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Zircon U–Pb and Hf isotopic study of gneissic rocks from the Chinese Altai: Progressive accretionary history in the early to middle Palaeozoic

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Abstract

Gneissic rocks in the Chinese Altai Mountains have been interpreted as either Paleozoic metasedimentary rocks or Precambrian basement. This study reports geochemical and geochronological data for banded paragneisses and associated gneissic granitoids collected along a NE–SW traverse in the northwestern Chinese Altai. Petrological and geochemical data suggest that the protoliths of the banded gneisses were possibly immature sediments with significant volcanic input and that the gneissic granitoids were derived from I-type granites formed in a subduction environment. Three types of morphological features can be recognized in zircons from the banded gneisses and are interpreted to correlate with different sources. Zircons from five samples of banded paragneiss cluster predominantly between 466 and 528 Ma, some give Neoproterozoic ages, and a few yield discordant Paleoproterozoic to Archean ages. Zircon Hf isotopic compositions indicate that both juvenile/mantle and crust materials were involved in the generation of the source rocks from which these zircons were derived. In contrast, zircons occur ubiquitously as elongated euhedral prismatic crystals in the four samples of the gneissic granitoids, and define single populations for each sample with mean ages between 380 and 453 Ma. The general absence of Precambrian inheritance and positive zircon εHf values for these granitoids suggest insignificant crustal contribution to the generation of the precursor magmas. Our data can be interpreted in terms of a progressive accretionary history in early to middle Palaeozoic times, and the Chinese Altai may possibly represent a magmatic arc built on a continental margin dominated by Neoproterozoic rocks.

Keywords: U–Pb age; Hf isotope; Gneiss; Zircon; Altaids

1. Introduction

The Central Asian Orogenic Belt (CAOB or Altaids or Altaid collage) is the largest Phanerozoic orogenic

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belt in the world, extending from the Urals in the west to the Pacific in the east and from Siberia in the north to the Tianshan in the south (Zonenshain et al., 1990; Mossakovsky et al., 1993; Şengör et al., 1993; Jahn et al., 2000a,b; Şengör and Natl'in, 2004; Windley et al., 2007). About 5.3 million km^2 of crustal materials were added to Asia along this belt, now found as fragments of island arcs, ophiolites, accretionary prisms, seamounts, and micro-continents, which were distributed in the Paleo-Asian Ocean, a long-lived ocean existed for 800 Ma from the late Mesoproerotoic to the Mesozoic (Khain et al., 2002; 2003; Windley et al., 2007; Kröner et al., in press, and references cited therein). In addition, voluminous granitoids from juvenile sources were emplaced in this region (Jahn, 2004 and references therein). Thus, this belt provides an excellent opportunity to study an accretionary orogen formed by continuous, long-lived subduction. However, unraveling the tectonic evolution of the CAOB is difficult because of the allochthonous nature of many terranes and their complicated amalgamation history. The tectonic settings of these terranes are controversial, thus leading to several competing models. For example, Şengör et al. (1993) proposed a single arc chain model that reconstructed the entire CAOB by oroclinally bending of the single Kipchak–Tuva–Mongol arc. In contrast, Didenko et al. (1994) and Mossakovsky et al. (1993) viewed the CAOB as a mosaic of exotic, and mostly unrelated arc terranes and microcontinents, a scenario similar to the present-day SW Pacific archipelago, which is in the process of becoming amalgamated to form an extensive new orogenic belt.

The Chinese Altai lies in the southern part of the CAOB and contains blocks of ophiolites, volcanic rocks, high-grade metamorphic rocks, and sedimentary sequences (Fig. 1). This varied assemblage makes the Chinese Altai not only an excellent natural laboratory in which to test the different models outlined above, but

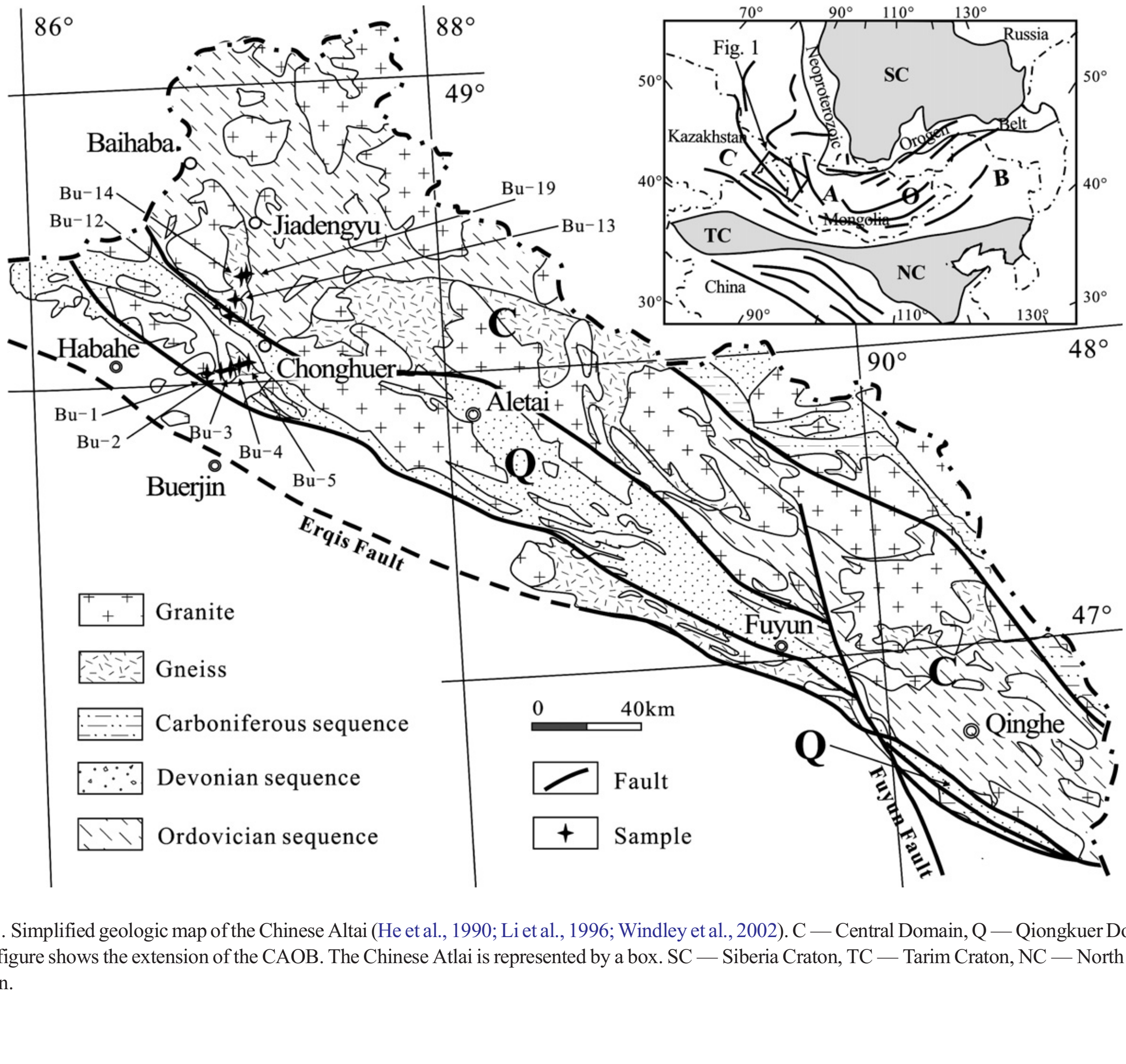

Fig. 1. Simplified geologic map of the Chinese Altai (He et al., 1990; Li et al., 1996; Windley et al., 2002). C — Central Domain, Q — Qiongkuer Domain. Inset figure shows the extension of the CAOB. The Chinese Atlai is represented by a box. SC — Siberia Craton, TC — Tarim Craton, NC — North China Craton.