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Early Mesozoic granites in the Nanling Belt, South China: Implications for intracontinental tectonics associated with stress regime transformation

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ABSTRACT

The link between two tectono-magmatic events during Early and Late Mesozoic periods in the Nanling Belt of South China remains debated. Here we present zircon U–Pb geochronology, Hf isotopes and whole-rock geochemistry of granitic intrusions from Zhuguangshan in the Nanling Belt. The zircon data exhibit two magmatic episodes with $^{206}Pb/^{238}U$ ages of ca. 230 Ma and 150 Ma, representing the Indosinian (Early–Middle Triassic period) and Early Yanshanian (Jurassic–Cretaceous period) events, respectively. The Indosinian granites are characterized by strongly peraluminous nature with high A/CNK values (>1.1), whereas the Early Yanshanian granites are weakly peraluminous (average A/CNK value of 1.06). Although the Early Yanshanian granites bear higher HREE contents and lower LREE/HREE ratios, the two-phase granites show enrichment in LREE, Rb, Th, U and Pb, depletion in Eu and negative Ba, Sr, Nb and Ti anomalies. All samples show variably negative $\varepsilon_{Hf}(t)$ values (−5 to −16) with two-stage Hf model ages clustered around 1.8–2.1 Ga. Our data indicate that the two-phase granitic magmas were generated from the partial melting of early Paleoproterozoic basement rocks with no input of mantle material. Combined with other geological evidence, we infer that the Indosinian tectono-magmatic event was closely related to intracontinental orogeny triggered by collisions along the boundaries of South China Craton, in relation to processes associated with the E–W trending Tethys tectonic domain. We envisage that the Early Yanshanian event might be a response to the back-arc extension of NW-directed paleo-Pacific plate subduction. The Nanling Belt is a critical zone that records the transformation from Tethys to paleo-Pacific tectonic regimes.

1. Introduction

The Nanling Belt is a major E–W-trending orogenic belt in South China, and is surrounded by the western Pacific plate in the southeast and Jiangnan orogen in the northwest (Fig. 1a). Developed on the Precambrian–Early Paleozoic metamorphic basement of Cathaysia, this belt witnessed multi-stage intense tectono-thermal events during Phanerozoic (Shu et al., 2004, 2014, 2015; Xu et al., 2005; Charvet et al., 2010; Deng and Shu, 2012). In the Paleozoic, the Nanling Belt was controlled by paleo-Tethys tectonic regime, forming the nearly E–W trending Nanling fold belt and Silurian granites. Since the Mesozoic, with the amalgamation of South China and North China Cratons in north and Southeast Asia and South China Cratons in south, the Nanling Belt was reworked, generating several regional tight folds and thrust-nappe structures during the Indosinian period (Early–Middle Triassic)(e.g. Xu et al., 2005; Shu et al., 2006, 2008b, 2015; Faure et al., 2009, 2014). Since the Middle Jurassic, the Nanling Belt witnessed a new cycle of structural deformation, magmatism and basin development (Zhou and Li, 2000; Zhou et al., 2006; Shu et al., 2009), mainly related to the transformation of two tectonic regimes: (1) E–W trending Tethys-Paleoasian tectonic regime before Jurassic; and (2) NE–SW trending paleo-Pacific tectonic regime during the Jurassic–Cretaceous (e.g. Shu et al., 2004; Sun et al., 2005; Zhou et al., 2006). These tectonic events triggered various magmatic and thermal activities and resulted in the formation of large-scale granitoids or volcanic rocks in the Nanling Belt during the Indosinian (Early–Middle Triassic period) and the Early Yanshanian (middle Jurassic–Cretaceous period), respectively (Jiangxi BGMR, 1984; Hunan BGMR, 1988; Fujian BGMR, 1985; Guangxi BGMR, 1985; Guangdong BGMR, 1988).

The Zhuguangshan region records various geological imprints from the Tethys-Paleoasian to the paleo-Pacific tectonic regime, including rock assemblages and their spatio-temporal distribution (Zhou and Li, 2000; Chen et al., 2002; Deng et al., 2004; Shu et al., 2004; Sun et al., 2005; Deng and Shu, 2012). Recent studies have addressed the geochronology, kinematics and lithospheric dynamics of the Zhuguangshan complex and the Nanxiong basin using different methods. Deng and Shu (2012) gave a summary of the crystallization ages which show that the Jiufeng, Hongshan, Sanjiangkou, Changjiang and Chashan plutons are of Early Yanshanian age. The Ledong, Tangdong, Baiyun, Jiangnan Baishun and Longhuashan plutons have been dated as Indosinian. Furthermore, combined with the geometrical and kinematic features, some workers confirmed that granitic doming, extensional tectonics and normal

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faulting are the major factors for constraining the basin-mountain evolution in the Nanling region (Shu et al., 2004, 2009; Deng and Shu, 2012). However, detailed zircon geochronology and comparisons, Lu–Hf isotopes and geochemistry of the Indosinian and Early Yanshanian plutons in Zhuguangshan have not yet been attempted.

In this study, we present results from zircon U–Pb geochronology, whole-rock geochemistry and zircon Lu–Hf isotopes for the Zhuguangshan granites with a view to gain better insights into the tectonic evolution of the Nanling Belt from Indosinian to Early Yanshanian period.

2. Geological background

The Zhuguangshan granitic complex, located in the junction of Guangdong, Jiangxi and Hunan provinces, witnessed magmatic doming and extensional tectonics with the Nanxiong basin along its southeastern domain (Fig. 1a, b). The complex shows a double-layer deformed structure, with hot-doming and extensional tectonics represented by a brittle deformed zone and a green-schist facies metamorphic zone, which are mainly distributed in the pre-Devonian basement, with a coeval basin-mountain tectonic system (Shu et al., 2004, 2009). The Nanxiong detachment fault is located between the Zhuguangshan complex and the Phanerozoic strata, leading to the formation of mylonitized gneissic zone and ductile deformation fabrics surrounding the Zhuguangshan complex (Shu et al., 2004, 2015). The Fuxi ductile strike-slip shear zone, and Baishun and Lanhe ductile normal faults are developed well in this region (Fig. 1c).

In the study area, almost all the overlying strata show NEE-trend (Fig. 1b). The Zhuguangshan complex intrudes into the metamorphic Pre-Devonian folded basement. The basement mainly contains gneisses, micaschists, phyllites and siliceous rocks which were dated as the stage from Neoproterozoic to Sinian (Shu et al., 2008a). The Cambrian strata consist of gray-green colored sandstone, silty slate and carbonaceous mudstone, whereas the Ordovician strata comprise mud-sandy flysch and siliceous rock in which graptolite and gastropoda (Sinoceras) were well preserved. The Silurian strata are absent in this region (Shu et al., 2008a, 2014). The middle Devonian–Carboniferous strata which overlie the Early Paleozoic strata consist of shallow-sea facies to littoral facies rocks and carbonates (limestone and dolomite) (Shu et al., 2008b, 2014, 2015). The Permian strata are generally absent in this area. The Jurassic strata are mainly composed of gray-colored conglomerate, sandstone, carbonaceous mudstone intercalated with basalt and rhyolite dated at 180–160 Ma (Deng et al., 2004; Shu et al., 2004, 2009), which show unconformable contact with the older strata. The Cretaceous strata mainly contain red-colored conglomerate, sandstone, mudstone, rhyolite intercalated with green-colored andesite and basalt. Gray-purple or dark-red coarse-grained clastic rocks, gypsum and oil shale were deposited during the late Cretaceous–Paleogene. In the southeastern part of Zhuguangshan, the Nanxiong basin is mainly composed of Cretaceous–Paleogene coarse detrital strata. Evidently, the deposits of Nanxiong basin are in direct contact with the granitic pluton along the Nanxiong normal fault (Fig. 1c).

Three major episodes of granitic magma emplacement have been traced in the Zhuguangshan complex: the Early Paleozoic, Indosinian and Early Yanshanian. The Indosinian and Yanshanian granites occupy a larger area than that of the Early Paleozoic granites. The Indosinian granites in the western Zhuguangshan distribute in N–S trend whereas the Early Yanshanian granites in the eastern Zhuguangshan extend

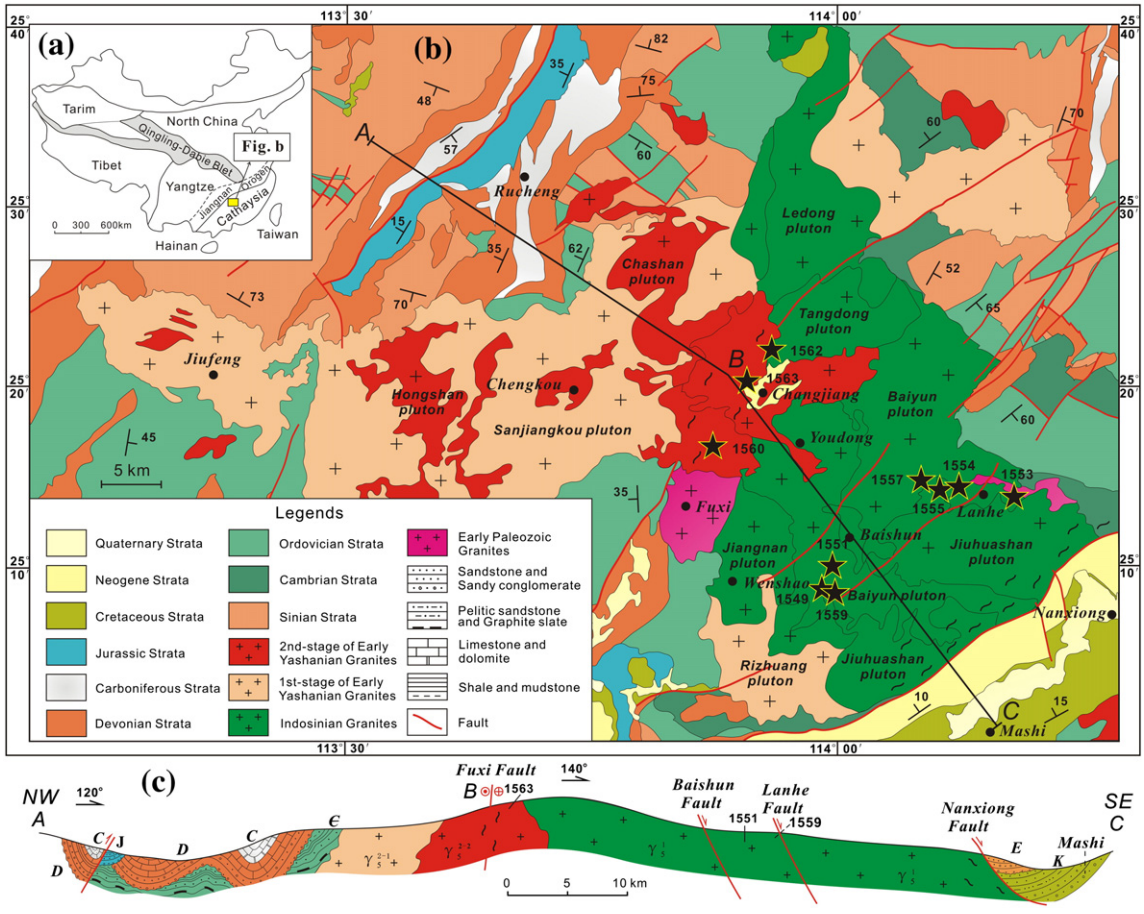

Fig. 1. (a) Tectonic outline of China. (b) Simplified geological map of the Zhuguangshan complex. (c) Cross section showing and the occurrence of the granites and their relation with country rocks.