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Generation of Late Cretaceous silicic rocks in SE China: Age, major element and numerical simulation constraints

Cheng-Hong Chen [a,*], Chi-Yu Lee [a], Hsueh-Yu Lu [b], Pei-Shan Hsieh [a]

[a] Department of Geosciences, National Taiwan University, No.1, Roosevelt Road Section 4, Taipei 106, Taiwan
[b] Department of Earth and Environmental Sciences, National Chung Cheng University, Chiayi, Taiwan

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Abstract

Rhyolite-dominating bimodal volcanic suites (rhyolite/basalt), mafic dikes and A-type granites distribute from N Zhejiang to S Fujian over 800 km in the Southeast Coast Magmatic Belt (SCMB) – the Late Yanshanian (LY) orogenic belt in SE China. Data of $^{40}Ar/^{39}Ar$ and K–Ar whole-rock ages and LA-ICPMS U–Pb zircon ages indicate that rhyolitic volcanism (101–72 Ma) is contemporaneous with the A-type granitic intrusions (100–90 Ma) and mafic dike injections (94–77 Ma). This time span is used to define the upper volcanic series in Zhejiang–Fujian areas. One striking feature of rhyolites in the SCMB is that many are strongly peraluminous (SP) and others, mostly restrict in Fujian, are peralkaline to mildly peraluminous (P-MP) and chemically resemble A-type granites. The SP character is unique among well-known large rhyolite provinces worldwide. Based on experimental works for a common thermal regime and inherited zircon age information, we suggest that SP and P-MP rhyolites represent low pressure melting of the felsic (quartzofeldspathic) granite (±metapelite) and the accompanied granodioritic, tonalitic and trondhjemitic member of the core complex assemblage, respectively, to account for the decreasing aluminosity. They could have also been contaminated by young igneous rocks, and ancient crust to a lesser degree, during ascent to the surface. Plate subduction and lithosphere extension processes, respectively, are numerically simulated for the magma generation of these rhyolites using the mafic underplating model. Results suggest that the most effective controlling factor to generate SP and associated P-MP (A-type) magmas during 95–80 Ma is thinning of the lithosphere thickness with a high exhumation rate. Under this circumstance, the core complex assemblage can be uplifted to lower level of the crust and match the constraint of experimental works.

Keywords: Strongly peraluminous (SP) rhyolites; A-type granites; Mafic underplating; Late Yanshanian orogeny; SE China

1. Introduction

The study of orogenesis is one of the major focuses among geologists because it is fundamentally important to the understanding of continental growth throughout geological time. Extensive orogenic movements commonly lead to vigorous magmatic activities in the lower to upper crust levels. Vast intermediate to acidic plutonic and silicic volcanic rocks, distributed over an area of ca. 204,000 km^2 in S China and known as products of the Yanshanian magmatism (Zhou et al., 2006), provide important records for the Mesozoic crustal evolution of the Cathaysia Block. Plutonism and volcanism occurred during middle to late Jurassic times are related to the Early Yanshanian (EY) orogeny and relevant rocks are mainly distributed in the interior of this Block; those occurred during early Cretaceous are related to the Late Yanshanian (LY) orogeny and more restricted in SE China coastal areas (Chen and Jahn, 1998). The LY magmatism is well accepted as had been affected by the paleo-Pacific subduction system in the continental margin (e.g., Zhou and Li, 2000) and the product is best exemplified by igneous rocks in the Southeast Coast Magmatic Belt (SCMB) and the accompanied core complex in the Changle-Nanao Metamorphic Belt (CNMB) (Fig. 1).

* Corresponding author. Tel.: +886 2 3366 5872; fax: +886 2 2363 6095.
E-mail address: chench@ntu.edu.tw (C.-H. Chen).

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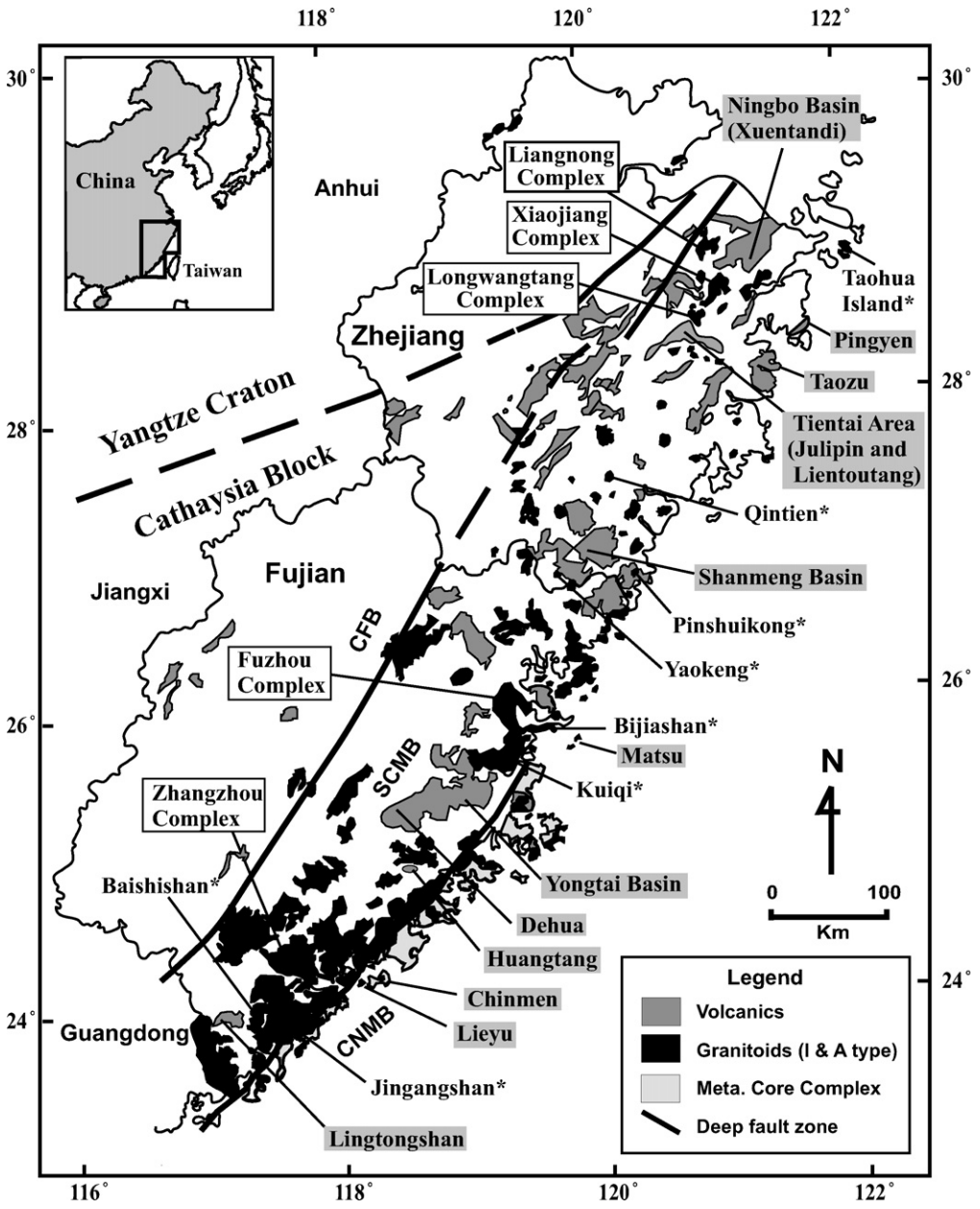

Fig. 1. Distribution of Cretaceous igneous rocks in the Zhejiang–Fujian area, SE China (modified from BGMRZJ, 1989 and BGMRFJ, 1985). CNMB: Changle-Nanao Metamorphic Belt; SCMB: Southeast Coast Magmatic Belt; CFB: Cathaysia Folded Belt (equivalent of the Cathaysia interior in the text). Locations for the 110–99 Ma I-type granitoids (Chen and Jahn, 1998) are framed, for the 100–90 Ma A-type granites (Chen et al., 2000; Qiu et al., 2004) are marked with an asterisk, and the studied rhyolite-dominating bimodal volcanics and mafic dikes are shaded. Mafic dikes mostly injected into the granitic rocks in Fuzhou, Matsu, Zhangzhou and Chinmen (including Lieyu).

The core complex in the CNMB consists of a series of gneissic-foliated, high aluminous rocks including gabbro, trondhjemite, tonalite and granodiorite and is associated with schistosed felsic granites and metapelites. These rocks have been suggested to be emplaced during 140–110 Ma, or 130–110 Ma if only the trondhjemite–tonalite–granodiorite assembalge is concerned (Chen et al., 2004, 2006 and references therein). In the SCMB, plutonic rocks are high-K calc-alkaline I-type granitoids, mainly including granodiorite, monzogranite and syenogranite, formed between 110 and 99 Ma (Chen and Jahn, 1998; Chen et al., 2000). Less voluminous and sporadically distributed A-type granites emplaced at 101–90 Ma (Martin et al., 1994; Chen et al., 2000; Qiu et al., 2004). The change from calc-alkaline I-type to more alkaline A-type shallow plutonism through time indicates that magmas were developed under the progressive extensional environment (Li, 2000).

LY volcanic rocks in the eastern Zhejiang and Fujian, i.e., north and south SCMB, are traditionally divided into the lower and upper series, mainly with high-K dacites and rhyolites (and minor andesites and basalts) in the former and rhyolite-dominating/basalt bimodal suites in the latter