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Carboniferous–Permian extensive magmatism in the West Junggar, Xinjiang, northwestern China: its geochemistry, geochronology, and petrogenesis

Rui Gao [a,b], Long Xiao [b,*], Franco Pirajno [c,d], Guo-can Wang [b], Xin-xing He [b], Gang Yang [b], Sheng-wu Yan [b]

[a] Key Laboratory of Tectonic Controls on Mineralization and Hydrocarbon Accumulation, Ministry of Land and Resources, Chengdu University of Technology, Chengdu, Sichuan, China
[b] School of Earth Sciences, China University of Geosciences, Wuhan, Hubei, China
[c] Geological Survey of Western Australia, Perth, Western Australia, Australia
[d] Centre for Exploration Targeting, University of Western Australia, Perth, Western Australia, Australia

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ABSTRACT

Located between the Tarim, Kazakhstan, and Siberian plates, the West Junggar terrane is a key component of the Paleozoic Central Asian Orogenic Belt (CAOB) with widespread late Paleozoic igneous rocks. In this paper, we report petrological, geochronological, and geochemical data for selected granitoids from the West Junggar. Based on geochronology, the I-type and A-type granites were formed predominantly at 347.9–319.0 Ma and at 321.4–290 Ma respectively. The early-stage I-type granites are characterized by low SiO_2, Na_2O, and K_2O contents with Na_2O/K_2O ratios > 1 and are metaluminous to weakly-peraluminous. They are enriched in large ion lithophile elements (LILE) and in Sr but depleted in high field strength elements (HFSE), with $(^{87}Sr/^{86}Sr)_i$ ratios of 0.7028–0.7044 and εNd(t) values varying from +5.74 to +7.76. The late-stage I-type granites are characterized by low contents of Si_2O and K_2O and relatively high contents of FeO, MgO, and Na_2O with Na_2O/K_2O ratios >1, and are metaluminous to weakly-peraluminous. They are also enriched in LILE and depleted in HFSE with Eu anomalies, $(^{87}Sr/^{86}Sr)_i$ ratios of 0.703–0.704, and εNd(t) values varying from +5.20 to +8.00. The A-type granites have high SiO_2 contents, high K calc-alkaline-shoshonitic affinities, positive εNd(t) values (5.76–7.77), and low initial $^{87}Sr/^{86}Sr$ ratios (0.7017–0.7045). Along with reported Sr-Nd isotopic data and regional geologic evidence the Early Carboniferous I-type granites are interpreted as products of partial melting of trapped oceanic crust triggered by underplated mantle wedge-derived basaltic magma; the Late Carboniferous–Early Permian I-type granites as derivatives of partially melted trapped oceanic crust; and the A-type granites as resulting from partial melting of trapped juvenile oceanic crust in an extensional regime. The A-type granitoids with high positive εNd(t) values and high Zr-saturation temperatures could be genetically related to a mantle plume or a regional-scale mantle upwelling in the CAOB.

1. Introduction

The Central Asian Orogenic Belt (CAOB) or Altaids, is a complex collage of ancient microcontinents, arc terranes, oceanic volcanic islands, oceanic crust, sediments and accretionary complexes (Sengor et al., 1993). The CAOB is not only the largest Phanerozoic juvenile crustal growth orogenic belt, but also the most significant accretionary orogenic belt and metallogenic domain in the world (Chen and Jahn, 2004; Hu et al., 2000; Jahn et al., 2004; Sengor et al., 1993; Windley et al., 2007; Xiao and Kusky, 2009; Xiao et al., 2010). Generally, continental crustal growth is dominated by lateral accretion of arc complexes in active continental margins and by underplating of mantle-derived basaltic magmas near or at the crust–mantle interface (Kay and Kay, 1988; Rudnick, 1990). Previous studies demonstrated that the CAOB represents the most significant mass transfer from the mantle to the continental crust in the Phanerozoic time (Chen and Arakawa, 2005; Chen and Jahn, 2004; Jahn et al., 2000, 2004). Numerous Paleozoic granitoids with positive εNd(t) values and young Nd model ages (T_{DM}) occur throughout the CAOB, providing crucial information on Phanerozoic crustal growth and the various tectonic settings and evolution of the CAOB (Chen and Jahn, 2004; Geng et al., 2009; Han et al., 1997, 2006; Jahn et al., 2000; Tang et al., 2010, 2012; Xu et al., 2013).

The West Junggar terrane is an important part of the CAOB, lying between the Tarim, Kazakhstan, and Siberian plates (Figs. 1 and 2; Feng et al., 1989; Pirajno et al., 2011; Sengor et al., 1993; Shen et al., 2010; Windley et al., 2007; Xiao et al., 2004, 2008). It is considered as one of the critical areas for study of the amalgamation history of the CAOB (Geng et al., 2009). A Phanerozoic crustal growth model for the CAOB is generally accepted due to a large number of granitic plutons

* Corresponding author.
E-mail address: longxiao@cug.edu.cn (L. Xiao).

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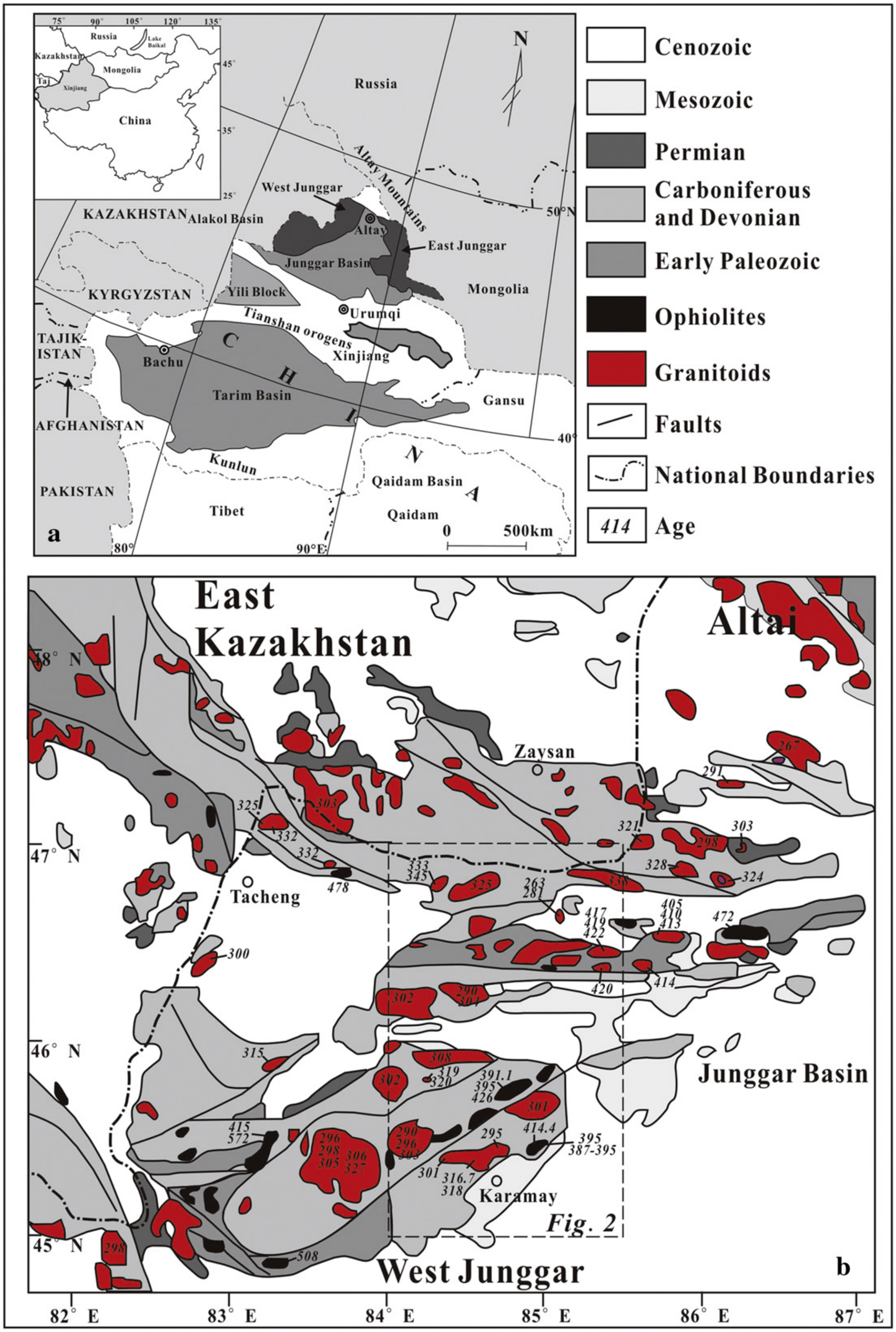

Fig. 1. (a) Xinjiang Uigur Autonomous Region (NW China) and its principal tectonic units (after Pirajno et al., 2011). (b) Simplified geological map of the West Junggar and adjacent Kazakhstan (modified after Chen et al., 2010a). Age data are from Chen et al., 2010a,b; Gao et al., 2006; Geng et al., 2009; Han et al., 2006; Kang et al., 2009; Liu et al., 2005; Su et al., 2006; Wei, 2010; Zhou et al., 2008 and this study.

and accretionary complexes in the belt (Han et al., 2006; Jahn et al., 2000; Sengor et al., 1993; Xiao et al., 2004). However, there are still debates among researchers over the Paleozoic granitoids in West Junggar, more specifically about the geochronological framework of magmatism (Chen et al., 2010a,b), the petrogenesis and tectonic setting of the I-type and A-type granitoids (Chen and Jahn, 2004; Chen et al., 2010a,b; Geng et al., 2009; Han et al., 1997, 2006; Tang et al., 2010; Zhou et al., 2008) and the thermal history (Chen and Jahn, 2004; Chen et al., 2010a; Su et al., 2006; Tang et al., 2012; Yin et al., 2010). Ridge subduction (Geng et al., 2009; Tang et al., 2012), intra-oceanic subduction (Wang