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# Detrital zircon U–Pb ages of Paleozoic sedimentary rocks from the eastern Hexi Corridor Belt (NW China): Provenance and geodynamic implications

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ABSTRACT

The Paleozoic tectonic framework of the eastern Hexi Corridor Belt is ambiguous. However, thick Paleozoic sediments from the eastern Hexi Corridor Belt can provide clues to this problem. In this paper, we deal with the detrital zircon provenance of Middle Ordovician to Late Devonian strata using LA-ICP-MS U–Pb dating, documenting the temporal and spatial changes of provenance. Detrital zircon U–Pb ages indicate that the primary provenance was the Qilian Orogenic Belt and the Alxa Block. However, two samples from Late Devonian strata show different provenance characteristics, from the North Qilian Orogenic Belt, and the Alxa Block and the North China Block, respectively. Different age distributions through time reflect provenance changes due to continuous convergence of the Central Qilian Block and the Alxa Block from the Middle Ordovician to Late Devonian. A significant age cluster ranging from 2000 to 1800 Ma, which is a detrital zircon signature of the North China Block, appeared in the Late Devonian Zhongning Formation. Our preferred interpretation is that the amalgamation of the Alxa Block and the North China Block likely occurred at that time. Moreover, similar Paleozoic fossils, paleolatitudes and detrital zircon distribution indicate that the Hexi Corridor Belt has an affinity to eastern Gondwana.



## 1. Introduction

The Hexi Corridor Belt (HCB) is located in the northwestern China, which is bounded by the northerly Alxa Block, the easterly North China Block (NCB) and the Qilian Orogenic Belt (QOB) to the south (Fig. 1); it is also the northeastern boundary of the Qinghai-Tibetan Plateau. It is considered to be a key region for understanding the tectonic evolution of the Qilian Ocean and the convergence of the Central Qilian Block (CQB), the Alxa Block and the NCB from the Cambrian to Devonian (Zhang et al., 2011, 2012, 2015, 2016; Li et al., 2012; Yuan and Yang, 2015). Previous studies were mainly focused on stratigraphy, petrology, paleontology and regional tectonic evolution (BGMRNHAR, 1990, 1996; Lin et al., 1991; Feng and He, 1995a, 1995b; Li, 1999; He et al., 2009; Li et al., 2009, 2010, 2011; Yuan and Yang, 2012, 2015; Yuan et al., 2012; Yang et al., 2014). However, since the Mesozoic, especially due to the Cenozoic India-Asia collision, the HCB was involved in intracontinental collision and orogeny, and it underwent extensive multi-stage uplift and deformation. Given this prolonged deformation history and very limited geochronological research, it is not surprising that some fundamental questions, such as the timing of collisional events, ocean-continent configuration, tectonic evolution and affinity, remain uncertain. It was argued that the tectonic setting of the study area was an aulacogen during the Early Paleozoic (Zhang, 1983, 1989; Lin et al., 1991; Ge and Liu, 1999; Ding et al., 2009). However, different stages of evolution were revealed by investigations of volcanic rocks in the QOB, which are Late Proterozoic to Cambrian continental rift volcanism, Late Cambrian to Early Ordovician mid-ocean ridge and ocean island volcanism, Ordovician island arc volcanism, Middle-Late Ordovician back-arc basin volcanism, and Late Ordovician to Silurian volcanism during closing of the oceanic basin (Xia et al., 1991a, 1991b, 1995a, 1995b, 1996a, 1996b, 2003). Furthermore, Early-Middle Ordovician ophiolites widely outcrop in the North Qilian Belt (Feng and He, 1995a; Zhang et al., 1997a), and most ophiolites have the geochemical characteristics of MORB and formed in a fore-arc, back-arc or island arc setting (Feng and He, 1995a; Zhang et al., 1997a). For example, Dongcaohe ophiolites, with the SHRIMP U–Pb age of 497 ± 7 Ma, is a complete preservation of the remnants of the oceanic crust (Zeng et al., 2007). More importantly, most ophiolites in the North Qilian Belt have a similar isotope composition to the MORB-type in the Palaeo-Indian Ocean, which suggests the Qilian Ocean may had been a part of the Proto-Tethyan Ocean system (Zeng et al., 2007; Hou et al., 2005, 2006). In the North Qilian suture zone, two sub-belts of high-pressure metamorphic rocks have already been identified (Wu

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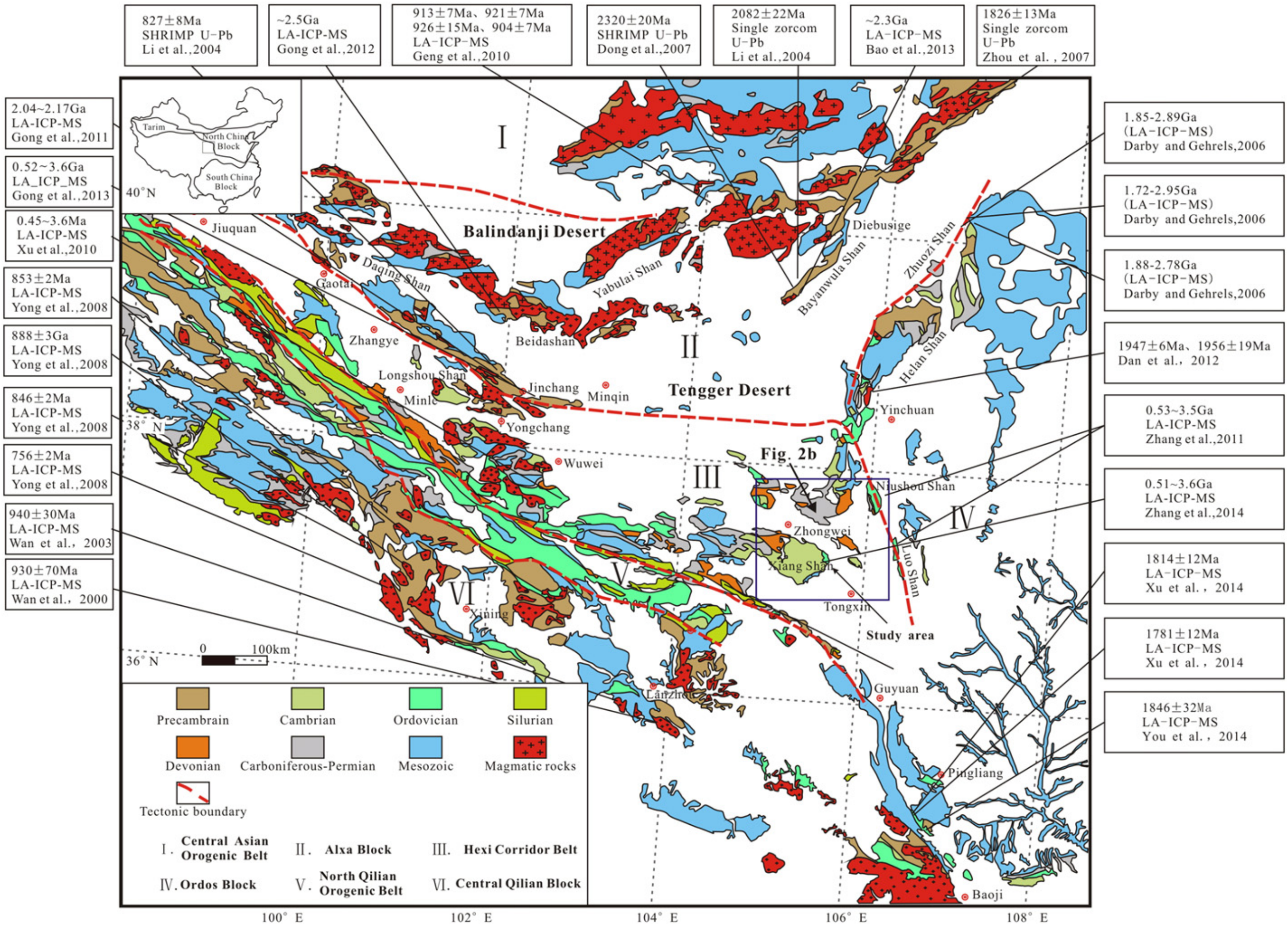


**Fig. 1.** Geological map of the northern Qinghai-Alxa-Western Ordos and age data of different geological units related to this study (modified after China Geological Survey, 2002).

et al., 1990, 1993; Song and Wu, 1992; Zhang and Xu, 1995; Song, 1996, 1997; Song et al., 2013), which marks oceanic crust subduction during the Mid-Late Ordovician (Song, 1997; Zhang et al., 1997b). Especially based on the study of the Early Paleozoic ophiolites in the NQOB, many scholars hold the view that the eastern HCB might represent an Early Paleozoic ocean basin (Feng and He, 1995a, 1995b; Zeng et al., 2007; Song et al., 2013). In addition, other evidence from detrital zircon geochronology also support this view (Dong et al., 2007a; Yang et al., 2009; Xu et al., 2010a, 2015). These are also different opinions on the timing of the Qilian Ocean closure and subsequent collision of the Qilian Block and the Alxa Block. Based on regional-stratigraphy framework and basin analysis, it is suggested that the Qilian Ocean closed during the Ordovician (Zhou et al., 1996; Liu et al., 2006; Yang et al., 2009; Song et al., 2013; Xu et al., 2015) and rapid orogenic uplift followed in the late Silurian and early Devonian (Song et al., 2013). This is in contrast to Wang et al. (2005), who proposed a final amalgamation in the Silurian, and Feng and He (1995b), who advocated a late Silurian collision time of the north and south continental blocks. Furthermore, Wu et al. (1993) argued that SW-dipping thrust faults, which developed in the Lower Paleozoic, reflect final continental collision in the early Devonian or later.

Clastic sedimentary rocks often record significant information about their provenance and tectonic processes during their original deposition (Oliveira et al., 2015), and detrital zircon provenance research in other orogenic systems has clarified the collisional records of many continental blocks (e.g., Gehrels et al., 1990; Thomas et al., 2004; Barbeau et al., 2005; Weislogel et al., 2006; Horton et al., 2008). Systematic study of characteristic detrital zircon ages obtained from sedimentary sequences in basins can reflect changes in sediment provenance and basin-range interactions (Tang et al., 2014). The goal of this paper is to use U–Pb detrital zircon geochronology to evaluate the provenance of the Ordovician to Devonian sedimentary rocks from the eastern HCB. The data are integrated to document the overall source evolution and its implications for the geodynamic evolution of the HCB from the Middle Ordovician to the Late Devonian.

## 2. Geological setting

The eastern HCB is located in a joint region among three tectonic units in China, i.e., the Alxa Block in the north, the NCB in the east and the QOB in the south (Fig. 2). Traditionally, the QOB is subdivided from north to south into the North Qilian Belt (NQB), Central Qilian Block (CQB) and South Qilian Belt (SQB), and the HCB belongs to the NQB (Du et al., 2004; Yang et al., 2009; Xu et al., 2010a). The HCB, which is the northern part of the QOB, is a significant transitional belt between the Alxa Block and the QOB.

The study area represents an arcuate tectonic belt, and its shape was mainly modified by Indian-Eurasian collision during the Cenozoic. Paleozoic strata are widely distributed in the study area. The Xiangshan Group, marking the bottom of the Paleozoic clastic succession, is composed of a suite of deep-water sedimentary sequence, including light metamorphic, grey-green, medium-fine grained feldspar quartz sandstone, slate, silty slate, thin-bedded limestone and chert. However, the accurate age assignment of the Xiangshan Group remains uncertain. According to the fossils and youngest detrital zircon in the Xiangshan Group, the depositional age range is from the Middle-Late Cambrian to