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Late Carboniferous high-Mg dioritic dikes in Western Junggar, NW China: Geochemical features, petrogenesis and tectonic implications

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ABSTRACT

Late Paleozoic High-Mg dioritic dikes widely occur in western Junggar, NW China. Ar–Ar dating on rock chips of the dikes has yielded a plateau age of 321 ± 3 Ma, indicating an early Carboniferous age for the dikes. The dikes are enriched in SiO_2 (52–57 wt.%), and characterized by high MgO (5.13–7.41 wt.%), Cr (134–204 ppm), Ni (59–141 ppm), Sr (468–724 ppm) and Ba (316–676 ppm) contents, with geochemical features analogous to those of sanukite of Setouchi volcanic belt, Japan. These dikes contain hornblende and biotite and generally have high Ba/La (27–124) and La/Nb (2.9–4.3) ratios and positive Eu anomalies, consistent with an origin from hydrous partial melting of a mantle source metasomatised by slab-derived component. The occurrence of sanukitic dikes, together with the coeval slab-related adakite in the area, implies that the western Junggar had been affected by hot, subduction-related regime, which gave rise to not only massive magmatism in the late Carboniferous, but also intensive Cu–Au mineralization in the area.

1. Introduction

Accretionary orogeny plays an important role in crustal growth (e.g. Sengör, 1990; Santosh et al., 2009). The Central Asia Orogenic Belt (CAOB) covers a large area of Asia and represents the most important crustal growth in the Phanerozoic (Sengör et al., 1993; Buslov et al., 2004; Jahn, 2004; Windley et al., 2007; Zhang et al., 2009; Xiao and Kusky., 2009). The long-lasting and complex tectonic evolutionary history and plentiful mineral sources have attracted the attention of geologists worldwide (Yakubchuk, 2004; Seltmann and Porter, 2005; Shen et al., in press). As a part of the CAOB, the Junggar basin is surrounded by mountain ranges and located in the central part of the Central Asia (Fig. 1). The west Junggar is economically important, not only as an important oilfield of China, but also as a potential target for Cu–Au–Pb–Zn exploration. Of its long evolutionary history, time from Carboniferous to Permian is a critical period, during which major metal ore deposits formed in the area. There is so far no consensus on its tectonic background during the period. Based on regional geology, and results of radiolarian and isotopic dating, the western Junggar was considered by some geologists as an intra oceanic arc (Xiao et al., 2006, 2009), which was comprised of several terranes amalgamate by the end of Carboniferous (Allen et al., 1989; Buckman and Aitchison, 2004), while others argue that the western Junggar had been in a post-collisional environment since the early Carboniferous because the widely occurred, isotopically juvenile I- and A-type granite were interpreted to be post-tectonic (Han et al., 2006; Fan et al., 2007). Obviously, more work is needed and a correct model not only sheds light on the tectonic evolution of the area, but also helps understanding the ore-forming processes. Mafic dikes commonly occur in extensional environment, and their formation implies not only the orientation of stress field but also occurrence of important geological events (Park et al., 1995; Ernst et al., 2001; Beutel et al., 2005; Zi et al., 2008). Doleritic to dioritic dikes extensively occur in the western Junggar (Fig. 1). The dikes consist of both high-Mg and low-Mg rocks, and were considered as post-collisional association (Qi, 1993; Li et al., 2004; Han et al., 2006). However, the available $^{40}Ar/^{39}Ar$ and K–Ar ages (ca. 240–270 Ma) are mainly for the dolerite and low-Mg dioritic dikes (Zhou et al., 2008; Xu et al., 2008), and systematic age dating and geochemical studies are absent for the high-Mg dioritic dikes. In this paper, we report the Ar–Ar age and geochemistry of Mg-rich dioritic dikes in the western Junggar, which, in combination with recent studies on other rock types of this area, would provide new constrains on the tectonic regime in the critical period.

2. Geological background

The western Junggar is located in the junction of Siberia, Kazakhstan and Tarim blocks and comprises terranes of various origins. Several ophiolite with ages ranging from 504 ± 60 Ma (Kwon et al., 1989) to 332 ± 14 Ma (Xu et al., 2006) have been reported in this

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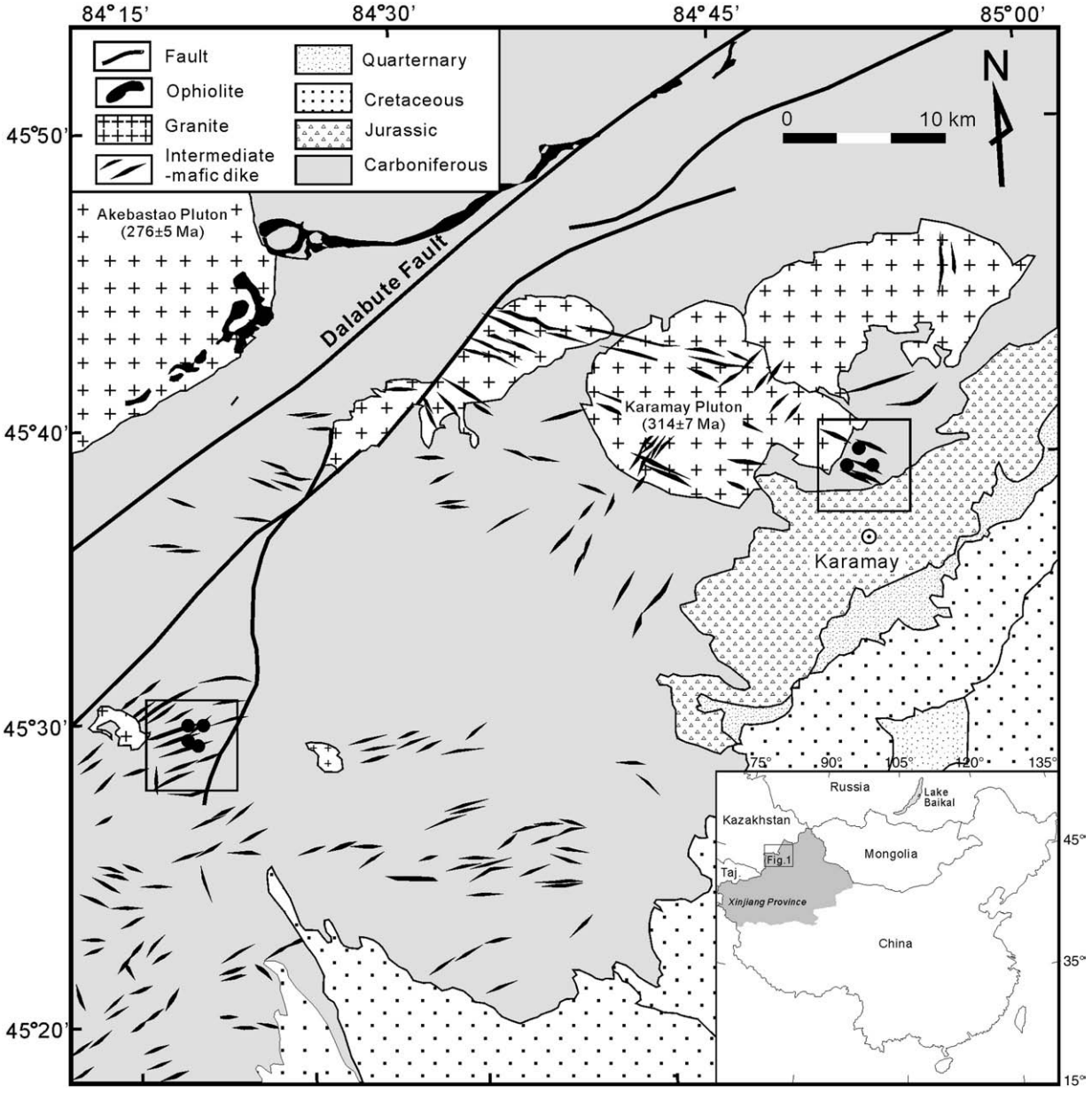

Fig. 1. Geological map of the western Junggar, NW China. Age data for Karamay and Akebastao plutons are from Han et al. (2006). Scale of the dikes is exaggerated for the purpose of recognition.

area, demonstrating a complex accretionary history starting from Cambrian (Fig. 1). Strata in the region are dominated by Devonian to Carboniferous volcano-originated sediments, e.g. tuff, tuffite, tuffaceous sandstone, siltstone, chert, intercalated with mafic to intermediate lavas. The early Carboniferous strata contain abundant fossils (e.g. radiolarian) and trace fossils, indicating a deep-sea environment (Li and Jin, 1989; Jin and Li, 1999; Guo et al., 2002). In the Late Carboniferous, the sedimentary environment changed to marine-terrigenous facies that remained until the Early Permian, when red molasse emerged in the area (Jin and Li, 1999). Granitic plutons commonly occur in the west Junggar and were mostly completed in the time period of 275–340 Ma (Han et al., 2006). Two pulses of granitic plutonism have been recognized (Han et al., 2006; Zhang et al., 2006). The older pulse, at 310 Ma or earlier, was predominated by magma with composition of diorite, quartz diorite and granodiorite, some of which show characteristics of adakite rocks and have good potential of porphyry Cu–Au mineralization (Zhang et al., 2006; Tang et al., 2009). The younger one, mostly formed after 310 Ma, is dominated by monzogranite and alkaline granite and some possess features of A-type granite or charnockite (Zhang et al., 2004; Chen and Arakawa, 2005; Han et al., 2006; Su et al., 2006; Geng et al., submitted for publication). Geochemical studies have revealed that granites in the western Junggar were mainly derived from partial melting of juvenile materials without involvement of Precambrian basement (Coleman, 1989; Feng et al., 1989; Kwon et al., 1989; Carroll et al., 1990; Chen and Jahn, 2004; Chen and Arakawa, 2005; Geng et al., submitted for publication). Dikes in the West Junggar dip steeply and occur mainly in two trends, i.e. NW–SE (280°–310°) and NE–SW (210°–230°) (Qi, 1993; Li et al., 2004). The dikes are highly variable in size and most are less than 1 km long and less than 20 m wide, although some dikes can be a few kilometers in length. Some dikes intruded the early Carboniferous rocks while others into granitic plutons (Gao et al.,