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Origin of Late Triassic high-K calc-alkaline granitoids and their potassic microgranular enclaves from the western Tibet Plateau, northwest China: Implications for Paleo-Tethys evolution

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A B S T R A C T

The western Tibet Plateau comprises a series of crustal terranes that were successively accreted to the southern margin of Eurasia associated with the evolution of Paleo- and Neo-Tethys. This paper presents the first detailed SHRIMP zircon U–Pb chronology, major and trace element, and Sr–Nd–Hf isotope geochemistry of three Mesozoic plutons (South Kudi, Arkarz and Mazha) and their microgranular enclaves in the western Kunlun and Tianshuihai terranes. SHRIMP zircon U–Pb dating shows that the three plutons were emplaced in the Late Triassic (215–209 Ma) and show a southward-younging trend. The South Kudi pluton (215 Ma) is composed of high-K calc-alkaline granodiorite and monzogranite, with initial $^{87}Sr/^{86}Sr$ ratios of 0.7093–0.7099, ε_{Nd} (T) of −4.9 to −5.4, and ε_{Hf} (T) (in-situ zircon) of 0.3. Elemental and isotopic data suggest that the granitoids were generated by partial melting of the Precambrian metasedimentary–igneous basement in the normal lower-crust (<40 km) of the western Kunlun terrane triggered by underplating of basaltic magma. The Arkarz pluton (213 Ma) consists of high-K calc-alkaline monzogranite, syenogranite and alkali-feldspar granite and contains abundant microgranular enclaves. The host granites have initial $^{87}Sr/^{86}Sr$ ratios of 0.7071–0.7085, ε_{Nd} (T) of –3.7 to −4.8, and ε_{Hf} (T) of −0.7, and were also generated by partial melting of the Precambrian metasedimentary–igneous basement in the normal lower-crust (<40 km) of the western Kunlun terrane triggered by underplating of enclave-forming potassic magma. Fractional crystallization of these pure crustal melts may explain the more felsic end-member granite. The enclaves are mainly basic (SiO_2 48.0–54.9 wt.%) with high K_2O (1.4–3.8 wt.%). They have initial $^{87}Sr/^{86}Sr$ ratios of 0.7071–0.7080 and ε_{Nd} (T) of −2.6 to −4.5. We interpret the enclave magmas as having been derived by partial melting of the metasomatized mantle wedge in the spinel–garnet transition zone (~60–80 km). The Mazha pluton (209 Ma) is composed of high-K calc-alkaline tonalite and granodiorite, with initial $^{87}Sr/^{86}Sr$ ratios of 0.7087–0.7097, ε_{Nd} (T) of −6.3 to −6.5, and ε_{Hf} (T) of −2.8. Elemental and isotopic data suggest that the granitoids were generated by mixing of mantle-derived basaltic magma with felsic melt derived by partial melting of lower crust of the Tianshuihai terrane. Our new data suggest that during the Late Triassic (215–209 Ma) the Tianshuihai terrane and the southern part of the western Kunlun terrane were a continental arc in response to the northward subduction of the Paleo-Tethys between the Tianshuihai and Karakorum terranes; the collision of the Karakorum terrane with the Tianshuihai terrane is not earlier than the age of 209 Ma, and most likely occurred during the Early Jurassic.

1. Introduction

The Tibetan plateau, the largest uplifted structure on Earth, is considered to be formed in response to the India–Asia collision since the Paleozoic (e.g. Zhu et al., 2013). It comprises a series of crustal terranes that were successively accreted to the southern margin of Eurasia (e.g. Zhang and Santosh, 2012). In the western Tibet Plateau, these terranes from north to south are the western Kunlun, Tianshuihai, Karakorum, and Kohistan terranes (Fig. 1a). It is now generally accepted that such terrane accretions were associated with the evolution of Paleo- and Neo-Tethys (e.g. Pan, 1996). However, the exact timing of the collision between each terrane still remains controversial and uncertain. For example, there are at least three opinions about the time of the collision between the western Kunlun and Tianshuihai terranes, i.e. Late Permian (e.g. Pan, 1996), Late Triassic (e.g. Matte et al., 1996; Mattern and Schneider, 2000) and Late Jurassic (e.g. Xiao et al., 2005). It is also uncertain when the Karakorum terrane collided with the Tianshuihai terrane. There are also at least three opinions about this topic, i.e. Late Triassic (e.g. Dewey et al., 1988; Pan, 1996), Early Jurassic (e.g. Matte et al., 1996; Mattern and Schneider, 2000) and Late Jurassic (e.g. Xiao et al., 2005).

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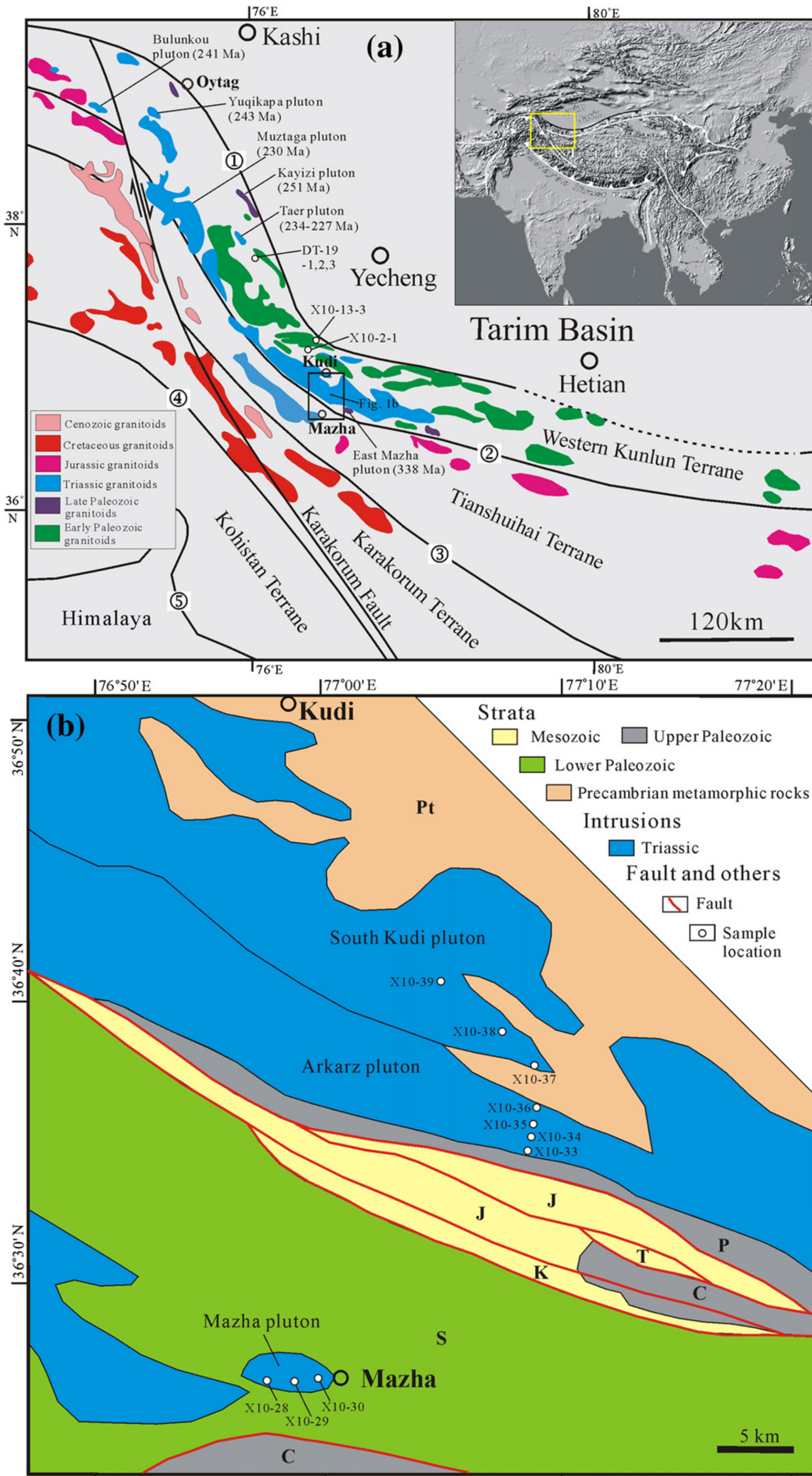

Fig. 1. (a) Sketch map showing the distribution of granitoids in the western Tibetan Plateau, and sample locations of the Precambrian basement rocks; (b) Simplified geological map of the South Kudi, Arkarz and Mazha plutons. In (a): ① = Oytag–Kudi suture, ② = Mazha–Kangxiwa suture, ③ = Hongshanhu–Qiaoertianshan suture, ④ = Bangong–Nujiang suture, ⑤ = Indus–Yarlung-Zangbo suture.
Modified after Jiang et al. (2013).