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Late Devonian-early Permian subduction-accretion of the Zharma-Saur oceanic arc, West Junggar (NW China): Insights from field geology, geochemistry and geochronology

Yichao Chen[a,b,c], Wenjiao Xiao[a,b,d,*], Brian F. Windley[e], Ji'en Zhang[d], Miao Sang[a,b,c], Rui Li[b,d], Shuaihua Song[b,d], Kefa Zhou[a,c]

[a] Xinjiang Research Center for Mineral Resources, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China
[b] University of Chinese Academy of Sciences, Beijing 100049, China
[c] Xinjiang Key Laboratory of Mineral Resources and Digital Geology, Urumqi, Xinjiang 830011, China
[d] State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China
[e] Department of Geology, The University of Leicester, Leicester LE1 7RH, UK

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ABSTRACT

Migration of arc magmatism is of significant importance for accretionary orogens, but few examples have been documented in ancient orogens. In this paper we report late Paleozoic-early Permian, migrating magmatism of the intra-oceanic Zharma-Saur arc in the Tarbagatay Mountains, West Junggar, NW China, in order to address the general role of a growing arc in accretionary orogenesis, and the debates on the formation and timing of the Kazakhstan orocline in the Central Asian Orogenic Belt (CAOB). Our detailed field work suggests that in the Zharma-Saur arc plutons and dikes intruded and lavas erupted in association with accretionary complexes that were dominated by ocean plate stratigraphy (OPS). Mafic to intermediate magmas have arc-type geochemical signatures such as depleted HFSEs and enrichments in LILEs and LREEs, coupled with high εNd(t) (+5.7 to +6.8) to low $^{87}Sr/^{86}Sr$ initial values (+0.7035 to +0.7037). The Tarbagatay accreted rocks contain early Paleozoic pillow lavas, which have depleted LILEs, high εNd(t) (+7.4 to +8.2) and high $^{87}Sr/^{86}Sr$ initial values (+0.7041 to +0.7063). These data suggest that the Zharma-Saur arc was an intra-oceanic island arc that developed on accreted OPS material. U-Pb zircon isotopic data (the ZWTB I diorite pluton, 322 ± 3 Ma; the JLDK diorite pluton, 318 ± 4 Ma; andesitic lavas, 312 ± 2 Ma, 310 ± 4 Ma, 301 ± 3 Ma) demonstrate that the Zharma-Saur arc magmatism occurred in the late Paleozoic. Integration with published geochronological data on the Zharma-Saur arc leads to a complex model of arc growth with a general southward younging of the arc magmatism from 383 Ma to 262 Ma. These relations imply a southward growth and migration of the magmatic axis of the Zharma-Saur arc that was associated with a short period of ridge subduction. The magmatic activity of the Zharma-Saur arc that probably continued until the early Permian resulted from migrations towards the forearc and backarc, as well as oblique or parallel motion to the trench. These new results not only provide robust evidence for resolving controversies about the Phanerozoic accretionary and continental growth of the Central Asian Orogenic Belt, but also shed light on the migration of magmatism in accretionary orogens in general.

1. Introduction

Migration of arc magmatism is significant and important for understanding accretionary orogens where there were considerable additions of juvenile material to the continental crust (Şengör et al., 1993; Dickinson, 2004). In the early growth of modern accretionary orogens, the migration of an arc axis has been well demonstrated in Cenozoic Japan (Taira, 2001; Wakita, 2013), the East Pacific (Dickinson, 2004; Bahlburg and Hervé, 1997), the Turkish plateau, and in Central Asia (Şengör and Natal'in, 1996). In the modern arcs in Japan and the East Pacific there are two types of arc migration: towards the fore-arc (Şengör and Natal'in, 1996), and the back-arc (Bahlburg and Hervé, 1997; Dickinson, 2004). An inevitable consequence of the opening and closure of oceans is the development of ocean plate stratigraphy (OPS), which records the travel history of the ocean (Kusky et al., 2013), the subduction of mid-ocean ridges and ridge-trench interactions (Sisson et al.,

* Corresponding author at: Xinjiang Research Center for Mineral Resources, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China.
E-mail address: wj-xiao@mail.iggcas.ac.cn (W. Xiao).

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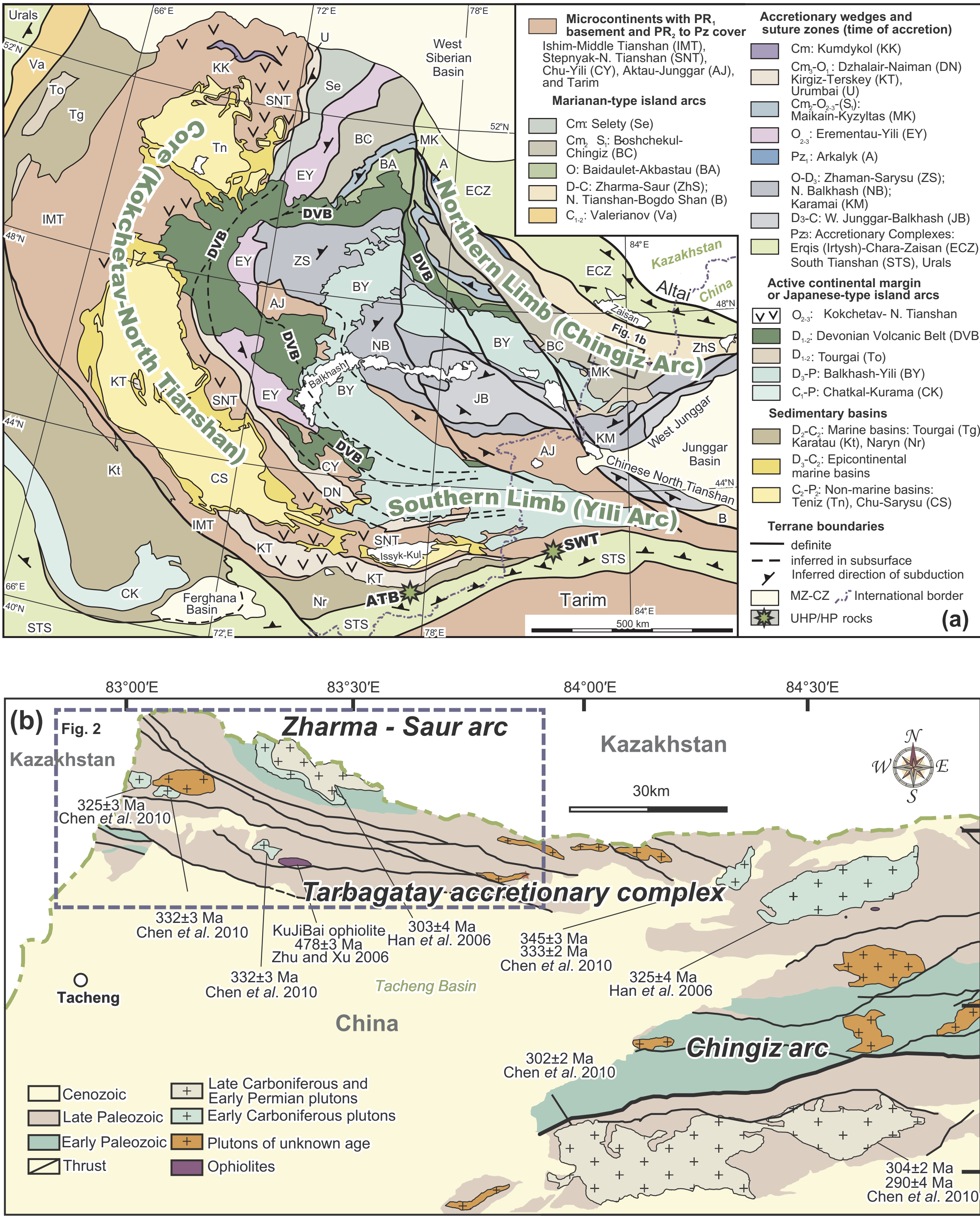

Fig. 1. (a) Tectonic map of the main components of the Central Asian Orogenic Belt, showing the Kazakhstan, Mongolia, and Tarim-North China collage systems, separated by a thick black dotted line, and the South Tianshan suture (modified after Şengör and Natal'in, 1996; Xiao et al., 2015). (b) Simplified geological map of northern West Junggar showing the position of the Tarbagatay belt between the Zharma-Saur and Boshchekol-Chingiz arcs. All published radiometric ages are indicated with their relevant references. The positions of Figs. 2 and 14 are marked (modified after XBGMR, 1984; Windley et al., 2007; Xiao et al., 2010).

2003), and the variable geometry of the oceans commonly leads to arc-parallel and/or oblique migration of arc axes during transpressional accretion (Kusky et al., 1997, 2003; Bradley et al., 2003; Osozawa et al., 2012). However, few examples of arc migration have been reported in pre-Mesozoic orogens (Windley et al., 2007; Jian et al., 2010; Cai et al., 2011, 2012; Ma et al., 2012; Yin et al., 2013; Cao et al., 2017).

The Central Asia Orogenic Belt (CAOB), which is bordered by the Siberian, East European, Tarim and North China Cratons (Fig. 1a),