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Origin of the Late Jurassic to Early Cretaceous peraluminous granitoids in the northeastern Hunan province (middle Yangtze region), South China: Geodynamic implications for the Paleo-Pacific subduction

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ABSTRACT

The Late Mesozoic granitic belt in the northeastern Hunan province (situated in the south of the middle Yangtze region) represents the western front of the large magmatic province of SE China. In order to determine their ages and petrogenesis, we carried out zircon U–Pb dating, Hf isotope and whole-rock geochemical analyses for four granitic plutons, namely Taohuashan, Dayunshan-Mufushan, Wangxiang and Lianyunshan. Our SIMS zircon U–Pb ages, together with previously published data, reveal that the magmatic activities in this area can be roughly subdivided into three phases at 151–146 Ma, 132–127 Ma and ca. 117 Ma, and the Dayunshan-Mufushan batholith therein is a composite pluton. These four plutons are mainly composed of weakly to strongly peraluminous biotite or two-mica monzogranites, with a minor amount of biotite granodiorites. Their geochemical features are similar to S-type as well as fractionated S-type granites, with enrichment in LREEs and negative Ba, Sr, Nb, P and Ti anomalies. All samples show negative zircon εHf(t) values ranging from −12.5 to −3.6, corresponding to crustal Hf model (T^{C}_{DM}) ages of 1.4–2.0 Ga. It is inferred that these granitoids were derived from partial melting of metasedimentary rocks analogous to the Neoproterozoic Lengjiaxi Group, predominantly with psammitic component. Fractional crystallization probably played an important role in the magma evolution, while input of mantle-derived magma was insignificant. Combined with other geological evidence, our new data allow us to propose that the Cretaceous (132–127 Ma and ca. 117 Ma) magmatism might be response to episodic slab rollback of the Paleo-Pacific plate, while the early-stage (151–146 Ma) magmatism that overlapped the epilogue of Jurassic magmatic flare-up and subsequent magmatic quiescence probably foreshadowed the transformation from foundering of a subducted flat-slab to slab rollback. Alternatively, slab foundering after a SE-directed intracontinental subduction in the central SCB cannot be ruled out for geodynamic interpretation of the Jurassic magmatism in SE China.

1. Introduction

Southeast China is an important part of the circum-Pacific magmatic and metallogenic belt (e.g., Zhou and Li, 2000; Zhou et al., 2006). Jurassic-Cretaceous (referred to as the "Yanshanian" period in Chinese literature) intrusive and volcanic rocks occupy a vast area of SE China (mostly in Anhui, Zhejiang, Jiangxi, Fujian and Guangdong provinces), forming a ca. 600 km wide magmatic belt parallel to the present coastline (Fig. 1). Despite intensive research in the past decades, origin and evolution of this large magmatic province are still hotly debated. For instance, its temporal-spatial configuration and geodynamic setting have not been well understood yet. The Jurassic (ca. 195–150 Ma) igneous rocks are widespread in the hinterland (e.g., the Nanling Range), while the Cretaceous (ca. 140–90 Ma) intrusive rocks coeval with voluminous volcanic rocks are mainly distributed in the coastal area and the middle-lower reaches of the Yangtze River. An oceanward younging trend for the Late Mesozoic magmatism resulted from northwestward subduction of the Paleo-Pacific plate with an increasing subduction angle had been proposed (Zhou and Li, 2000). Instead, Wang et al. (2011) recently suggested that the 180–125 Ma igneous rocks experienced a northeastward migration due to southwestward Paleo-Pacific subduction and corresponding slab rollback. Furthermore, it is noteworthy that more Jurassic granites have been identified in the coastal area in recent years (Q. Liu et al., 2012; Cui et al., 2013; Huang et al., 2013; Zhang

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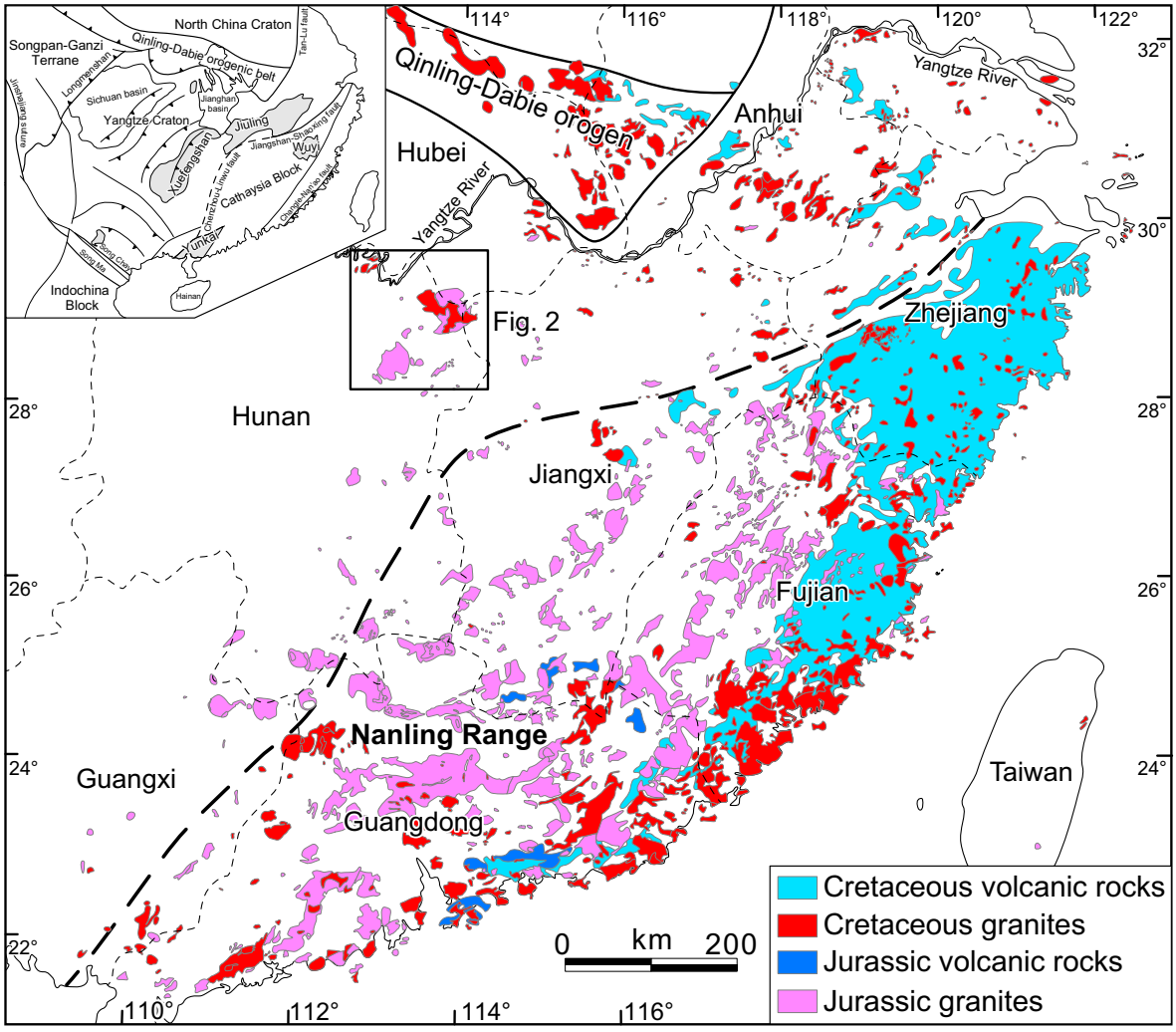

Fig. 1. Schematic map showing distribution of the Jurassic-Cretaceous magmatic rocks in SE China (modified after Zhou et al., 2006) and location of the study area. The dashed line indicates the Jiangshan-Shaoxing fault at the northeastern segment (representing the reworked Neoproterozoic suture zone) and the Chenzhou-Linwu fault at the southwestern segment (probably as a scar of the Triassic intracontinental orogeny). Inset shows the tectonic sketch of the SCB, with the Jiuling-Xuefengshan belt in the central part.

et al., 2015). Thus temporal-spatial distribution of the Jurassic-Cretaceous magmatic rocks deserves a reappraisal. Geodynamic trigger of the Mesozoic tectono-magmatism in eastern China has been generally ascribed to the subduction of the Paleo-Pacific plate beneath the Eurasian continent. However, the subduction pattern is still an open question, diverse models have been proposed for SE China, such as shallow subduction and subsequent slab rollback (Zhou and Li, 2000; Jiang et al., 2009, 2011), break-up and foundering of a subducted flat-slab (Li and Li, 2007; X.H. Li et al., 2007, 2013a; Z.X. Li et al., 2012), ridge subduction (Ling et al., 2009; Sun et al., 2010; H. Li et al., 2012) and repeated slab advance-retreat (Jiang et al., 2015; Wang et al., 2016). Particularly, the Paleo-Pacific subduction beneath SE China was supposed to initiate during the Permian (Li and Li, 2007), Late Triassic (Jiang et al., 2015), Early Jurassic (Zhou et al., 2006) or Early Cretaceous (Chen et al., 2008). Other outdated or minority models include Alpine-type continental collision (Hsü et al., 1990), wrench faulting (Xu, 1993), strike-slip faulting plus concomitant rifting (Gilder et al., 1996), and lithospheric extension maybe unrelated to the Paleo-Pacific subduction (Li, 2000).

More importantly, numerous polymetallic deposits in SE China have been inferred to be closely related to the Mesozoic granitoids (Wang et al., 2011; Mao et al., 2013 and references therein). In addition to the geodynamic setting, controversial issues on the granitoids themselves involve their petrogenetic types (such as I-type, S-type or A-type granites, as well as fractionated granites) and the nature of source rocks, especially the degree of mantle contribution to the magma generation (e.g., Li et al., 2007; Wong et al., 2009; Jiang et al., 2009, 2011; Huang et al., 2013, 2015; Huang and Jiang, 2014; Zhang et al., 2015; Wang et al., 2016). Several Late Mesozoic granitic plutons crop out in the northeastern part of Hunan province, situated in the south of the middle Yangtze region (middle reach of the Yangtze River; Figs. 1 and 2). These granitic plutons represent the western front of the large magmatic province of SE China. However, due to the lack of detailed investigations, the geochronology and petrogenesis of these granitic rocks remain in dispute (Wang and Deng, 2004; Li et al., 2005; L.X. Wang et al., 2008, 2014; Xu et al., 2009). In this paper, we present zircon U–Pb ages and Hf isotopic data, major and trace element geochemical data for four granitic plutons (namely Taohuashan, Dayunshan-Mufushan, Wangxiang and Lianyunshan) in this area. This provides us an opportunity to decipher their origin and tectonic implications for the Late Mesozoic tectono-magmatic history of SE China.