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Proto- to Paleo-Tethyan evolution of the eastern margin of Simao block

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ABSTRACT

The Simao block, northern extension of Indochina block, was located along the Proto-Tethyan subduction zone in Early Paleozoic and subducted by the Paleo-Tethyan Ailaoshan ocean along its eastern margin in Permo-Triassic. The location of Simao block in the Proto-Tethyan paleogeography and the Permo-Triassic consumption process of the Ailaoshan ocean were unclear. Detrital zircons from Silurian to Triassic strata and the representative Xin'anzhai intrusion in the eastern margin of Simao block are studied to constrain the Proto- to Paleo-Tethyan evolution. The major age peaks of detrital zircons in Early Silurian–Early Devonian strata are ~0.95 Ga and ~0.45 Ga, which are consistent with those of detrital zircons in the time-equivalent strata in the Simao–Indochina block rather than Yangtze block. This implied that the Paleo-Tethyan suture of the Ailaoshan ocean was located along the Ailaoshan–Tengtiaohe fault. The dominant and diagnostic ~450 Ma detrital zircons with large variation of $\varepsilon_{Hf}(t)$ in the above strata were derived from arc igneous rocks associated with the evolution of Proto-Tethyan oceanalong the western margin of Simao block. This feature contrasts with the equivalent strata from Qiangtang and Tethyan Himalaya blocks, located along Gondwana Indian margin, which was dominated by ~0.95 Ga detrital zircons that derived from the orogenic belt within Gondwana. This difference indicates that the Simao block located outboard of the Indian margin of Gondwana before the opening of Paleo-Tethyan ocean. During the consumption of Paleo-Tethys, the I-type Xin'anzhai granitic intrusion emplaced at ca. 257 Ma. Geochemical compositions of the intrusion can be modeled by the partial melting of Proterozoic gneiss with an addition of 30–45% arc basaltic magma. Age histogram of detrital zircons from Upper Triassic sediments is featured by a peak of 254 Ma, similar to the emplacement age of the Xin'anzhai intrusion. This suggests an extensive magmatism occurred at ca. 255 Ma, which can be explained by the rollback of the Paleo-Tethyan slab. The subsequent granitoids emplaced in 247–237 Ma show different features of high-silica, peraluminous and a derivation from meta-sedimentary rocks, and were suggested to be produced in syn-collision setting. The Early Paleozoic strata in the eastern margin of Simao block generally show a NW–SE foliation and NE–SW striking stretching lineation, reflecting a NE–SW compression resulted from block amalgamation after the Paleo-Tethyan closure. In the angularly-unconformable overlying Upper Triassic strata, these structural traces are absent. It means that the area has evolved into post-collision extensional setting in Late Triassic.

1. Introduction

Most fragmental blocks in SE Asia have witnessed the Proto-Tethyan subduction along the Gondwana margin in Early Paleozoic. And then they disaggregated from the continent and drifted northwards due to the opening of Paleo-Tethys, and finally accreted together in Permo-Triassic as a result of the closures of different branches of Paleo-Tethyan ocean (Metcalfe, 2006; Deng et al., 2014a; Faure et al., 2014). Magmatic rocks with arc geochemical affinity in the blocks including West Qiangtang, Lhasa, Sibumasu and Indochina blocks were researched to construct the Proto-Tethyan evolution model (e.g., Mao et al., 2012; Lehmann et al., 2013; Wang et al., 2013a; Nie et al., 2015). And the Paleo-Tethyan closure processes have been extensively studied on the sutures like Changning–Menglian (e.g., Peng et al., 2008; Yang et al., 2014), Jinshajiang (e.g., Chung et al., 1997; Wang et al., 2000; Yang et al., 2012, 2014) and Ailaoshan (e.g., Chung et al., 1997; Sone and Metcalfe, 2008; Wang et al., 2014a; Xia et al., 2016) sutures according to the evolution of magmatic rocks.

The Simao block, bounded by the Paleo-Tethyan Ailaoshan suture to the east, is the northern part of Indochina block. The researches in the eastern margin of Simao block focused on the location of Paleo-Tethyan suture (Chung et al., 1997; Sone and Metcalfe, 2008; Wang et al., 2014a; Xia et al., 2016), Permo-Triassic magmatic processes (Peng et al., 2008; Jian et al., 2009a, 2009b; Fan et al., 2010; Liu et al., 2011; Lai et al., 2014a, 2014b; Liu et al., 2014, 2015; Wu et al., 2017), and Triassic crustal deformation (Lepvrier et al., 2008; Cai and Zhang, 2009; Faure et al., 2016).

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Despite these researches, the Proto-Tethyan evolution in this part is ambiguous. The precise location of the suture is in debate, which was suggested to be the Ailaoshan fault (Sone and Metcalfe, 2008), Jiujia–Anding fault (Wang et al., 2014a), or Amojiang–Lixianjiang fault (Chung et al., 1997) by different researchers (Fig. 1b). In addition, the magmatic petrogenesis and evolution associated with the Permo-Triassic Paleo-Tethyan orogenesis is not in consensus (e.g., Fan et al., 2010; Liu et al., 2015). For instance, the petrogenesis of Xin'anzhai pluton, the greatest pluton in the Ailaoshan suture, was thought to melt from Proterozoic basement (Liu et al., 2015); and contemporaneous pluton related to the Paleo-Tethyan closure was explained to have additional mantle input (e.g., Zi et al., 2012). Arc magmatic tempos were less controlled (e.g., Jian et al., 2009a, 2009b). The precise closure time of Paleo-Tethyan ocean was uncertain, which was proposed to be Late Permian (e.g., Li et al., 2013; Wang et al., 2014b), Early Triassic (e.g., Zi et al., 2012; Liu et al., 2015) and Late Triassic (e.g., Wang et al., 2000; Liu et al., 2011).

In this contribution, we carried out researches on the provenance of Early Silurian–Early Devonian and Late Triassic sedimentary units and the geochemistry of representative Xin'anzhai intrusion and its contrast with the Permo-Triassic igneous rocks in the eastern margin of Simao block (Fig. 1b). These new observations, integrated with previous studies, are used to (1) determine the precise location of Paleo-Tethyan Ailaoshan suture; (2) decipher the Early Paleozoic paleogeographic position of Simao block in Gondwana margin; (3) constrain the Permo-Triassic Paleo-Tethyan evolution. This study provides new information for completing Proto-Tethyan paleographic reconstruction and Paleo-Tethyan evolution model.

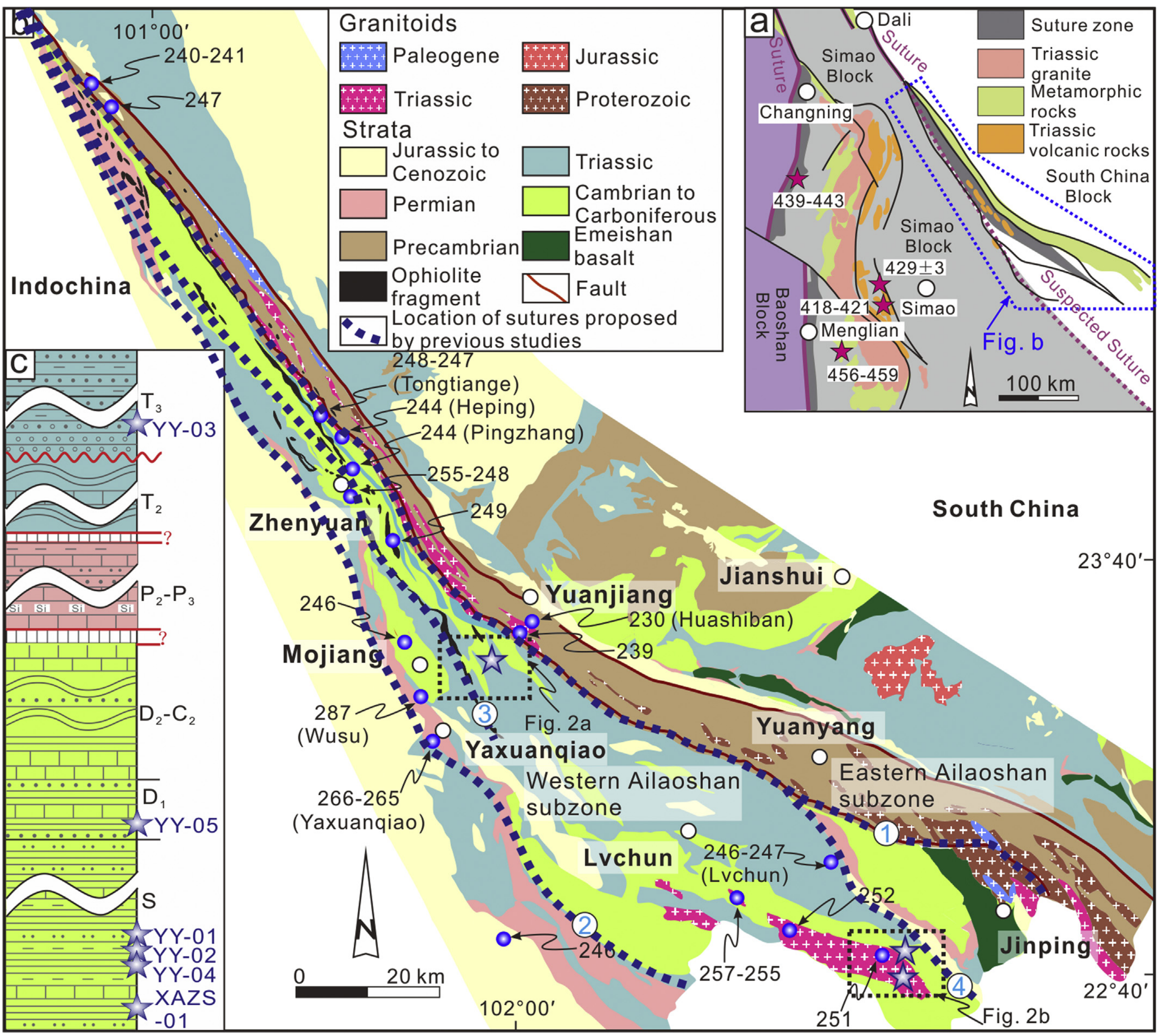

Fig. 1. (a) Distribution of the principal continental blocks and sutures of Southeast Asia (revised from Lehmann et al. (2013)), showing the locations of Early Paleozoic–Early Carboniferous magmatic rocks. These magmatic rocks are followed by Mao et al. (2012), Lehmann et al. (2013), Wang et al. (2013a) and Nie et al. (2015). (b) Geological map of the Ailaoshan tectonic zone showing the stratigraphic and igneous components (after YNGMR, 1990). Locations and ages of igneous rocks are followed by Jian et al. (2009b), Fan et al. (2010), Liu et al. (2011), Lin et al. (2012), Li et al. (2013), Liu et al. (2014), Lai et al. (2014a, 2014b), Liu et al. (2015) and Wu et al. (2017). The locations of the suture between Yangtze block and Simao block numbered 1, 2, 3 and 4 are from Sone and Metcalfe (2008), Chung et al. (1997), Wang et al. (2014a) and this study, respectively. (c) Simplified stratigraphic column in the eastern margin of Simao block (modified from YNGMR, 1990). Relative stratigraphic positions of the collected samples used in this study are indicated.