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Precambrian tectonic attribution and evolution of the Songliao terrane revealed by zircon xenocrysts from Cenozoic alkali basalts, Xilinhot region, NE China

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ABSTRACT

U–Pb dating and Hf isotopic analyses were carried out on xenocrystic zircons from the Cenozoic alkali basalts in the Xilinhot region, NE China, to constrain the nature and evolution of the underlying Songliao terrane, and its role in the assembly of the Central Asian Orogenic Belt. Our data show a wide range of U–Pb age distributions, with Precambrian clusters of ca. 2500 Ma, 2400–2200 Ma, 2000–1700 Ma, 1500 Ma, 1000–800 Ma, 700–500 Ma, and Phanerozoic peaks at 494 Ma, 411 Ma, 312 Ma, 263 Ma, 214 Ma, 140 Ma and 44 Ma. The Phanerozoic age peaks are well-recognized in supracrustal rocks in the Songliao terrane or near the sample location. Although most Phanerozoic zircons have positive $\varepsilon_{Hf}(t)$ values, which is consistent with many locations throughout the Central Asian Orogenic Belt, some Phanerozoic ones have negative $\varepsilon_{Hf}(t)$ values and T_{crust} up to ca. 2.5 Ga, indicating the involvement of old crustal components during the Phanerozoic thermal events. More importantly, zircons with $^{207}Pb/^{206}Pb$ ages between ca. 2500 Ma and 1700 Ma have T_{crust} of 2.5–3.5 Ga, revealing the possible occurrence of unexposed Archean crustal remnants beneath the Songliao terrane, where no known supracrustal rocks are older than Neoproterozoic. Integrating the U–Pb and Hf isotopic results, we interpret the Songliao terrane as ancient in nature and with a complex crustal evolution history, including the addition of juvenile materials at ~2.5 Ga, reworking of pre-existing crustal components at 2.4–2.2 Ga, 2.0–1.8 Ga, 1.8–1.7 Ga, 1.0 Ga, 0.7–0.6 Ga, and massive crustal growth during the Phanerozoic. Comparing these data with the Precambrian zircon age distributions of other cratons or micro-continents, we suggest the Songliao terrane shows an affinity to both Monglia and NE Gondwana.

1. Introduction

The Central Asian Orogenic Belt (CAOB), sandwiched between the Siberian craton to the north and the Tarim-North China craton to the south (Fig. 1 inset), is one of the largest accretionary orogenic belts worldwide and represents a region of massive crustal growth during the Phanerozoic (Jahn et al., 2000; Jahn, 2004). It is currently accepted that this fold belt experienced a long and complicated formational process related to the breakup of the Rodinia supercontinent, subduction of the Paleo-Asian Ocean and amalgamation of a variety of terranes (Badarch et al., 2002; Khain et al., 2002, 2003; Kröner et al., 2007; Torsvik and Cocks, 2004; Windley et al., 2007; Xiao et al., 2003, 2009). However, due to different interpretations of the nature and origin of these terranes, there is still disagreement on an evolutionary model for the CAOB (i.e. Sengör and Burtman, 1993; Windley et al., 2007; Lehmann et al., 2010; Wilhem et al., 2012).

As the southeastern segment of the CAOB, NE China consists of several tectonic units, including the Erguna, Xing'an, Songliao, Jiamusi and Khanka terranes from west to east (Fig. 1). During the Paleozoic, the tectonic evolution of NE China was governed by the Paleo-Asian Ocean tectonic regime and characterized by the amalgamation of the terranes mentioned above. Whether the Jiamusi and Khanka terranes were involved is still controversial, as suggested by Wu et al. (2007a), Wilde et al. (2010), Zhou et al. (2010) and Wang et al. (2013). Since early Mesozoic time, NE China has been strongly overprinted by circum-Pacific tectonic events (Wu et al., 2002, 2011; Li, 2006; Xu et al., 2009, 2013; Meng et al., 2010;

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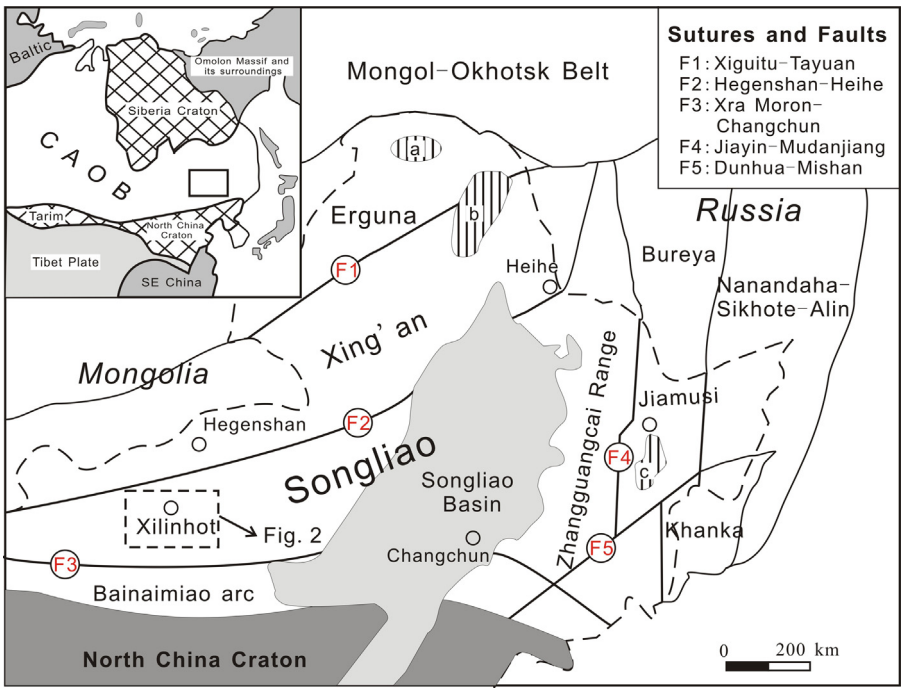

Fig. 1. Tectonic sketch map of terranes in NE China, modified after Wilde et al. (2010). a–c represents the Late Pan-African metamorphic belt including the Mohe complex (Zhou et al., 2011b), Xinghuadukou Group (Miao et al., 2007; Zhou et al., 2011a) and Mashan complex (Wilde et al., 2000), respectively. Inset shows the regional setting of the Central Asian Orogenic Belt (CAOB), with rectangle outlining the area of NE China. Dashed line is the boundary between China and Russia.

Zhang et al., 2010; Wang et al., 2012), or even affected by the closure of the Mongol-Okhotsk Ocean (Wang et al., 2006; Ying et al., 2010; Tang et al., 2014).

Due to these intensive Phanerozoic tectonic events, the tectonic attribution and evolution of terranes in NE China is highly unclear. It remains to be determined whether Precambrian basement exists and how the ancient crustal materials are distributed within these terranes. Understanding the fundamental natures of major constituent units in NE China is required to constrain tectonic models for the formation of the CAOB. The Songliao terrane is located in the center and occupies the largest area of the CAOB in NE China. Some high-grade metamorphic complexes, which were once considered as Precambrian basement rocks, have been interpreted to be formed in the early Paleozoic (Shi et al., 2003; Chen et al., 2009);

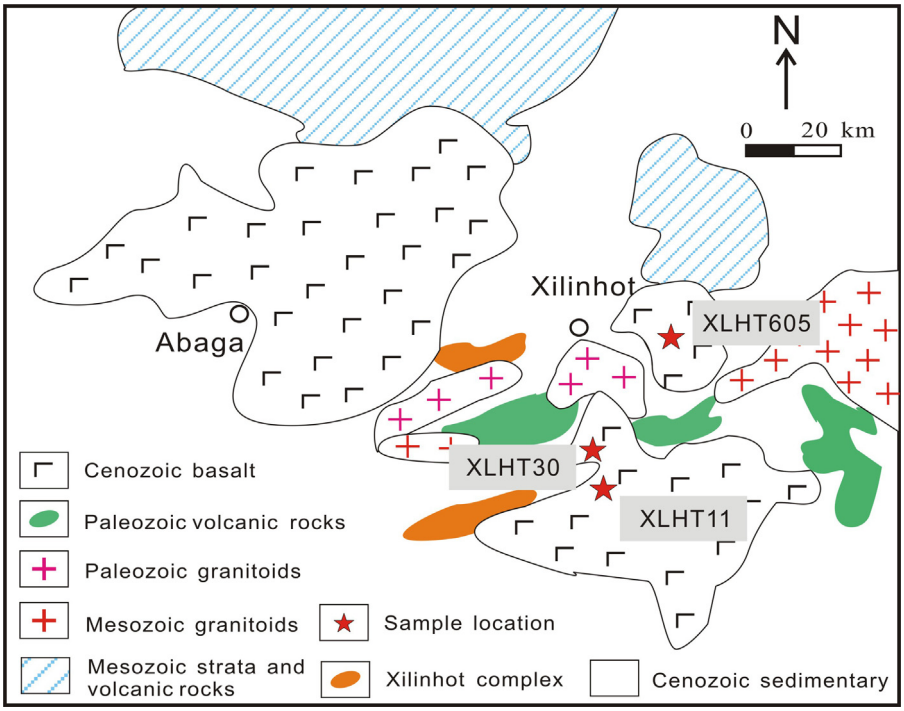

Fig. 2. Geological map of the studied area, southwestern Songliao terrane.

Modified from Zhang et al. (2006).