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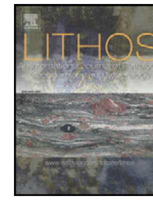

Zircon U–Pb ages, Hf–O isotopes and whole-rock Sr–Nd–Pb isotopic geochemistry of granitoids in the Jinshajiang suture zone, SW China: Constraints on petrogenesis and tectonic evolution of the Paleo-Tethys Ocean

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ABSTRACT

The Jinshajiang suture zone, located in the eastern part of the Tethyan tectonic domain, is noticeable for a large-scale distribution of Late Jurassic to Triassic granitoids. These granitoids were genetically related to the evolution of the Paleo-Tethys Ocean. Beiwu, Linong and Lunong granitoids occur in the middle zone of the Jinshajiang Suture Zone, and possess similar geochemical features, indicating that they share a common magma source. SIMS zircon U–Pb dating reveals that the Beiwu, Linong and Lunong granitic intrusions were emplaced at 233.9 ± 1.4 Ma (2σ), 233.1 ± 1.4 Ma (2σ) and 231.0 ± 1.6 Ma (2σ), respectively. All of these granitoids are enriched in abundances of Si (SiO_{2t} = 65.2–73.5 wt.%), and large-ion lithophile elements (LILEs), but depleted in high field strength elements contents (HFSEs, e.g., Nb, Ta, and Ti). In addition, they have low P_2O_5 contents (0.06–0.11 wt.%), A/CNK values ([molecular Al_2O_3/(CaO + Na_2O + K_2O)], mostly < 1.1) and 10,000 Ga/Al ratios (1.7–2.2), consistent with the characteristics of I-type granites. In terms of isotopic compositions, these granitoids have high initial $^{87}Sr/^{86}Sr$ ratios (0.7078–0.7148), Pb isotopic compositions [$(^{206}Pb/^{204}Pb)_t$ = 18.213–18.598, $(^{207}Pb/^{204}Pb)_t$ = 15.637–15.730 and $(^{208}Pb/^{204}Pb)_t$ = 38.323–38.791], zircon $\delta^{18}O$ values (7.3‰–9.3‰) and negative $\varepsilon_{Nd}(t)$ values (−5.1 to −6.7), suggesting they were predominantly derived from the continental crust. Their Nb/Ta ratios (average value = 8.6) are consistent with those of the lower continental crust (LCC). However, variable $\varepsilon_{Hf}(t)$ values (−8.6 to +2.8) and the occurrences of mafic microgranular enclaves (MMEs) suggest that mantle-derived melts and lower crustal magmas were involved in the generation of these granitoids. Moreover, the high Pb isotopic ratios and elevated zircon $\delta^{18}O$ values of these rocks indicate a significant contribution of the upper crustal composition. We propose a model in which the Beiwu, Linong and Lunong granitoids were generated under a late collisional or post-collisional setting. It is possible that this collision was completed before Late Triassic. Decompression induced mantle-derived magmas to be underplated and provided the heat for the anatexis of the crust. Hybrid melts including mantle-derived and the lower crustal magmas were then generated. The hybrid melts thereafter ascended to a shallow depth and resulted in some degree of sedimentary rock assimilation. Such three-component mixing magma source and subsequent fractional crystallization could be responsible for the formation of the Beiwu, Linong and Lunong granitoids.

1. Introduction

As widely accepted (Wu, et al., 2007; Wyllie, 1977; Zhang et al., 2008b), most granites are of crustal origin. The majority of I- and S-type granites in the continental crust are considered to be derived from preexisting infracrustal igneous rocks and supracrustal sedimentary rocks (Li et al., 2009a; White and Chappell, 1977). However, recent studies indicate mantle-derived magma input might be inevitable for most granites, and mantle-derived magmas were even involved in the generation of some strongly peraluminous S-type granites and rhyolites (Clemens, 2003; Kemp et al., 2007; Li et al., 2009a; Sylvester, 1998). Apparently, it is significant to identify these components associated with mixing of magmas. In general, geochemical and Sr–Nd–Pb isotopic data were proposed for identifying mantle-derived and crustal compositions, however, it is usually difficult to provide satisfactory evidence due to their uncertain interpretations (Chappell et al., 1987; Chappell and White, 1992; Kemp, et al., 2007; Li et al., 2009a). Oxygen isotopes of zircon can provide an effective constraint on the involvement of mantle-, upper crust- and lower crust-derived magmas in the genesis of granites (Kemp, et al., 2007; Lackey et al., 2005; Valley et al., 2005; Zheng et al., 2007). Zircon has high oxygen isotope closure temperature, which is

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not to be reset even if the mineral underwent granulite-facie metamorphism (King et al., 1998; Valley et al., 1994). Thus, oxygen isotopes of zircon preserve the features of magma sources. Mantle-derived magmas ($\delta^{18}O$ value = 5.3‰ ± 0.3‰; King et al., 1998; Valley et al., 1998), the lower crustal granulite-facies igneous rocks ($\delta^{18}O$ value = 7‰; Pamela et al., 1992), and the supracrustal magmas ($\delta^{18}O$ value = 10‰–30‰; Valley et al., 2005) have distinct O isotopes. Zircon Hf isotopes provide another approach to trace the origin of granites. Because zircons have high Hf concentrations (generally about 10,000 ppm or 1%), low Lu/Hf ratios (~<0.01) and resistance to isotopic disturbance (Goodge and Vervoort, 2006), they can preserve details of isotopic variations during the mixing of the different magmas (Griffin et al., 2002; Li et al., 2009a). Therefore, combined with geochemical and Sr–Nd–Pb isotopic data, zircon Hf–O isotopes can provide important constraints on the origin of granites.

The Sanjiang Domain (SD) in southwestern China is located in the eastern part of the Tethyan–Himalayan tectonic belt, and also in the tectonic junction between Gondwanaland and Eurasia (Hou et al., 2003; Li et al., 1999; Li and Jiang, 2003; Lü et al., 1993; Mo et al., 1993). Several of the Paleozoic sutures in the region provide a record of the history of the Paleo-Tethys Ocean, which consists of four paleo-oceanic basins: the Garze–Litang, Jinshajiang, Lancangjiang and

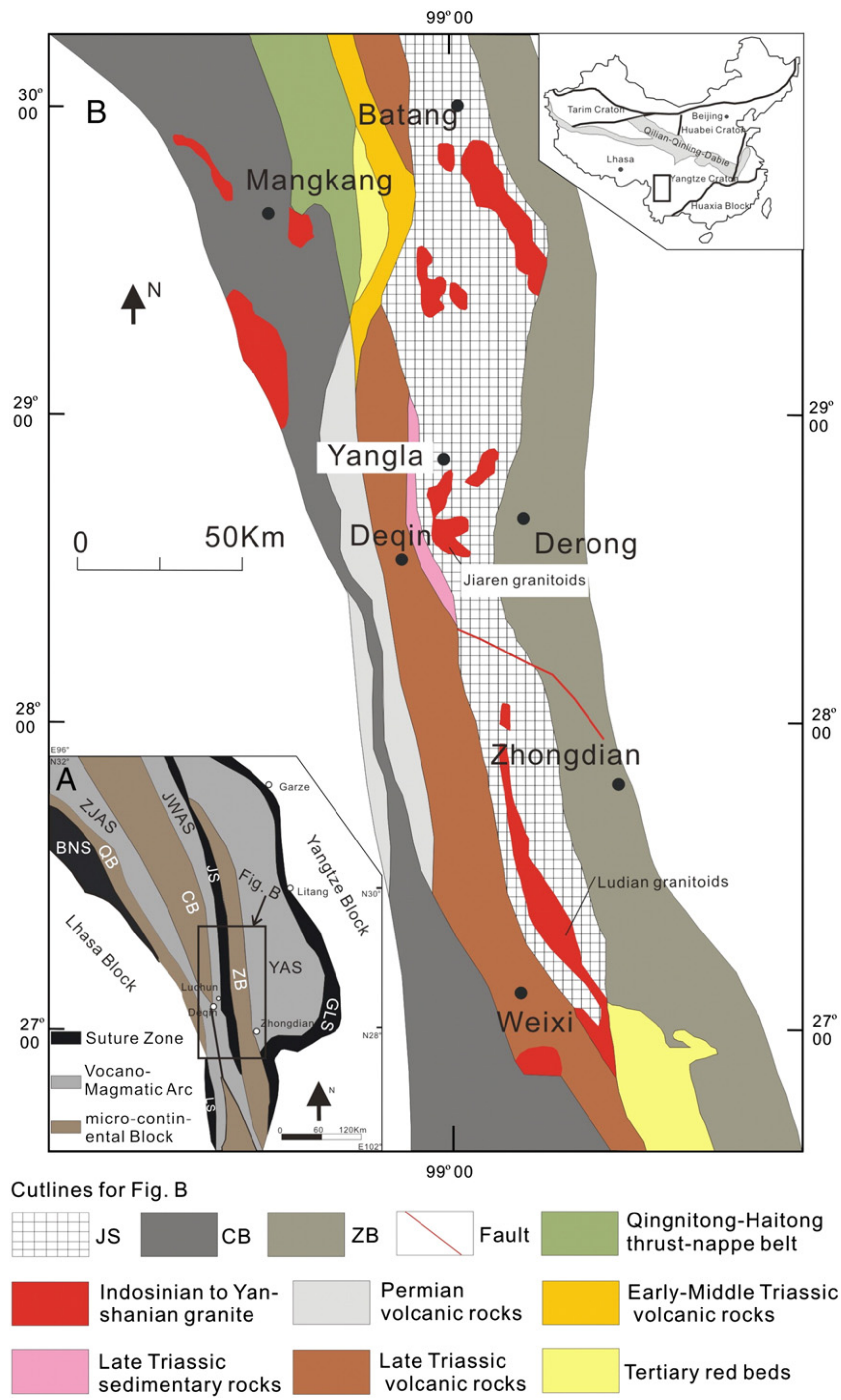

Fig. 1. Sketch showing tectonic framework (A) and the distribution of magmatic rocks (B) in the Jinshajiang suture zone and adjacent areas (modified after Hou et al. (2003)). Abbreviations: GLS = Garze–Litang Suture Zone; JS = Jinshajiang Suture Zone; LS = Lancangjiang Suture Zone; BNS = Bangonghu–Nujiang Suture Zone; YAS = Yidun Arc; JWAS = Jomda–Weixi Arc; ZJAS = Zaduo–Jinghong Arc; ZB = Zhongza micro-continental Block; CB = Changdu–Simao micro-continental Block; QB = Qiangtang micro-continental Block.