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Geochemistry and geochronology of Paleozoic intrusions in the Nalati (Narati) area in western Tianshan, Xinjiang, China: Implications for Paleozoic tectonic evolution

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ABSTRACT

The Nalati (Narati) area in the Chinese western Tianshan is characterized by abundant Paleozoic intrusions, including granites, diorites and gabbros. They are not only indicators of the interaction between crust and mantle, but also useful clues for tracing the tectonic history of the Tianshan Orogen. Most Early Paleozoic granitoids (biotite monzonitic granites and muscovite granites) of this study are from the Yili Block. The biotite monzonitic granites (mixed-source-derived I-type granites) have a zircon U–Pb age of 497.0 ± 5.9 Ma, indicating the time of the subduction of the Terskey Oceanic crust in the Late Cambrian. The 427.2 ± 5.7 Ma Zircon U–Pb age of the S-type muscovite granites let us interpret that these granites may have been formed during the crust thickening process after the collision between the Yili Block and the Nalati Block. In western Tianshan the Late Paleozoic biotite granites, muscovite granites, quartz diorites, biotite monzonitic granites, granodiorites and alkali granites have respectively a LA-ICPMS zircon U–Pb age of 371.8 ± 6 Ma, 357.2 ± 7.5 Ma, 313.9 ± 2.5 Ma and 296.9 ± 2.4 Ma. The biotite granites display I-type geochemical features and are considered to have been derived from a lower continental crust source. The muscovite granites have a pronounced S-type affinity and are considered to have been formed by the partial melting of thickened continental crust after the collision between the Central Tianshan Belt and the South Tianshan Belt. The quartz-diorites are adakite-like and have an I-type affinity, which are considered to have been formed by partial melting of a delaminated lower crust in a post-orogenic extension setting. The granodiorites also show some typical geochemical features of adakite. Their formation is considered to be related to the lower crustal delamination and the ascending of asthenosphere after the collision event. The alkali granites show an A-type granite affinity. They may have been formed in a within-plate tectonic setting and possibly related to rifting as a consequence of extension.

The gabbros can be divided into two groups based on their geochemical characteristics and ages. The older gabbros (415–429 Ma) with lower TiO_2 contents are formed in an arc-related setting. The younger ones (340–318 Ma) with higher TiO_2 content are formed in an intracontinental setting and influenced by crustal contamination.

Magmatic activities recorded by Paleozoic intrusions can constrain the tectonic history of the Tianshan region from subduction of oceanic crust to intraplate extensional collapse and to rifting, and can also corroborate that the final closure of the South Tianshan Ocean occurred in the Late Devonian–Early Carboniferous time.

1. Introduction

The Central Asian Orogenic Belt (CAOB) is one of the largest accretionary orogens and a most significant site of crustal growth in the Phanerozoic (Sengör et al., 1993; Jahn et al., 2000a,b; Xiao et al., 2004, 2008, 2009, 2010; Kovalenko et al., 2004; Shen et al., 2008; Chai et al., 2009; Safonova et al., 2008; Wong et al., 2010; Rojas-Agramonte et al., 2011; Dong et al., 2011). The Tianshan orogenic belt, which extends over 2500 km from NW China in the east to Kyrgyzstan in the west, is the southernmost part of the CAOB. The Tianshan orogenic belt is dominated by Paleozoic subduction, collision and rift related rocks along the Northern Central Tianshan and Southern Central Tianshan sutures, which separate the North Tianshan, Central Tianshan and South Tianshan Belts from north to south (Ao et al., 2010; Coleman, 1989; Windley

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et al., 1990; Allen et al., 1992; Gao et al., 1998; Dong et al., 2001, 2005, 2006, 2007; Xiao et al., 2004, 2008, 2009; Xu et al., 2006; Qian et al., 2009; Zhang et al., 2010; Ren et al., 2011; Xia et al., 2008). Qian et al. (2009) identified the Lower Paleozoic Northern Nalati suture between the Yili and Nalati continental blocks within the Central Tianshan (Fig. 1). During the past decades, it has been well documented that the Tianshan orogenic belt was finally formed by the collision of the Northern Tianshan Belt, the Central Tianshan Belt and the Southern Tianshan Belt. But the time of collision was strongly disputed. Some authors suggested that the collision occurred during the Late Devonian to Early Carboniferous (Windley et al., 1990; Allen et al., 1992; Xia et al., 2008; Xu et al., 2010), while others believed that the collision occurred at the end of the Early Carboniferous (Gao et al., 1998; Gao and Klemd, 2003; Su et al., 2010; Zhao et al., 2003; Zhang et al., 2009) or even Late Carboniferous to Early Permian (Biske and Seltmann, 2010; Chen et al., 1999; Jong et al., 2007; Konopelko et al., 2007). Xiao et al. (2004, 2008, 2009) suggested a Late Permian collision, while a Triassic collision between the Yili-Central Tianshan and Tarim Blocks was proposed by Zhang et al. (2007). In addition, the late-stage or post-collisional orogenic processes remain poorly constrained due to the scarcity of geochemical and geochronological data.

The most important feature of the Central Tianshan Belt is the occurrence of voluminous multi-stage plutons, which were mainly formed in the Paleozoic. Detailed mapping and studies revealed that multi-stage granitoids and basic intrusions were emplaced from the Silurian to Early Permian times in the Nalati area in west segment of the Central Tianshan (XBGMR, 1992, 1993; Gao and Klemd, 2003; Wang et al., 2008; Dong et al., 2011). In this paper,

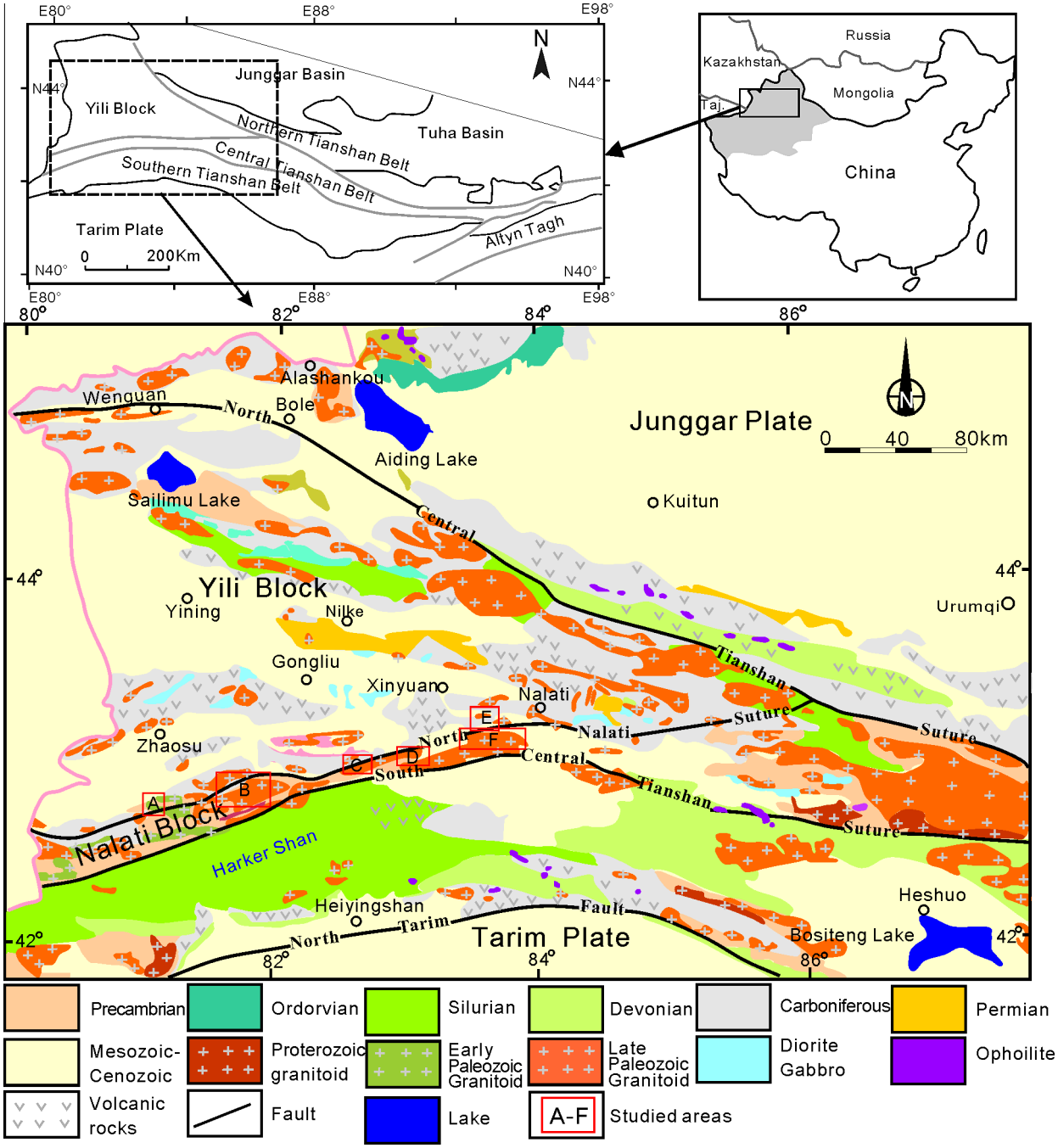

Fig. 1. Simplified geological map of the Chinese Western Tianshan showing the distribution of intrusions and the tectonic division (modified after Gao et al. (2007)).