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Research paper

Geochronology and Sr–Nd–Hf isotopic composition of the granites, enclaves, and dikes in the Karamay area, NW China: Insights into late Carboniferous crustal growth of West Junggar

Di Li, Dengfa He*, Chun Fan

The Key Laboratory of Marine Reservoir Evolution and Hydrocarbon Accumulation Mechanism, The Ministry of Education, China University of Geosciences, Beijing 100083, China

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ABSTRACT

New whole-rock major and trace elements, and zircon U–Pb and Hf–Nd isotope compositions are reported for the Karamay dikes, enclaves, and host granites in the West Junggar, NW China. Zircon U–Pb dating of the Karamay pluton yields an age of 300.7 ± 2.3 Ma for the enclave and 300.0 ± 2.6 Ma for the host granite, which was intruded by dike with an age of 298 Ma. The host granites exhibit relatively low SiO_2 contents and A/CNK and Ga/Al ratios, low initial $^{87}Sr/^{86}Sr$ ratios (0.703421–0.703526) and positive $\varepsilon_{Hf}(t)$ (5.5–14.1) and $\varepsilon_{Nd}(t)$ (7.3–8.1) values with a young model age, suggesting that they are I-type granites and were mainly derived from a juvenile lower crustal source. The enclaves and dikes belong to an andesitic calc-alkaline series and have high MgO concentrations at low silica content and positive $\varepsilon_{Hf}(t)$ (7.6–13.2, 14.2–14.9) and $\varepsilon_{Nd}(t)$ (6.8–8.3, ~6.9) values. They are enriched in LILEs (Rb, Ba and U) and LREE and depleted in HFSEs (Nb and Ta) with insignificant negative Eu anomalies, indicating that the melts were derived from an enriched lithospheric mantle modified by subducted oceanic crust-derived melts and minor fluids, followed by fractional crystallization. The Karamay host granites and enclaves are of mixed origin and are most probably formed by the interaction between the lower crust- and lithospheric mantle-derived magmas, and were intruded by the unmixed dikes subsequently. The upwelling mantle through a slab window in an island arc environment might have triggered partial melting of the lithospheric mantle and its subsequent interaction with the granitic magma, further suggesting that the ridge subduction played an important role in the crustal growth of West Junggar.

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1. Introduction

The Central Asian Orogenic Belt (CAOB) or the Altaids is an important site of juvenile crustal growth in the Phanerozoic; it extends from the Siberia craton in the north to the Tarim–North China cratons in the south and from the Urals in the west to the Pacific in the east (Fig. 1a). The most likely and widely accepted models suggest that the CAOB was built by successive lateral accretion of arcs, accretionary complexes, and a few continental blocks (Coleman, 1989; Şengör et al., 1993; Dobretsov et al., 1995; Şengör and Natal'in, 1996; Gao et al., 1998; Buchan et al., 2002; Xiao et al., 2003, 2004a,b, 2008; Li, 2004; Li et al., 2006; Windley et al., 2007; Shi et al., 2010; Rojas-Agramonte et al., 2011; Wainwright et al., 2011), accompanied by emplacement of immense volumes of late Paleozoic and early Mesozoic granitic magmas (Han et al., 1997, 1998; Chen et al., 2000; Jahn et al., 2000; Wu et al., 2000, 2006; Han et al., 2004; Chen et al., 2006; Windley et al., 2007; Yuan et al., 2007). These granitic intrusions constitute significant parts of the continental crust, and record crustal growth and associated processes. Therefore, their age, composition, and petrogenesis are important for understanding the crustal growth of the CAOB.

West Junggar is a part of CAOB and made up of the Paleozoic volcanic arcs and accretionary complexes (Windley et al., 2007; Xiao et al., 2008) with many early Paleozoic ophiolitic fragments having zircon U–Pb ages of 332–572 Ma (Figs. 1b and 2)

* Corresponding author. Tel.: +86 10 82323868; fax: +86 10 82326850.
E-mail addresses: xdlidi@163.com (D. Li), hedengfa282@263.net (D. He).

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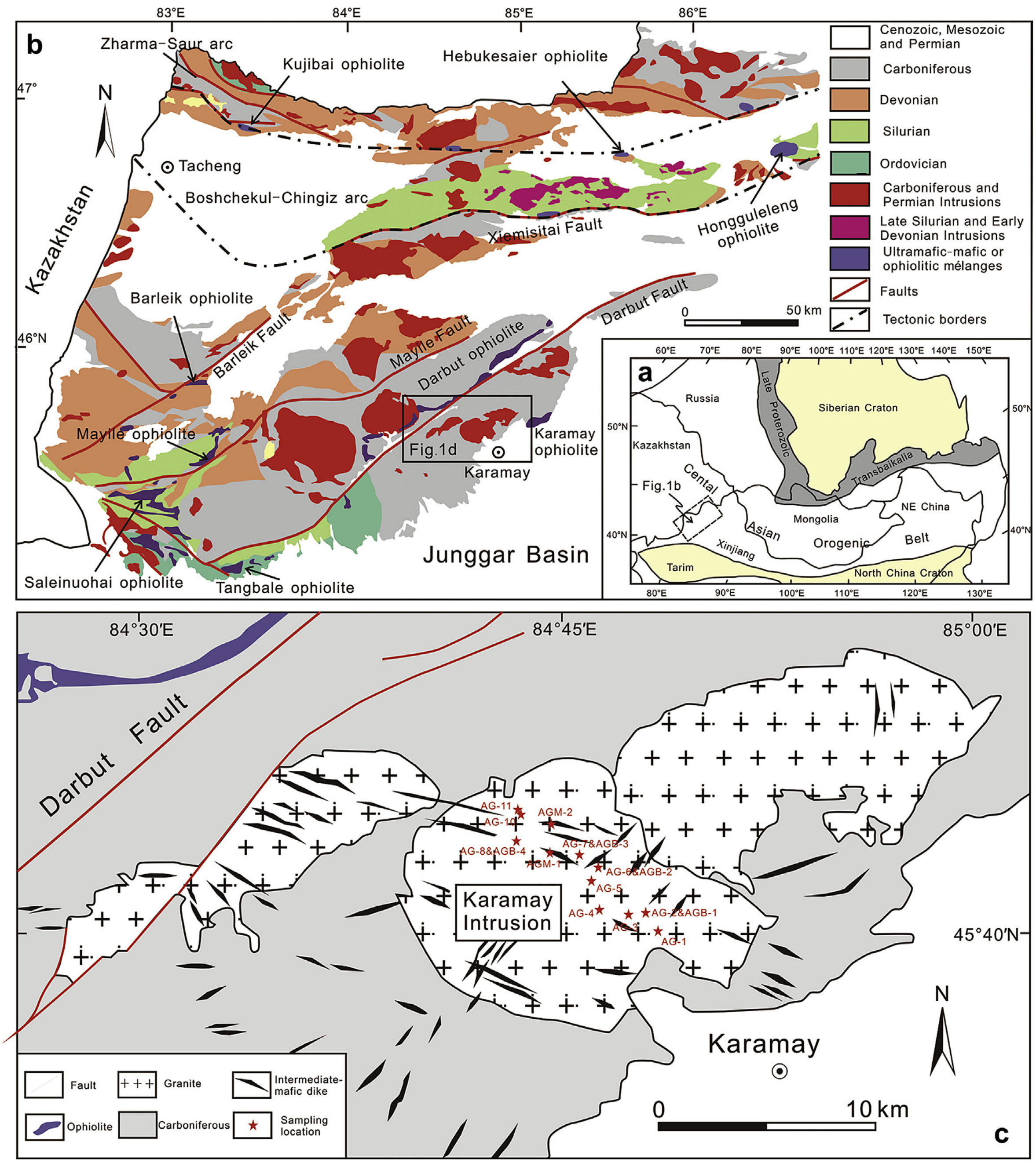

Figure 1. (a) Relationship of the West Junggar terrane with the CAOB (modified after Jahn et al., 2004; Windley et al., 2007; Han et al., 2010). (b) Simplified geological map of the West Junggar terrane and adjacent Junggar basin in northern Xinjiang (modified after BGMRXUAR, 1993). (c) Geological map of the Karamay area (modified after Yin et al., 2010), showing locations of studied dikes, granites, and enclaves.

(Feng, 1987; Buckman and Aitchison, 2001; Jian et al., 2005; Xu et al., 2006; Zhu and Xu, 2006; Zhu et al., 2007; Xu et al., 2011; Yang et al., 2012a,b). These Paleozoic volcanic rocks were intruded by numerous late Carboniferous and Permian I- and A-type granitoid plutons (BGMRXUAR, 1993). The presence of abundant intermediate–basic enclaves in some granites, and the intermediate–basic dikes intruded into granites and Carboniferous strata (Yin et al., 2010), indicate that the crustal growth and/or reworking and interaction between crust and mantle occurred predominantly during the late Paleozoic. However, the petrogenesis and geodynamic setting of these granitic intrusions and the predictions of models associated with the crustal growth in the CAOB are controversial. Two models have been proposed for the Karamay intrusions in the southern West Junggar. One model considers that such magmatism was generated in an island arc setting related to oceanic ridge subduction (Liu et al., 2007; Jian et al., 2008; Geng et al., 2009; Tang et al., 2010; Yin et al., 2010; Zhang et al., 2011a,b). The other model suggests that the crustal growth/reworking was related to depleted mantle contributions in a post-collisional extensional setting (Chen and Arakawa, 2005; Han et al., 2006, 2010; Su et al., 2006; Zhou et al., 2008; Chen et al., 2010). The distinctive geodynamic backgrounds indicate significantly different growth patterns of continental crust.

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