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Neoproterozoic tectonic evolution of the Precambrian Aksu blueschist terrane, northwestern Tarim, China: Insights from LA-ICP-MS zircon U–Pb ages and geochemical data

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ABSTRACT

The Precambrian Aksu blueschist terrane (ABT) located in the northwestern Tarim Craton was formerly regarded as a Mesoproterozoic or an early Neoproterozoic complex. Yet, its tectonic significance remains poorly understood due to the lack of reliable age. We have conducted a detrital zircon U–Pb geochronological study of both the metasedimentary rocks from the ABT and the unmetamorphosed sandstones from the overlying Sinian succession to better constrain the age of the ABT. In addition, geochemical analyses were performed on the metasedimentary rocks to establish the broad tectonic setting of the source region of sediments. Our first U–Pb dating results suggest a maximum deposition age of ca. 730 Ma for the protolith of the metasedimentary rocks in the ABT and a maximum deposition age of 602 Ma for the unmetamorphased Sinian sandstones immediately overlying the ABT. Therefore, the blueschist-facies metamorphism in the ABT must have taken place after ca. 730 Ma, but prior to 602 Ma. This metamorphism may manifest the Pan-African orogeny (ca. 700–500 Ma), which is related to the assemblage of Gondwana, in the northern Tarim. Furthermore, the age range of 1.3–0.9 Ga was not recorded in the detrital zircons from both the metasedimentary rocks and the Sinian sandstones, suggesting that the northern Tarim Craton may not be significantly affected by the Grenville-age orogeny. A major age population at Paleopreoterozoic (ca. 2.0–1.8 Ga) was found in all samples, implying a Paleoproterozoic orogeny in the northern Tarim, which is coincident with the timing of the orogeny associated with the assembly of the Columbia supercontinent. Taking together the geochemical and chronological data, we propose that the northern margin of the Tarim Craton was probably a late Neoproterozoic active continental margin and a major source for the sedimentary rocks of the ABT, which provided a mixture of both old recycled sedimentary material from the basement rocks and juvenile material from the igneous rocks.

1. Introduction

Blueschists are metamorphosed basaltic rocks with diagnostic mineral glaucophane. A typical mineral assemblage of blueschists include glaucophanic amphibole + lawsonite (or epidote) + chlorite + albite + quartz ± sodic (jadeitic) clinopyroxene ± aragonite (Ota and Kaneko, 2010). The protoliths of blueschists could be mid-ocean ridge basalt (MORB; e.g. Becker et al., 2000), ocean island basalt (OIB; e.g. Volkova and Budanov, 1999) or calc-alkaline basalt (CAB, e.g. Mahe'o et al., 2006). It is well known that blueschists are produced during high-pressure metamorphism and it is widely believed that the occurrence of blueschist-facies metamorphism is indicative of subduction events (Ernst, 1988; Stern, 2005). Based on the nature of subduction, Maruyama et al. (1996) and Maruyama and Liou (1998) divided high-pressure (HP) and ultra-high-pressure (UHP) blueschist–eclogite belts into A-type (collision type) and B-type (Cordillera type), corresponding to A-type and B-type subduction, respectively. The A-type HP–UHP metamorphic belts result from continental collisions, usually consisting of passive continental margin materials and recording higher metamorphic pressure as well as temperature. The B-type HP blueschists correspond to subduction of oceanic plates and are commonly derived from oceanic basalt (MORB or OIB) or island arc basalt. Blueschists most commonly occur in Mesozoic and Cenozoic terranes (Molnar and Gray, 1979) and rarely appear in Precambrian terranes (Jahn et al., 2001).

The Aksu blueschist terrane (ABT) is located in northwestern China (Fig. 1) and is regarded as one of the oldest well-substantiated Precambrian blueschist terranes in the world (Liou et al., 1989,

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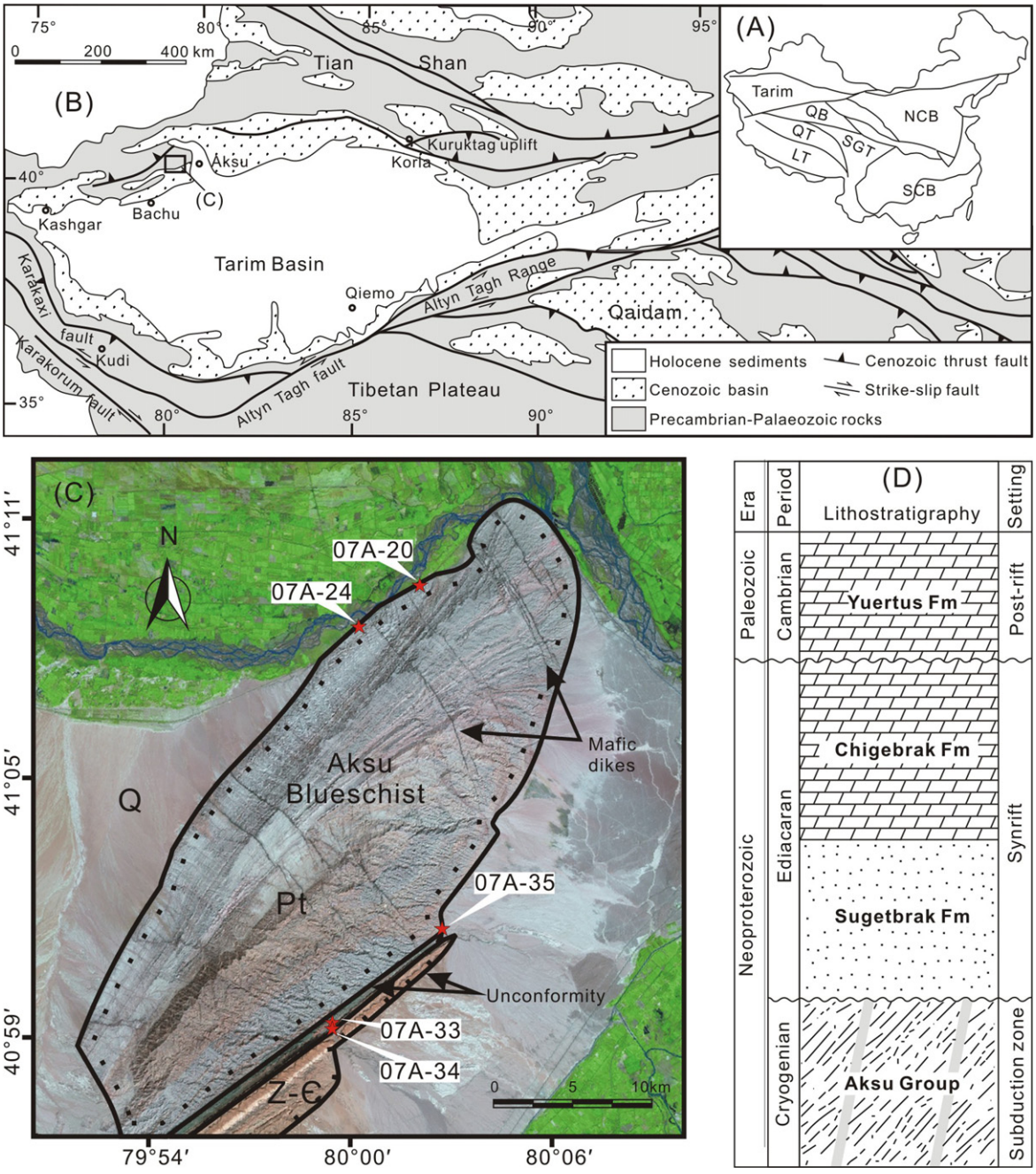

Fig. 1. A. Main tectonic elements of China. NCB: North China block, SCB: South China block, SGT: Songpan-Ganzi terrane, QB: Qaidam basin, QT: Qiangtang terrane, LT: Lhasa terrane (modified after Li et al., 2007). B. Simplified tectonic map of the Tarim craton and its surrounding areas in northwest China (modified after Yin and Nie, 1996). C. Interpretation of remote sensing image of the Aksu blueschist terrane (Landsat-7 ETM+ image, composed of 5, 4, 3 bands). Pt: Proterozoic, Z: Sinian, Є: Cambrian, Q: Quaternary (after Zheng et al., 2010). D. Simplified stratigraphic column of the Neoproterozoic to Early Cambrian in the NW Tarim Basin (modified after Turner, 2010).

1996; Nakajima et al., 1990). The ABT was intruded by numerous unmetamorphosed mafic dykes and is overlain by the Sinian successions (Figs. 1 and 2). Despite of more than two decades of research, the tectonic significance of the ABT remains a matter of intense debate. The ABT has been interpreted either as (1) an accretionary complex formed 700 Ma ago along the northern margin of the proto-Tarim Craton, which presumably constituted the northernmost front of the Gondwana supercontinent (Liou et al., 1989, 1996; Nakajima et al., 1990); or as (2) a terrane experienced high-pressure metamorphism associated with the Grenville Orogeny and the amalgamation of Rodinia around 1.0 Ga (Gao et al., 1993; Chen et al., 2004; Lu et al., 2008; Zhang et al., 2009a). Although several geochronological methods had been used to study the Aksu blueschists and intruding mafic dykes in previous studies (Table 1), the conflicting geochronological results did not allow a satisfactory interpretation of the tectonic significance of the ABT.

In order to obtain reliable age data we conducted detrital zircon U–Pb geochronological studies on both the metasedimentary rocks from the ABT and the unmetamorphosed sandstones from the overlying Sinian succession. The youngest zircon can define the maximum deposition ages of both the metasedimentary rock and the overlying Sinian succession. Logically, after the deposition of the protolith of metasedimentary rocks, but prior to the deposition of the overlying Sinian succession, the blueschist-facies metamorphism occurred. Moreover, single-grain U–Pb dating of detrital zircons is also a powerful tool for provenance studies because it