Journal of Asian Earth Sciences 72 (2013) 63–74

Contents lists available at SciVerse ScienceDirect

Journal of Asian Earth Sciences

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

Magmatic and metamorphic development of an early to mid-Paleozoic continental margin arc in the southernmost Central Asian Orogenic Belt, Inner Mongolia, China

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ARTICLE INFO

Article history:
Available online 6 June 2012

Keywords:
Zircon
Continental margin arc
Magmatism
Metamorphism
Central Asian Orogenic Belt
Paired metamorphic belts

ABSTRACT

The Bainaimiao arc in Inner Mongolia, China, comprises a weakly metamorphosed volcani-sedimentary sequence and a low-*P*/*T* metamorphic complex. In this study we present SHRIMP zircon ages and geochemical data to document the temporal and genetic relationships between these two tectonic units. Zircons from a rhyolite and two dacites (high-K calc-alkaline) of the volcani-sedimentary sequence yielded $^{206}Pb/^{238}U$ ages of 474 ± 7 Ma, 453 ± 7 Ma and 436 ± 9 Ma respectively, that we interpret as recording the timing of three volcanic arc episodes. Rocks from the low-*P*/*T* metamorphic complex yielded zircon ages of 462 ± 11 Ma for a sillimanite gneiss and 437 ± 5 Ma for a plagioclase–hornblende gneiss, reflecting two distinct anatectic events. Also from the low-*P*/*T* complex, the protolith age of a metadiorite is 438 ± 2 Ma. A diorite from a weakly deformed diorite–granodiorite pluton in the low-*P*/*T* complex has a zircon age of 419 ± 10 Ma that correlates in time with regional collisional magmatism. An undeformed pegmatite dike cutting the low-*P*/*T* metamorphic complex has an age of 411 ± 8 Ma, which postdates collision and provides an upper limit for the termination of orogeny. Accordingly, we conclude that the volcani-sedimentary sequence and the low-*P*/*T* metamorphic complex evolved coherently in the early to mid-Paleozoic and formed an integral continental margin arc in the southernmost Central Asian Orogenic Belt.

1. Introduction

In the context of plate tectonics, accretionary orogeny is partly explained by the development of convergent margins via subduction zone and terminal collisional processes (e.g., Hamilton, 1988; Maruyama, 1997; Shervais, 2001; Shervais et al., 2004; Stern, 2002; for overview see also Cawood et al., 2009). A complete convergent margin forms an accretionary prism (i.e. a subduction–accretion complex), a forearc with a suprasubduction zone (SSZ) ophiolite, a magmatic arc (either intraoceanic or continental) and a back-arc basin, all these being genetically linked to an oceanic subduction zone (e.g., Pearce et al., 1984; Maruyama, 1997; Shervais, 2001; Shervais et al., 2004; Pearce, 2003; Stern, 2002, 2004). In addition to subduction-related magmatism (e.g. Shervais, 2001; Shervais et al., 2004; Stern, 2002, 2004), metamorphism plays a key role in the development of a convergent margin. Paired metamorphic belts best represent a diagnostic feature of a Pacific-type convergent margin or a cordilleran-type orogenic belt and are particularly informative: a high-pressure metamorphic belt (blueschist- and/or eclogite-facies) formed in a trench and a low-pressure metamorphic belt formed beneath a volcanic arc chain in the continental margin (Miyashiro, 1973; for overview see also Maruyama, 1997).

The Central Asian Orogenic Belt (CAOB) (Fig. 1 inset) is a wide (ca. 800 km) and complex accretionary orogen located between the Siberian and North China cratons (Jahn et al., 2000; Kröner et al., 2007; Windley et al., 2007). A striking tectonic feature of the southern CAOB in Inner Mongolia of China (Fig. 1) is the presence of two early to mid-Paleozoic orogens of opposite polarities (Jian et al., 2008), which are separated by the Permian Solonker suture zone (Xiao et al., 2003; Chen et al., 2000, 2009; Jian et al., 2010). In the Southern Orogen, a SSZ-type ophiolite at Tulinkai (Fig. 1) and a magmatic arc (the Bater arc) had previously been dated and geochemically studied in detail by Jian et al. (2008). Here we present new SHRIMP zircon ages and geochemical data in order to constrain the magmatic and metamorphic history of an early to mid-Paleozoic continental margin arc, the Bainaimiao arc (Xiao et al., 2003) in the Southern Orogen and on the border of the North China craton (Figs. 1 and 2). The Bainaimiao arc occurs along the strike of, and likely represents an eastern extension of, the Bater arc (Fig. 2), but it is distinguished from the Bater arc by having a low-pressure (*P*)/*T* (temperature) metamorphic complex (Nie, 1990; Nie and Pei, 1990; Nie et al., 1991, 1993, 1994; Nie and Bjørlykke, 1999; Jian et al., 2007).

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http://dx.doi.org/10.1016/j.jseaes.2012.05.025

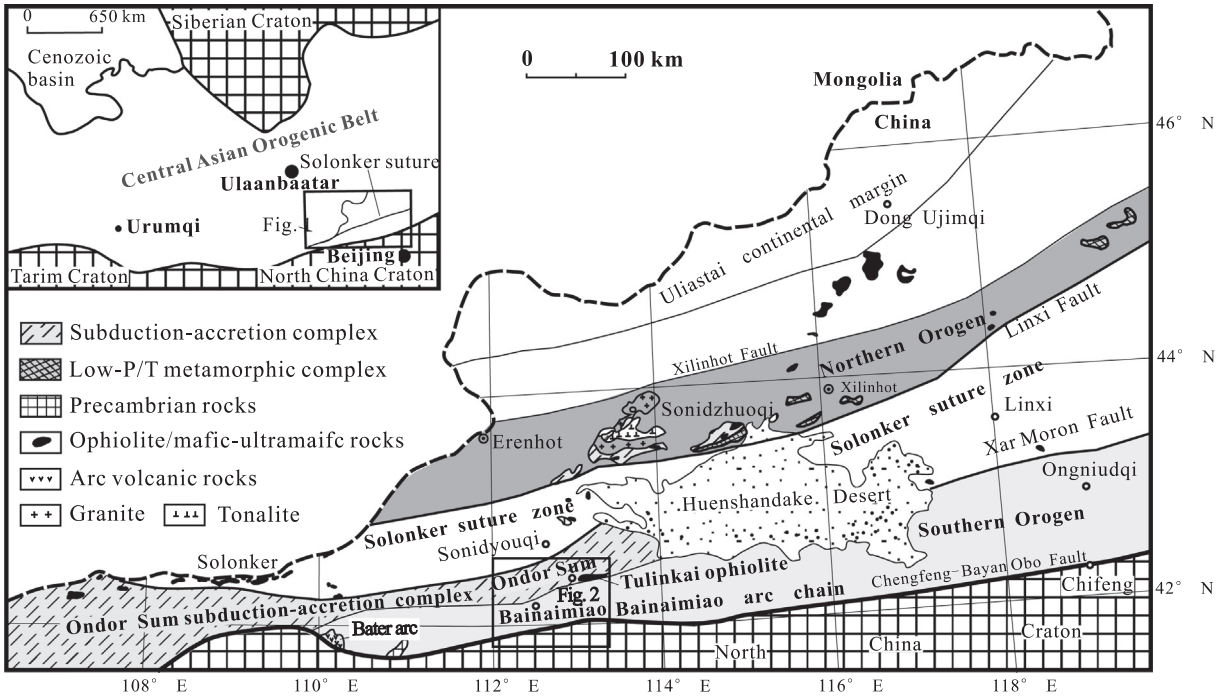

Fig. 1. Sketch map of the geology of Inner Mongolia showing the Solonker suture zone separating the Northern (dark gray) and Southern (light gray) early to mid-Paleozoic orogens (after Jian et al., 2008). The Bainaimiao Arc forms part of the Southern Orogen and its position is indicated.

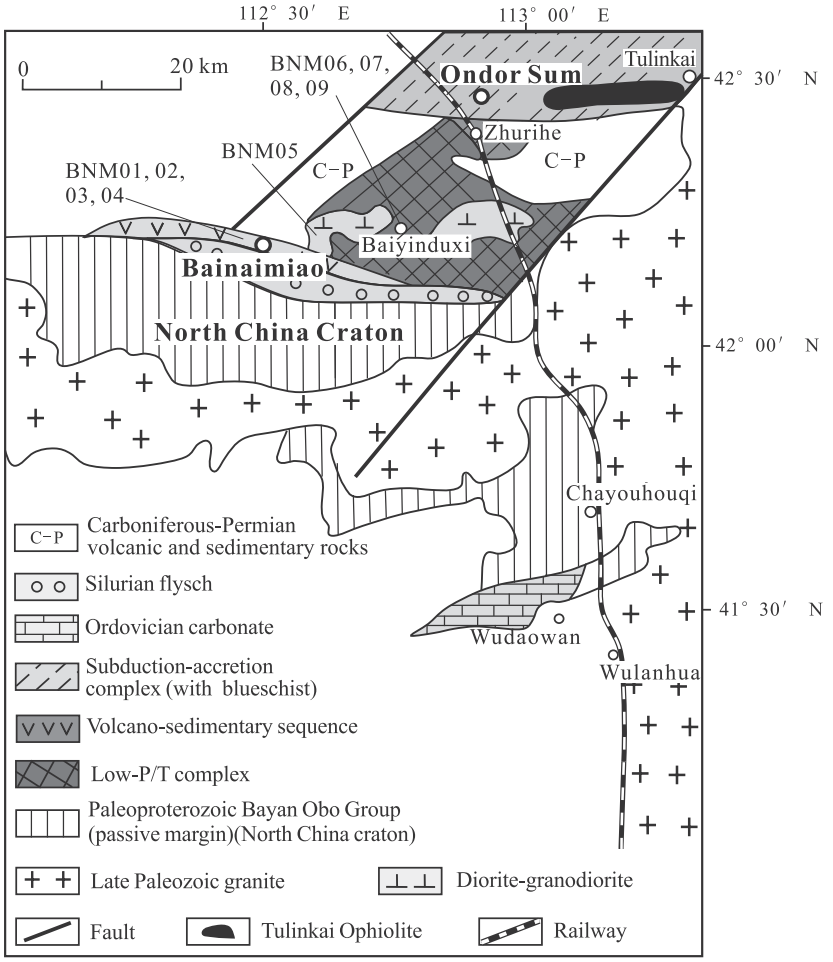

Fig. 2. Simplified geological map of the Bainaimiao-Tulinkai area (after Jian et al., 2007). The volcani-sedimentary sequence, along with the low *P*/*T* metamorphic complex makes up the Bainaimiao continental margin arc, which, as the Barter arc shown in Fig. 1, is part of the Bainaimiao arc chain. Positions of analyzed samples are marked.