triassic magmatism and sedimentation in the Qiangtang block, is still an issue of debate (Wang et al., 2008; Fu et al., 2010; Zhai et al., 2011, 2013a). Hence, knowledge about the syn- to post-collisional history in this region remains unknown. Moreover, in the case of the granite belt that is parallel to the HP metamorphic belt in the central Qiangtang, little attention has been paid to its association with the middle–late Triassic volcanoclastic and metamorphic rocks (Kapp et al., 2000, 2003). The significance of these granites in a reconstruction of the Paleo-Tethys remains uncertain, because few geochronological and geochemical data are available.

In this contribution, we present whole-rock geochemical and Sr–Nd isotopic compositions, and zircon U–Pb dating and Lu–Hf isotope results for the Late Triassic granites in the central Qiangtang, Eastern Tibetan Plateau. Based on our data, coupled with regional results, our aims are to: (1) illustrate the nature and source of the protoliths of the Late Triassic granites and their melting process; (2) shed insights into the geodynamic mechanism of their generation; and 3) discuss the relationships between the Late Triassic crustal anatexis and the evolution of the Paleo-Tethys.

2. Geological background and petrography

The Eastern Tibetan Plateau is a collage of several blocks or microplates (terranes), including the Songpan–Ganzi, Yidun, Qiangtang and Eastern Lhasa terranes, where numerous important geological records related to the evolution of the Eastern Paleo-Tethys have been well documented (Lv et al., 1993; Pan et al., 2003; Zhang and Santosh, 2012; Zhang et al., 2012; Zheng et al., 2013; Zhu et al., 2013; Zhang et al., in 2014). It is also a key metallogenic district, named as the Tethys metallogenic domain in West China (Pan et al., 2003; Hou et al., 2011; Wang et al., in press; and references therein), in which many economically important Cu-polymetallic ore deposits have been discovered, such as the Yulong, Zhongdian, Yangla and Narigongma porphyry Cu ore deposits (Hou et al., 2007; Liang et al., 2009; Wang et al., 2011; Yang et al., 2012), and the Gachun and Luchun volcanogenic massive

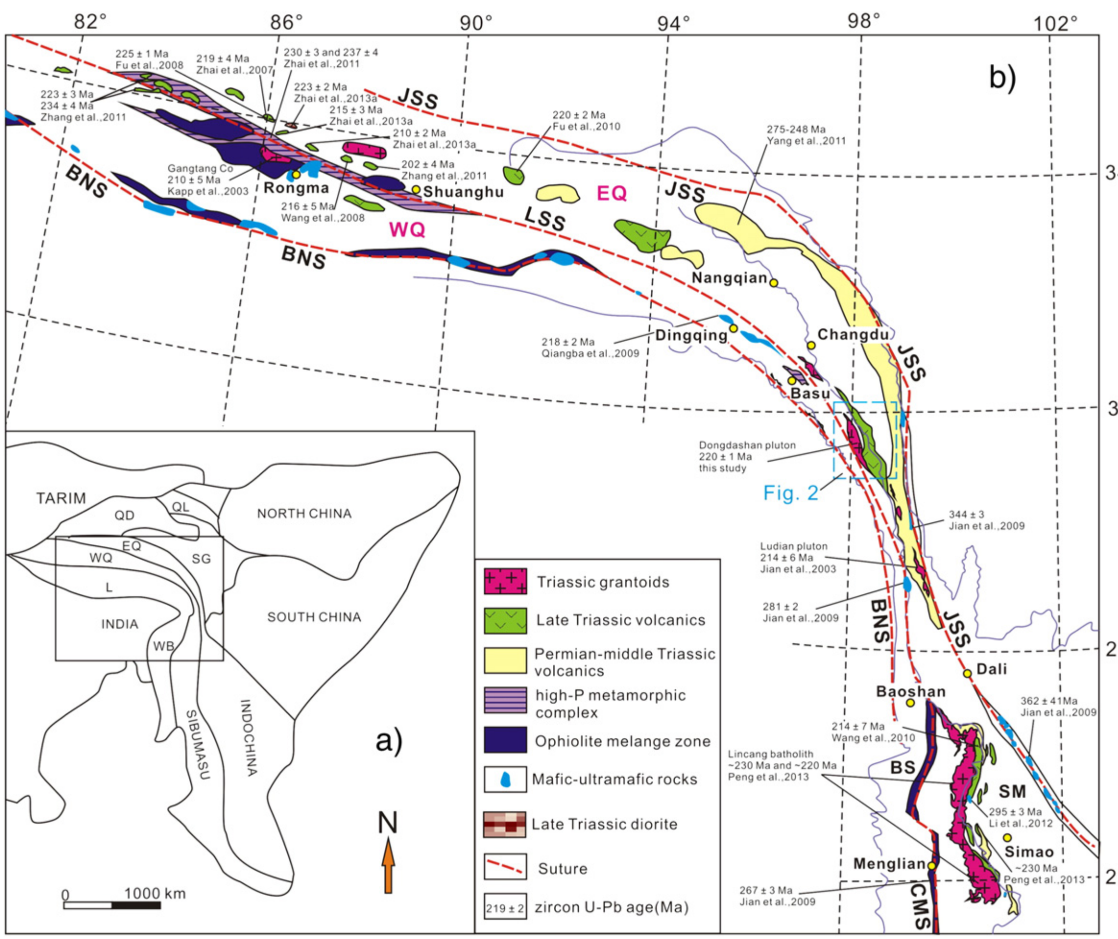

Fig. 1. Simplified geological map (a) and tectonic units (b) of the Sanjiang region in eastern Tibet and Yunnan, SW China (modified from Liu et al., 2011; Deng et al., 2012; Metcalfe, 2013). Tectonic sutures: *BNS*, Bangong–Nujiang suture; *CMS*, Changling–Menglian suture; *JSS*, Jinshajiang suture; *LSS*, Longmu Co–Shuanghu suture. Continental blocks: *BS*, Baoshan; *EQ*, Eastern Qiangtang; *L*, Lhasa; *QD*, Qaidam; *QL*, Qilian; *SG*, Songpan Ganzi; *SM*, Simao; *WB*, West Burma; *WQ*, Westernern Qiangtang. Available ages (with references) are included.

Please cite this article as: Peng, T., et al., Late Triassic granitic magmatism in the Eastern Qiangtang, Eastern Tibetan Plateau: Geochronology, petrogenesis and implications f..., Gondwana Research (2014), http://dx.doi.org/10.1016/j.gr.2014.01.009