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Late Cretaceous lithospheric extension in SE China: Constraints from volcanic rocks in Hainan Island

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ABSTRACT

Petrological, geochemical and in-situ zircon U–Pb dating and Hf-isotope analyses have been carried out on a suite of basalt–andesite–rhyolite volcanic rocks exposed in the Liuluocun area, Hainan Island, SE China. Zircon analyses show that these volcanic rocks crystallized in the Early Cretaceous (ca. 102 Ma). The basalts are characterized by low MgO contents and mg-numbers but high rare earth element, high field strength element and large ion lithophile element contents and Nb–Ta negative anomalies. They have relatively uniform Sr–Nd isotope compositions with $\varepsilon_{Nd}(t)$ values of −4.09 to −3.63. The andesites show enrichment of high field strength element and rare earth element with negligible Eu anomalies. They have $\varepsilon_{Nd}(t)$ values of −2.35 to −3.88 and $\varepsilon_{Hf}(t)$ values of −9.73 to −1.13. The rhyolites have high K_2O and SiO_2 contents. They are characterized by prominent Eu, P and Ti negative anomalies and enrichment in large ion lithophile element, and show $\varepsilon_{Hf}(t)$ values of −7.51 to +0.47 and $\varepsilon_{Nd}(t)$ values of −2.49 to −2.69. Petrogenetic analysis indicates that the Liuluocun volcanic rocks were produced by incomplete reaction of the mantle wedge peridotite with felsic melts derived from partial melting of subducted sediment. All these characteristics, combined with geological observations, suggest that their formation was related to regional lithospheric extension in the South China Craton during the Early Cretaceous, which may have been caused by subduction of the Paleo-Pacific plate beneath the continental plate of China.

1. Introduction

Late Mesozoic igneous rocks are widely distributed in eastern South China, on the western Pacific margin, and provide a good opportunity to understand the tectonic evolution of the South China Block. These igneous rocks consist of voluminous granites and rhyolites associated with small volumes of mafic and intermediate rocks, which show an oceanward younging trend and were emplaced during three episodes, of which two occurred in the inland area with ages of 180–160 Ma and 160–140 Ma, and one on the eastern coastal area with Cretaceous-ages (140–90 Ma) (Zhou et al., 2006) (Fig. 1b). Different models have been proposed to explain their petrogenesis. A subduction model suggests that late Mesozoic magmatism in eastern South China resulted from subduction of the Paleo-Pacific plate beneath the Eurasian plate (e.g., Jiang and Li, 2014; Jiang et al., 2005; Li and Li, 2007; Y.H.M. Li et al., 2014; Z. Li et al., 2014; Martin et al., 1994; Tang et al., 2014; Xia and Zhao, 2014). A mantle plume model argues that a granite-type (G-type) large igneous province (LIP), characterized by the development of numerous granitoid bodies, resulted from partial melting at the bottom of the crust and probably induced by a Mesozoic super mantle plume (Zhang, 2013; Zhang et al., 2009). Recently, a model for tectono-magmatism in Eastern China during the Yanshanian tectonic event (200–135 Ma) was discussed by Wan and Zhao (2012). In this model, magmatic activity was controlled by regional faults and spheres (such as Moho) causing a partial decrease in pressure and increase in temperature, during which a tectonic detachment and Late Mesozoic igneous rocks were formed.

Although the Late Mesozoic mafic and felsic igneous rocks in eastern South China have been extensively studied (e.g., Qiu et al., 2014; Zheng et al., 2013a; Zhou and Li, 2000), intermediate assemblages recording crucial information on crust–mantle interaction (Griffin et al., 2002; Kemp et al., 2007; Rahman, 2014) are lacking. This paper presents data for a newly discovered suite of basalt–andesite–rhyolite volcanic rocks emplaced during the late Mesozoic in Liuluocun area, Hainan Island, SE China. Field investigations, petrography, geochemical studies, zircon U–Pb–Hf, and whole-rock Nd–Sr isotope analysis were carried

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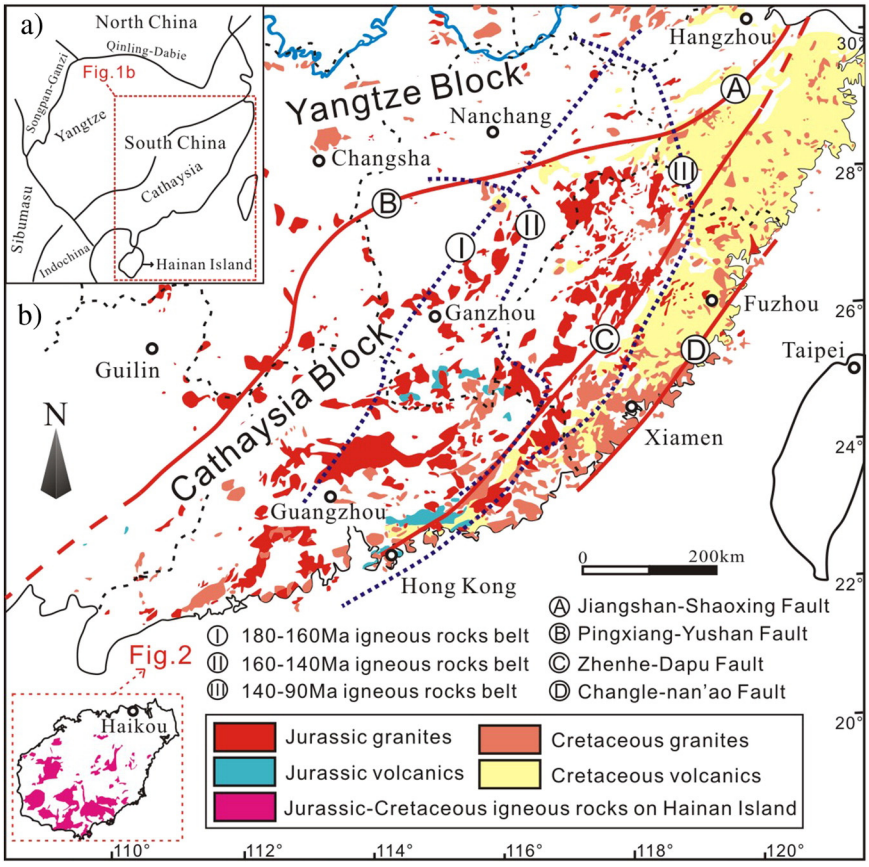

Fig. 1. (a) Simplified geological map of Southeast Asia showing the distribution of principal continental blocks; (b) Distribution of Jurassic–Cretaceous granites and volcanic rocks in southeastern China.
(a) Modified after Metcalfe (1996). (b) Modified after Z. Li et al. (2014), Zhou et al. (2006).

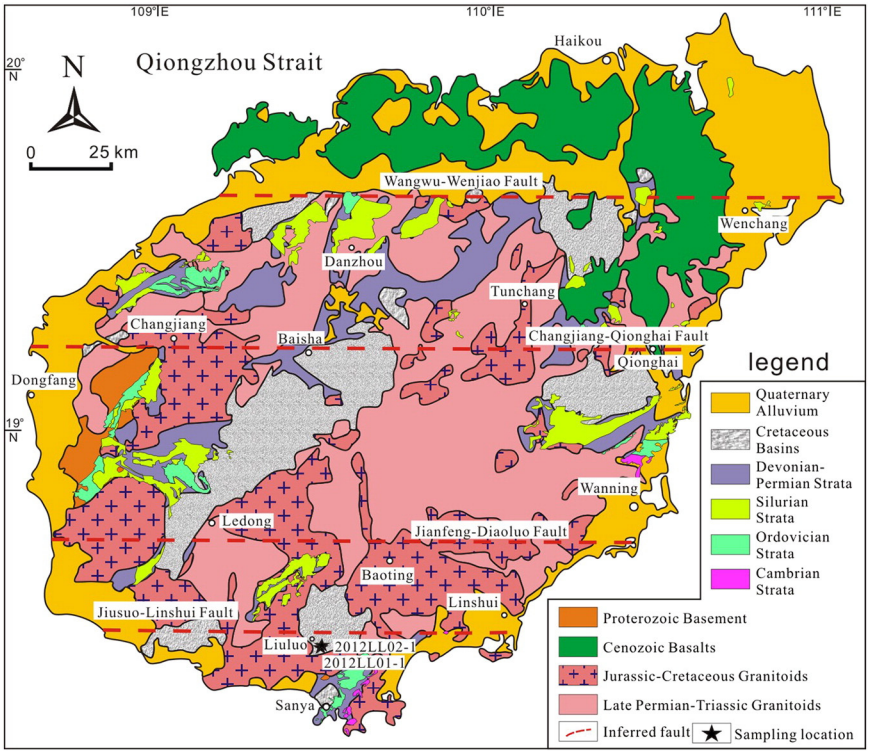

Fig. 2. Geological sketch map of Hainan Island.
Modified after Wang et al. (2012).