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# Tectono-magmatic evolution of the Gaoligong belt, southeastern margin of the Tibetan plateau: Constraints from granitic gneisses and granitoid intrusions

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ABSTRACT

The Gaoligong belt is located in the southeastern margin of the Tibetan plateau, and is bound by the Tengchong and Baoshan blocks. This paper presents new data from zircon geochronology, geochemistry, and whole-rock Sr–Nd–Pb–Hf isotopes to evaluate the tectonic evolution of the Gaoligong belt. The major rock types analysed in the present study are granitic gneiss, granodiorite, and granite. They are metaluminous to peraluminous and belong to high-K, calc-alkaline series. Laser ablation inductively coupled plasma mass spectrometry (LA–ICP–MS) analyses of zircons from nine granitic rocks yielded crystallization ages of 495–487 Ma, 121 Ma, 89 Ma, and 70–63 Ma. The granitoids can be subdivided into the following four groups. (1) Early Paleozoic granitic gneisses with high $\varepsilon_{Nd}(t)$ and $\varepsilon_{Hf}(t)$ values of −1.06 to −3.45 and −1.16 to 2.09, and model ages of 1.16 Ga to 1.33 Ga and 1.47 Ga to 1.63 Ga, respectively. Their variable $^{87}Sr/^{86}Sr$ and Pb values resemble the characteristics of the Early Paleozoic Pinghe granite in the Baoshan block. Our data suggest that the rocks were derived from the break-off of the Proto-Tethyan oceanic slab between the outboard continent and the Baoshan block, which induced the partial melting of Mesoproterozoic pelitic sources mixed with depleted mantle materials. (2) Early Cretaceous granodiorites with low $\varepsilon_{Nd}(t)$ and $\varepsilon_{Hf}(t)$ values of −8.92 and −4.91 with Nd and Hf model ages of 1.41 Ga and 1.49 Ga, respectively. These rocks have high initial $^{87}Sr/^{86}Sr$ (0.711992) and lower crustal Pb values, suggesting that they were derived from Mesoproterozoic amphibolites with tholeiitic signature, leaving behind granulite residue at the lower crust. (3) Early Late Cretaceous granites with low $\varepsilon_{Nd}(t)$ and $\varepsilon_{Hf}(t)$ values of −9.58 and −4.61 with Nd and Hf model ages of 1.43 Ga and 1.57 Ga, respectively. These rocks have high initial $^{87}Sr/^{86}Sr$ (0.713045) and lower crustal Pb isotopic values. These rocks were generated from the partial melting of Mesoproterozoic metapelitic sources resulting from the delamination of thickened lithosphere, following the closure of the Bangong–Nujiang Ocean and collision of the Lhasa–Qiangtang blocks. (4) Late Cretaceous to Paleogene granitic gneisses with low $\varepsilon_{Nd}(t)$ and $\varepsilon_{Hf}(t)$ values of −4.41 to −10 and −5.95 to −8.71, Nd model ages ranging from 1.08 Ga to 1.43 Ga, and Hf model ages from 1.53 Ga to 1.67 Ga, respectively. These rocks show high initial $^{87}Sr/^{86}Sr$ (0.713201 and 714662) and lower crustal Pb values. The data suggest that these rocks are likely related to the eastward subduction of the Neo-Tethyan Oceanic slab, which induced partial melting of Mesoproterozoic lower crustal metagreywacke. The results presented in this study from the Gaoligong belt offer important insights on the evolution of the Proto-Tethyan, Bangong–Nujiang, and Neo-Tethyan oceans in the southeastern margin of the Tibetan Plateau.



## 1. Introduction

The closure of the Tethyan Ocean and the collision between the Indian and Eurasian continents constructed the Himalayan orogen and elevated the Tibetan Plateau (e.g., Yin and Harrison, 2000; Searle et al., 2007; Gibbons et al., 2015). Several large-scale and numerous small-scale strike-slip faults and shear zones developed in the convergent belt including the Gaoligong belt (Wang et al., 2006). These shear zones are considered to have formed through intra-continental deformation by northward subduction of the Indian plate beneath the Eurasian Plate, which led to the southeastward extrusion of the Indochina block away from the convergent front (Tapponnier et al., 1982, 1986; Replumaz and Tapponnier, 2003; Wang et al., 2006; Replumaz et al., 2014). These shear zones and strike-slip faults accommodate southeastward material flow between several blocks such as the Tengchong, Baoshan, Indochina (Eroğlu et al., 2013) by crustal shortening or lateral extrusion outward from the plateau (Dewey et al., 1989; Wang and Burchfiel, 1997; Wang et al., 2006). Therefore, investigations to constrain the processes of deformation and southeastward material extrusion are crucial in understanding the geodynamics

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of the India–Eurasia continental collision (Socquet and Pubelier, 2005; Schoenbohm et al., 2006; Searle, 2006).

The Gaoligong belt in southwest Yunnan plays a vital role in our understanding of the subduction of the Tethyan Oceanic slab and the collision between the Indian and Eurasian continents. Previous research in this region has mainly focused on the Cenozoic deformation events (Wang et al., 2006, 2008; B. Zhang et al., 2010; Eroğlu et al., 2013) and the basement which was defined as the product of Meso- to Neoproterozoic tectonics (BGMRYP, 1990; Zhong, 1998). However, recent geochronological investigations have revealed multiple stages of magmatism and metamorphism in this belt (Eroğlu et al., 2013). The magmatism includes Early Paleozoic ca. 490 Ma (granitic gneiss, 500 Ma, Li et al., 2012a; gneissic granite, 487 Ma, Song et al., 2007) and Early Cretaceous, and the latter contains magmatic rocks including volcanics with ca. 120 Ma age (Yang et al., 2006; Cong et al., 2011; Bai et al., 2012; Li et al., 2012b,c). In order to understand the multi-stages of magmatism in the Gaoligong belt, we present new zircon U–Pb geochronology, whole-rock major and trace element geochemistry, and whole-rock Sr–Nd–Pb–Hf isotopic compositions of a suite of representative samples from the Gaoligong belt. These data reveal four stages of magmatism in the belt corresponding to 495–487 Ma, 121 Ma, 89 Ma, and 70–63 Ma. We correlate the magmatism with the evolution of the Proto-Tethyan, Bangong–Nujiang, and Neo-Tethyan oceans.

## 2. Geological setting

The N–S trending Gaoligong belt is located at the western part of the Nujiang valley and to the east of Longchuanjiang. The region lies northward of the Eastern Himalayan Syntaxis and southwestward of the Tengchong–Baoshan area and the Burma block, extending over a length of 400 km in the Yunnan Province in China (Fig. 1; BGMRYP, 1990). The belt forms the boundary between the Tengchong and Baoshan blocks and separates the Tengchong block to the west and the Baoshan block to the east. The Tengchong and Baoshan blocks have been considered as part of the Sibumasu continent, which broke away from eastern Gondwana in the early Permian (Metcalfe, 2002, 2011, 2013). However, the tectonic affinity of the Tengchong block remains controversial (C.M. Wang et al., 2014). The relationship between the Tengchong and Baoshan blocks is also not clear, and several lines of evidence were evaluated by Zhao et al. (2014). Jin (2002) suggested that the earlier locations of the Tengchong and Baoshan blocks were different from their present position, although both these blocks were juxtaposed during Permo–Carboniferous. The juxtaposition of the Baoshan and Tengchong blocks as seen today was due to later tectonic movements. In addition, the Gaoligong Formation contains the oldest basement rocks (1094–840 Ma; Zhong, 1998) in the Gaoligong belt, which are composed of metamorphosed volcano-sedimentary rocks, tonalite, and gabbro, in the absence of Early Paleozoic sediments.

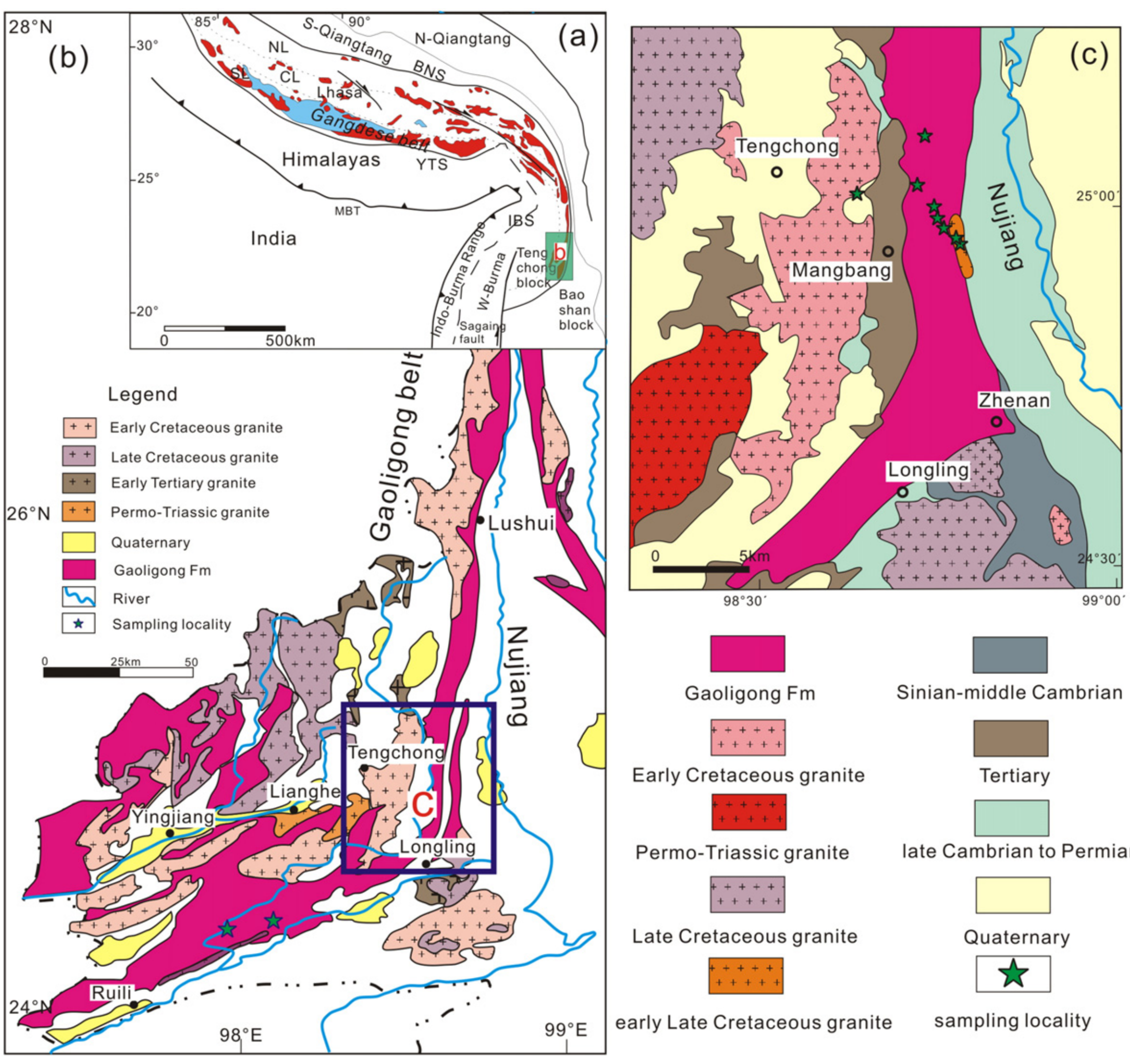


**Fig. 1.** Simplified geological map of the Himalaya-Tibet tectonic realm (a, modified after Wang et al., 2013), the Gaoligong belt, southeastern margin of Tibetan plateau (b, modified after Xu et al., 2008) and the samples localities in the belt (c).