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Zircon ages and Hf isotopic compositions of Ordovician and Carboniferous granitoids from central Inner Mongolia and their significance for early and late Paleozoic evolution of the Central Asian Orogenic Belt

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ABSTRACT

We present zircon ages and Hf-in-zircon isotopic data for plutonic rocks and review the evolution of central Inner Mongolia, China, in the early and late Paleozoic. Zircons of a granodiorite yielded a $^{206}Pb/^{238}U$ age of 472 ± 3 Ma that reflects the time of early Paleozoic magmatism. Zircon ages were also obtained for a tonalite (329 ± 3 Ma), quartz-diorite (320 ± 3 Ma), and granite vein (297 ± 2 Ma). Our results, in combination with published zircon ages and geochemical data, document distinct magmatic episodes in central Inner Mongolia.

The dated samples are mostly granodiorite, tonalite and quartz-diorite in composition with intermediate to high-silica, high Na_2O (3.08–4.26 wt.%), low K_2O (0.89–2.86 wt.%), and high Na_2O/K_2O and Sr/Y ratios. Their chondrite-normalized REE patterns are characterized by LREE enrichment. In mantle-normalized multi-element variation diagrams they show typical negative Nb and Ta anomalies, and all samples display positive $\varepsilon_{Hf}(t)$ and $\varepsilon_{Nd}(t)$ values, and low I_{Sr}. The Ordovician rocks, however, show higher Sr/Y and La/Yb ratios than the Carboniferous samples, implying that the older granitoids represent adakitic granitoids, and the Carboniferous granitoids are typical subduction-related arc granitoids but also with adakite-like compositions. The results are compatible with the view that the Central Asian Orogenic Belt (CAOB) in Inner Mongolia evolved through operation of several subduction systems with different polarities: an early–middle Paleozoic subduction and accretion system along the northern margin of the North China Craton and the southern margin of the Mongolian terrane, and late Paleozoic northward subduction along the northern orogen and exhumation of a high-pressure metamorphic terrane on the northern margin of the North China Craton.

1. Introduction

Adakite was originally proposed as a genetic term to define intermediate to high-silica, high Sr/Y and La/Yb volcanic and plutonic rocks derived from melting of young, subducted lithosphere (Defant and Drummond, 1990). However, most volcanic rocks in modern island and continental arcs are probably derived from melting in the mantle wedge (Gill, 1981). Trace element chemistry with high Sr/Y ratios is a distinguishing characteristic of adakites (Defant and Drummond, 1990). Ordovician and Carboniferous granitoids with high Sr/Y ratios occur in central Inner Mongolia, which is situated on the southern margin of the Central Asian Orogenic Belt (CAOB, Jahn et al., 2000). This belt is a giant accretionary orogen (Windley et al., 2007), bounded by the Siberian, Tarim, and North China cratons (Jahn et al., 2000; Badarch et al., 2002), and reflects a complex evolution from the late Mesoproterozoic to late Paleozoic (Tang, 1990; Dobretsov et al., 1995; Xiao et al., 2003; Jian et al., 2007, 2008; Kröner et al., 2014). It is still debated whether the CAOB evolved through subduction and accretion of a single, long-lasting, subduction system (Sengör et al., 1993) or through several subduction systems with different polarities and through collision/accretion of arcs and microcontinents (Coleman, 1989; Mossakovskii et al., 1993; Kröner et al., 2007, 2014; Windley et al., 2007). Early Paleozoic (Tang, 1990; Shi et al., 2004, 2005a; Jian et al., 2008; Zhang and Jian, 2008; Zhang et al., 2013;

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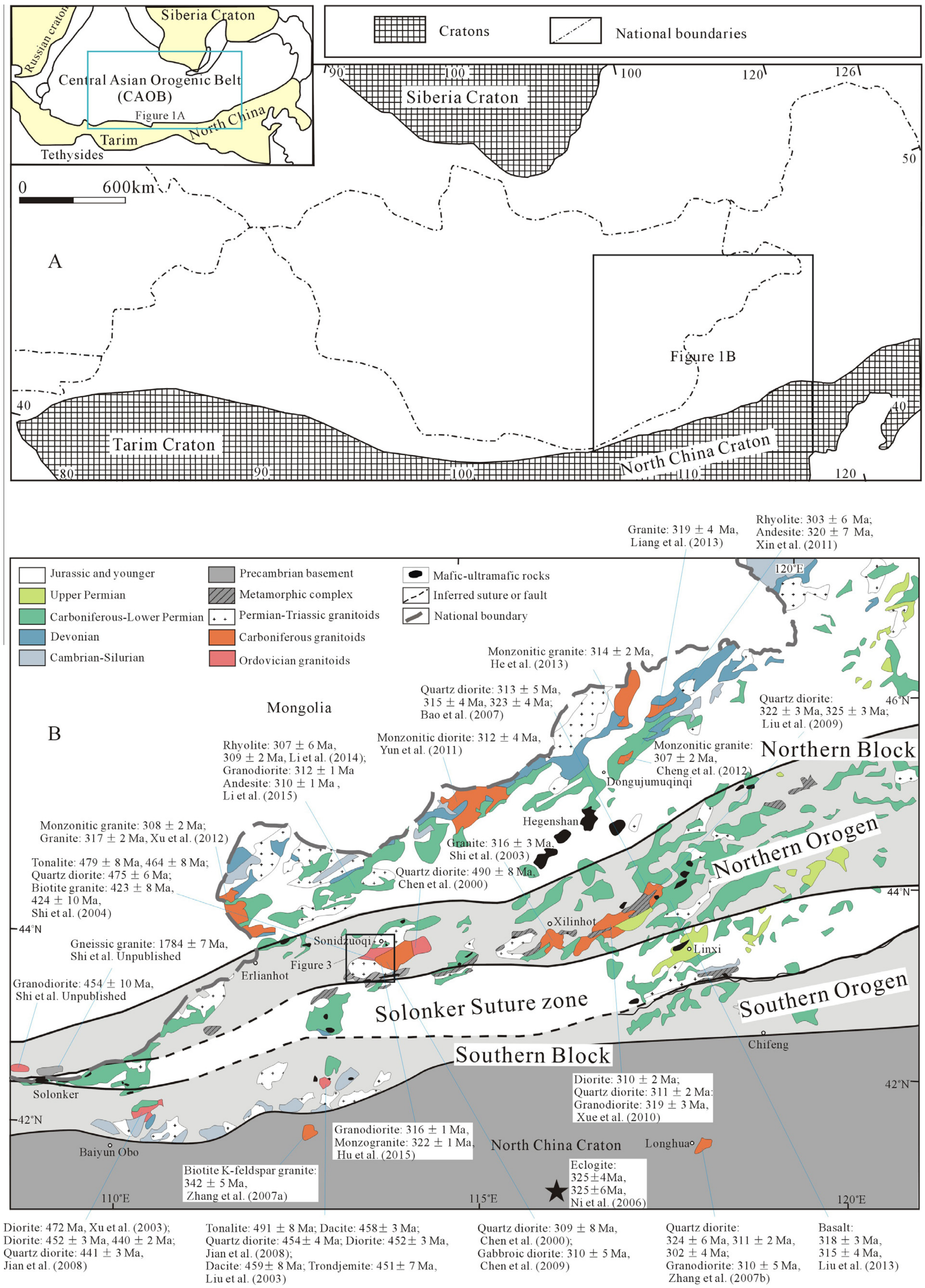

Fig. 1. Geological sketch map of the southeastern CAOB (the inset map of figure A compiled after Jahn et al., 2000; figure B after Miao et al., 2008; Jian et al., 2010). In figure B, the Solonker suture zone represents the tectonic boundary between the northern and the southern continental blocks (Jian et al., 2010). Position of Fig. 3 is marked.