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Petrogenesis and tectonic significance of the plagiogranites in the Zhaheba ophiolite, Eastern Junggar orogen, Xinjiang, China

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ABSTRACT

Plagiogranites (albitite and albite granite dikes/lenses) occur in the western section of the Zhaheba ophiolite, middle part of the Eastern Junggar orogen. The Zhaheba albitites (498.0 ± 5.8 Ma) and albite granites (494.6 ± 6.9 Ma) were roughly coeval and with distinct petrographic textures, i.e., cumulus texture for the albitites and granitic texture for albite granites. The Zhaheba plagiogranites are Na-enriched and LILE-depleted, resembling typical plagiogranites. Geochemical characteristics and cumulus texture of the albitites indicate that they may have been formed by early stage accumulation of albite, whereas the albite granites may have been the products of the residual magma consolidation. The $\varepsilon_{Nd}(t)$ values of the albitites and albite granites vary in the ranges of 7.2–7.7 and 6.4–7.3, respectively, whereas the $\varepsilon_{Hf}(t)$ values vary in the ranges of 11.5–17.9 and 9.8–13.9, respectively. Isotopic compositions and Zr/Hf ratios of the Zhaheba plagiogranites are similar to those of typical MORB, implying a genetic relationship with the oceanic crust. The low TiO_2, Nb, Ta content, LREE enrichment and elevated $(^{87}Sr/^{86}Sr)_i$ values of the Zhaheba plagiogranites indicate that the rocks were likely derived from the anatexis of amphibolites, which were related to hydrothermal alteration of gabbros in intra-oceanic backarc basin. U–Pb geochronology of the Zhaheba plagiogranites indicates that it is more reasonable to connect the Zhaheba–Armantai and Karamay ophiolites to the Zaysan collision zone.

1. Introduction

Plagiogranites are felsic plutonic rocks (including diorite, quartz diorite, tonalite, trondhjemite and albitite/anorthosite) that occur in modern oceanic crust and ophiolites (Coleman and Peterman, 1975; Coleman and Donato, 1979; Li et al., 2013). Despite their minor volume, plagiogranites provide crucial constraints on the formation ages of oceanic crust and ophiolites (Tilton et al., 1981; Jiang et al., 2008; Grimes et al., 2008, 2013) and offer a unique way to investigate oceanic basin and orogenic evolution. Three models have been proposed for the petrogenesis of plagiogranites:

(1) Products of shallow differentiation of basaltic magmas in oceanic crust, representing the final stage of the oceanic crustal evolution (Coleman and Donato, 1979; Lippard et al., 1986; Jiang et al., 2008);
(2) Partial melting of hydrous gabbros (or basalts) (Malpas, 1979; Gerlach et al., 1981; Koepke et al., 2004; Grimes et al., 2013) or amphibolites in the shear zones at spreading centres (Flagler and Spray, 1991);
(3) Immiscibility products of a felsic melt and a Fe-enriched basaltic melt under anhydrous conditions (Dixon and Rutherford, 1979).

Obviously, studies on the plagiogranite petrogenesis are very important for understanding the oceanic crustal evolution.

In terms of regional tectonic significance, the Eastern Junggar orogen is located in the southwest segment of the Central Asian Orogenic Belt (CAOB), lying between the Ertix and Kalamaili faults (Fig. 1). The Dulate arc, Zhaheba–Armantai ophiolites, Yemaquan arc and Kalamaili ophiolite are distributed from north to south in the region. The widespread Late Palaeozoic volcanic rocks and minor Late Carboniferous to Permian granitoids and mafic intrusions (Li, 2004; Li et al., 2014) in the Easter Junggar orogen have preserved a complete record of the Palaeozoic magmatism–tectonism, making it one of the key areas for investigating the evolution of the CAOB's southwest segment. The Zhaheba–Armantai ophiolites are located in the middle part of the Eastern Junggar

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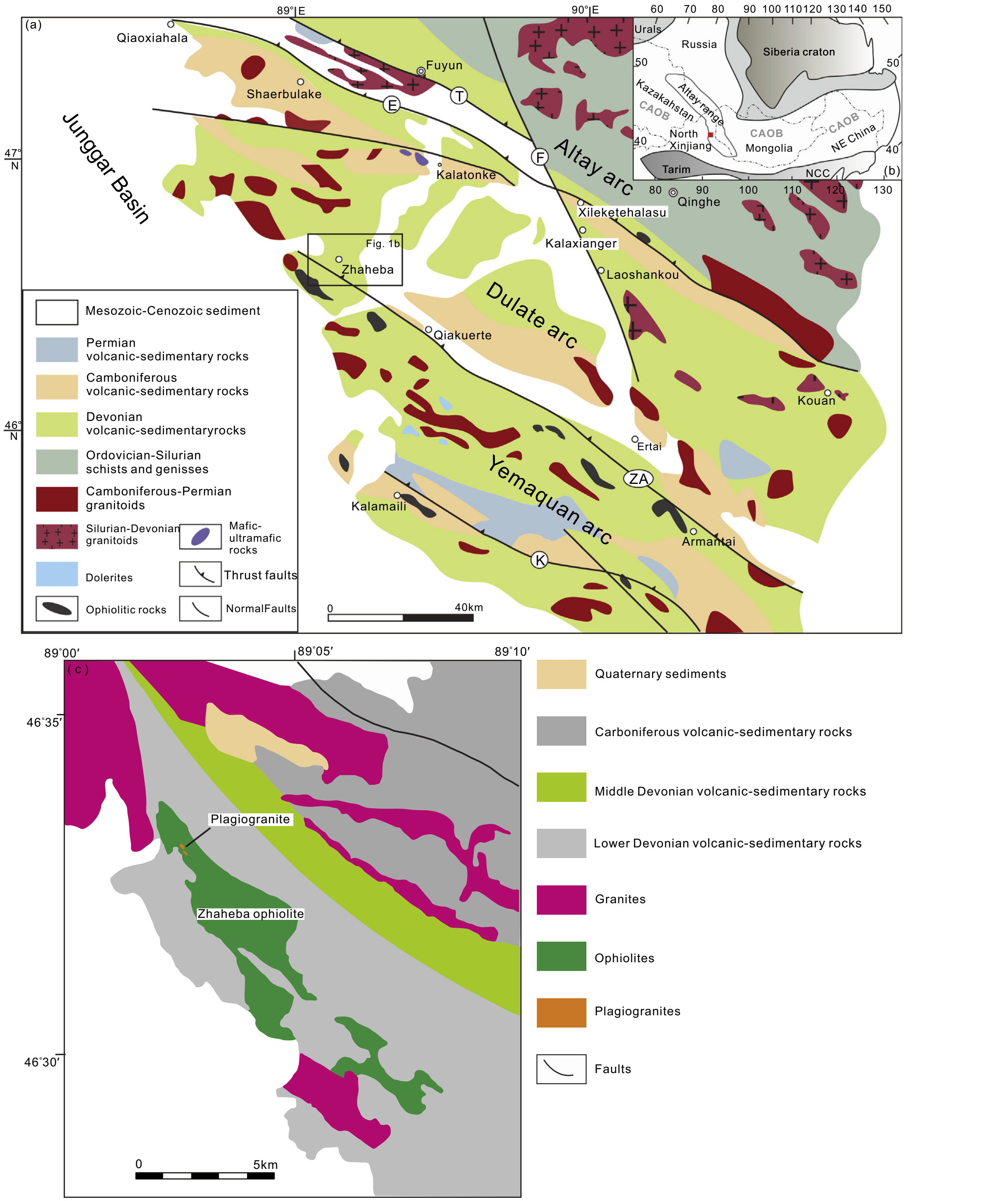

Fig. 1. (a) Location of the study area in the Central Asian Orogenic Belt (after Shen et al., 2011) and (b) simplified geologic map of the Zhaheba area (after Niu et al., 2007). Major faults: E: Ertix thrust; F: Fuyun fault; ZA: Zhaheba–Armantai thrust; K: Kalamaili thrust.

orogen (He et al., 2001; Li, 1995, 2004; Long et al., 2012; Wang et al., 2003; Xiao et al., 2006a, 2009). The discovery of the ultrahigh-pressure (UHP) metamorphic blocks in the orogen (garnet–pyroxenite, quartz-magnesite and garnet–amphibolite) (Niu et al., 2007, 2008, 2009) suggests that the ophiolites have experienced deep subduction and the subsequent exhumation. Therefore, systematic study of the Zhaheba–Armantai ophiolites can effectively contribute substantially to the tectonic reconstruction of the CAOB. Precious attempts on dating the Zhaheba–Armantai ophiolites (with various methods) have yielded inconsistent ages ranging from 479 Ma to 508 Ma (Liu, 1993; Jin et al., 2001; Jian et al., 2003; Huang et al., 2013; Xiao et al., 2006b, 2009). Moreover, published works on the plagiogranites in the Zhaheba–Armantai ophiolites were limited to geochronological