Geoscience Frontiers 6 (2015) 141–152

HOSTED BY

ELSEVIER

Contents lists available at ScienceDirect

China University of Geosciences (Beijing)

Geoscience Frontiers

journal homepage: www.elsevier.com/locate/gsf

Research paper

Geochemical characteristics and tectonic setting of the Tuerkubantao mafic-ultramafic intrusion in West Junggar, Xinjiang, China

Yufeng Deng[a,*], Feng Yuan[a], Taofa Zhou[a], Chao Xu[a], Dayu Zhang[a], Xuji Guo[b]

[a] School of Resources and Environmental Engineering, Hefei University of Technology, Hefei 230009, China
[b] No. 706 Geological Party, Xinjiang Geoexploration Bureau for Nonferrous Metals, Altai 836500, China

A R T I C L E I N F O

Article history:
Received 3 April 2013
Received in revised form
10 September 2013
Accepted 25 October 2013
Available online 16 November 2013

Keywords:
Alaskan-type complexes
Subduction setting
Metasomatized mantle
Tuerkubantao mafic-ultramafic intrusion
West Junggar

A B S T R A C T

Mineral chemistry, whole-rock major oxide, and trace element compositions have been determined for the Tuerkubantao mafic-ultramafic intrusion, in order to understand the early Paleozoic tectonic evolution of the West Junggar orogenic belt at the southern margin of the Central Asian orogenic belt. The Tuerkubantao mafic-ultramafic intrusion is a well-differentiated complex comprising peridotite, olivine pyroxenite, gabbro, and diorite. The ultramafic rocks are mostly seen in the central part of the intrusion and surrounded by mafic rocks. The Tuerkubantao intrusive rocks are characterized by enrichment of large ion lithophile elements and depleted high field strength elements relative to N-MORB. In addition, the Tuerkubantao intrusion displays relatively low Th/U and Nb/U (1.13–2.98 and 2.53–7.02, respectively) and high La/Nb and Ba/Nb (1.15–4.19 and 37.7–79.82, respectively). These features indicate that the primary magma of the intrusion was derived from partial melting of a previously metasomatized mantle source in a subduction setting. The trace element patterns of peridotites, gabbros, and diorite in the Tuerkubantao intrusion have sub-parallel trends, suggesting that the different rock types are related to each other by differentiation of the same primary magma. The intrusive contact between peridotite and gabbro clearly suggest that the Tuerkubantao is not a fragment of an ophiolite. However, the Tuerkubantao intrusion displays many similarities with Alaskan-type mafic-ultramafic intrusions along major sutures of Phanerozoic orogenic belts. Common features include their geodynamic setting, internal lithological zoning, and geochemistry. The striking similarities indicate that the middle Devonian Tuerkubantao intrusion likely formed in a subduction-related setting similar to that of the Alaskan-type intrusions. In combination with the Devonian magmatism and porphyry mineralization, we propose that subduction of the oceanic slab has widely existed in the expansive oceans during the Devonian around the Junggar block.

1. Introduction

The Central Asian orogenic belt (CAOB) is the largest Phanerozoic orogenic belt in the world which is bordered by the Siberian craton to the north and North China-Tarim craton to the south (Fig. 1a). The West Junggar orogenic belt is located at the southern margin of the Central Asian orogenic belt and accreted onto the Kazakhstan plate as the Tarim, Kazakhstan and Siberian plates converged (Şengör et al., 1993; Windley et al., 2007; Xiao et al., 2008). Although much work has been carried out on the late Paleozoic volcanic and acid intrusive rocks (Han et al., 1997; Yuan et al., 2006; Zhou et al., 2006a, 2008; Fan et al., 2007; Geng et al., 2009; Shen et al., 2009, 2012; Chen et al., 2010; Yin et al., 2010; Tang et al., 2012), the early Paleozoic tectonic evolution of the belt is poorly constrained.

Mafic-ultramafic rocks can be formed in variable tectonic environments, such as ophiolites in the active orogenic areas, Alaskan-type complexes in the subduction-related setting and large stratiform complexes in non-orogenic areas. They have different geochemical features that can be used to identify the tectonic environment and constrain the nature of the mantle source (Naldrett and Cabri, 1976; Wilson, 1989; Deng et al., 2011, 2013). Mafic-ultramafic intrusions are known to occur in West Junggar orogenic belt. Most of them were regarded as the ophiolitic mélanges (Feng et al., 1989; Zhang and Huang, 1992; Wang et al., 2003a, b; Zhu and Xu, 2006; Zhu et al., 2008; Xu et al., 2012; Yang et al., 2012a), but more and more of mafic-ultramafic intrusions were proved unrelated to ophiolitic mélanges (Guo, 2009;

* Corresponding author. Tel./fax: +86 (0) 551 62901525.
E-mail address: dyfeng_214@sina.com (Y. Deng).

Peer-review under responsibility of China University of Geosciences (Beijing)

1674-9871/$ – see front matter © 2015, China University of Geosciences (Beijing) and Peking University. Production and hosting by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.gsf.2013.10.003

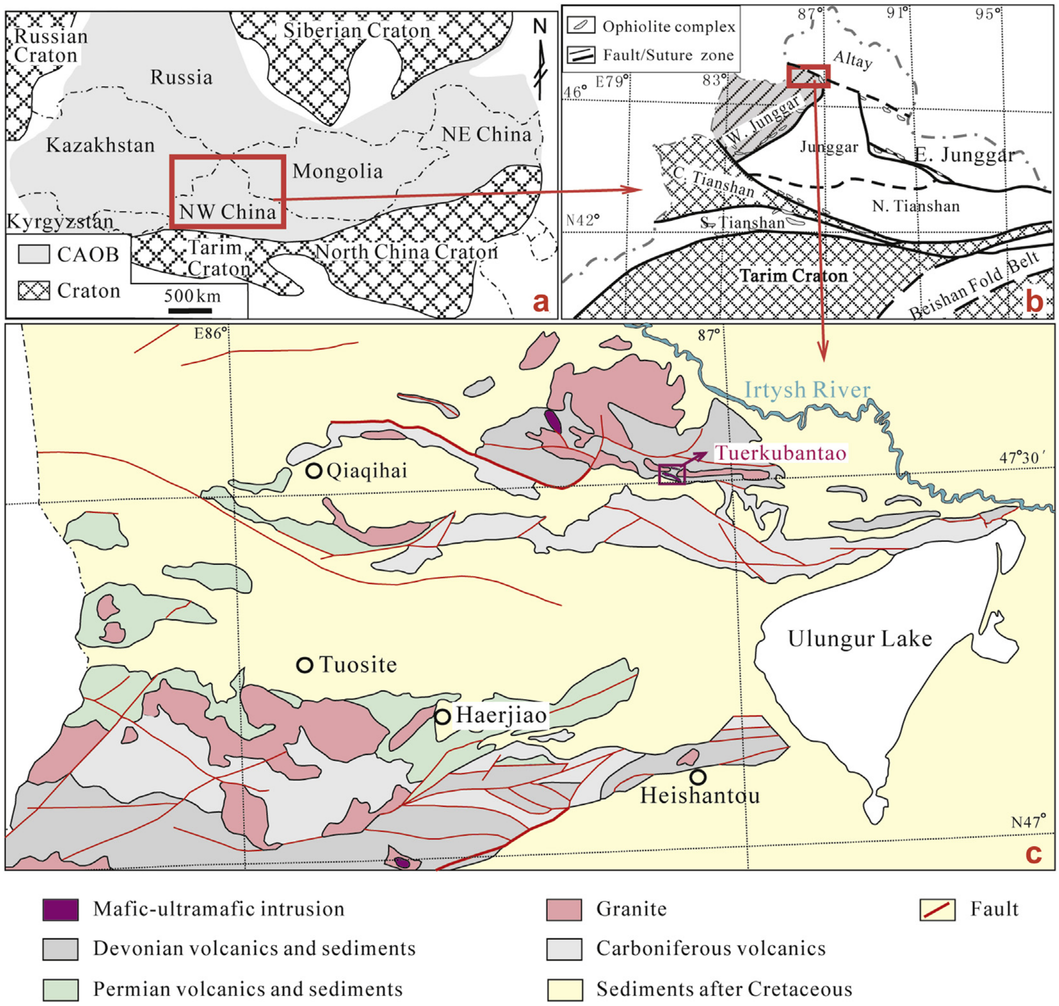

Figure 1. (a) Schematic geological map of the Central Asian orogenic belt (after Jahn et al., 2000; Xiao et al., 2009); (b) simplified geological map of northern Xinjiang (after BGMX, 1993); (c) simplified geological map of northern West Junggar orogenic belt, modified from 1:1,000,000 regional geologic map (after Xinjiang Bureau of Geology and Mineral Resources, 2000).

Zhu and Xu, 2009). Thus, the mafic-ultramafic intrusion in the West Junggar orogenic belt can potentially provide useful information on the tectonic evolution of the belt.

The Tuerkubantao mafic-ultramafic intrusion in the northwestern Junggar orogenic belt was considered as a part of ophiolite (Wang et al., 2012). The zircon U-Pb ages of the gabbro and gneissic granite are 363 and 355 Ma, respectively (Wang et al., 2012), whereas LA-ICP-MS U-Pb zircon ages indicate that the gabbro was emplaced at 394.6 ± 4.9 Ma (Guo, 2009). Because of its Ni-Cu sulfide ore potential, some exploration work has been carried out. The objectives of this study were to understand the nature of the mantle source of the Tuerkubantao intrusion and the tectonic evolution of the region in which the intrusion was emplaced by using mineral chemistry, major elements, and trace elements data.

2. Geological background

The West Junggar orogenic belt, bounded by the Altai orogen to the north and by the Tianshan orogen to the south, extends westward to the Junggar-Balkhash in adjacent Kazakhstan and eastward to Junggar Basin in China (Fig. 1b). It is divided into a northern and southern part by the Hongguleleng-Xiemisitai fault. The northern part is composed by Paleozoic volcanic arcs and characterized by EW-trending faults and fault-bounded blocks. Whereas the southern West Junggar is comprised of disrupted Paleozoic ophiolites, oceanic island arcs, mid-ocean ridges, and accretionary complexes with NE–SW oriented faults (Feng et al., 1989; Windley et al., 2007; Xiao et al., 2010).

The northern West Junggar belt consists mainly of the Devonian to Permian volcanic-sedimentary rocks (Fig. 1c; BGMX, 1993; Zhou et al., 2006b, 2008). The Devonian rocks consist of calc-alkaline volcanics and marine clastic sediments overlain by thick Carboniferous marine clastic sedimentary successions and volcanic formations (BGMX, 1993). Liu et al. (2003) used Rb/Sr methods to date the Carboniferous volcanic rocks and obtained an Rb/Sr isochron age of 343 ± 22 Ma. Some researchers suggested that it is a Devonian–Carboniferous island arc related to northward subduction of the Junggar Ocean (Shen et al., 2005, 2008; Zhang et al., 2007). The Permian volcanics, including a series of continental basic and acidic volcanic rocks and pyroclastic rocks, have the characteristics of typical bimodal volcanic rocks (Tan et al., 2007). They were formed at 280–297 Ma (Zhou et al., 2006c) and covered by Quaternary loose accumulation. According to the lithological and petrographic characteristics of volcanic rocks, the Permian volcanism was considered as the products of post-collisional magmatism (Zhou et al., 2006b,c). Late Carboniferous–Permian mafic to felsic intrusions are widespread in the West Junggar (Fig. 1c). Voluminous alkali-feldspar granites yielded zircon U-Pb ages of ca. 290–340 Ma