Journal of Asian Earth Sciences 123 (2016) 119–141

Contents lists available at ScienceDirect

Journal of Asian Earth Sciences

journal homepage: www.elsevier.com/locate/jseaes

Age and provenance constraints on seismically-determined crustal layers beneath the Paleozoic southern Central Asian Orogen, Inner Mongolia, China

Ping Jian [a], Alfred Kröner [a,b,*], Yuruo Shi [a], Wei Zhang [a], Yaran Liu [a], Brian F. Windley [c], Bor-ming Jahn [d], Liqao Zhang [e], Dunyi Liu [a]

[a] Beijing SHRIMP Center, Institute of Geology, Chinese Academy of Geological Sciences, Baiwanzhuang Road 26, Beijing 100037, China
[b] Institut für Geowissenschaften, Universität Mainz, D-55099 Mainz, Germany
[c] Department of Geology, University of Leicester, Leicester LEI 7RH, UK
[d] Institute of Earth Sciences, Taiwan National University, Nangang, Taipei 11529, Taiwan
[e] Inner Mongolian Institute of Geology, Hohhot 010055, China

ARTICLE INFO

Article history:
Received 6 October 2015
Received in revised form 1 April 2016
Accepted 1 April 2016
Available online 13 April 2016

Keywords:
Zircon xenocryst
Zircon O isotope composition
Intraplate basaltic rock
Seismic profile
Central Asian Orogenic Belt

ABSTRACT

We present 110 ages and 51 *in-situ* $\delta^{18}O$ values for zircon xenocrysts from a post-99 Ma intraplate basaltic rock suite hosted in a subduction–accretion complex of the southern Central Asian Orogenic Belt in order to constrain a seismic profile across the Paleozoic Southern Orogen of Inner Mongolia and the northern margin of the North China Craton. Two zircon populations are recognized, namely a Phanerozoic group of 70 zircons comprising granitoid-derived (ca. 431–99 Ma; $n = 31$; peak at 256 Ma), meta-granitoid-derived (ca. 449–113 Ma; $n = 24$; peak at 251 Ma) and gabbro-derived (436–242 Ma; $n = 15$; peaks at 264 and 244 Ma) grains. Each textural type is characterized by a distinct zircon oxygen isotope composition and is thus endowed with a genetic connotation. The Precambrian population (2605–741 Ma; $n = 40$) exhibits a prominent age peak at 2520 Ma (granulite-facies metamorphism) and four small peaks at ca. 1900, 1600, and 800 Ma. Our new data, together with literature zircon ages, significantly constrain models of three seismically-determined deep crustal layers beneath the fossil subduction zone–forearc along the active northern margin of the North China Craton, namely: (1) an upper arc crust of early to mid-Paleozoic age, intruded by a major Permian–Triassic composite granitoid–gabbroic pluton (8–20 km depth); (2) a middle crust, predominantly consisting of mid-Meso- to Neoproterozoic felsic and mafic gneisses; and (3) a lower crust composed predominantly of late Archean granulite-facies rocks. We conclude that the Paleozoic orogenic crust is limited to the upper crustal level, and the middle to lower crust has a North China Craton affinity. Furthermore, integrating our data with surface geological, petrological and geochronological constraints, we present a new conceptual model of orogenic uplift, lithospheric delamination and crustal underthrusting for this key ocean–continent convergent margin.

1. Introduction

The Southern Orogen of Inner Mongolia (Jian et al., 2007; Eizenhöfer et al., 2014, 2015) constitutes the southernmost segment of the Central Asian Orogenic Belt (CAOB) in northern China (Fig. 1A). It comprises, from north to south, an early to mid-Paleozoic subduction–accretion complex, a supra-subduction zone (SSZ)-type ophiolite with plutonic forearc rocks, a magmatic arc (Jian et al., 2008; Zhang et al., 2013) and a (retroarc) foreland basin built on North China Craton crust (Xu et al., 2013; Song et al., 2015). The surface geology suggests southward oceanic subduction beneath the northern margin of the North China Craton (NCC) (Fig. 1B; Xiao et al., 2003; Zhang et al., 2013). However, seismic images (Li et al., 2013; Zhang et al., 2014a) clearly show that the underlying middle to lower crust consistently dips to the north along the northern margin of the North China Craton (Fig. 1C). Zhang et al. (2014a) interpreted these crustal reflectors to portray a northward-dipping foreland fold-and-thrust belt in which thrusting became younger southwards and cratonwards from the late Permian to late Triassic (Wang et al., 2013).

* Corresponding author at: Institut für Geowissenschaften, Universität Mainz, D-55099 Mainz, Germany.
E-mail address: kroener@uni-mainz.de (A. Kröner).

http://dx.doi.org/10.1016/j.jseaes.2016.04.001
1367-9120/

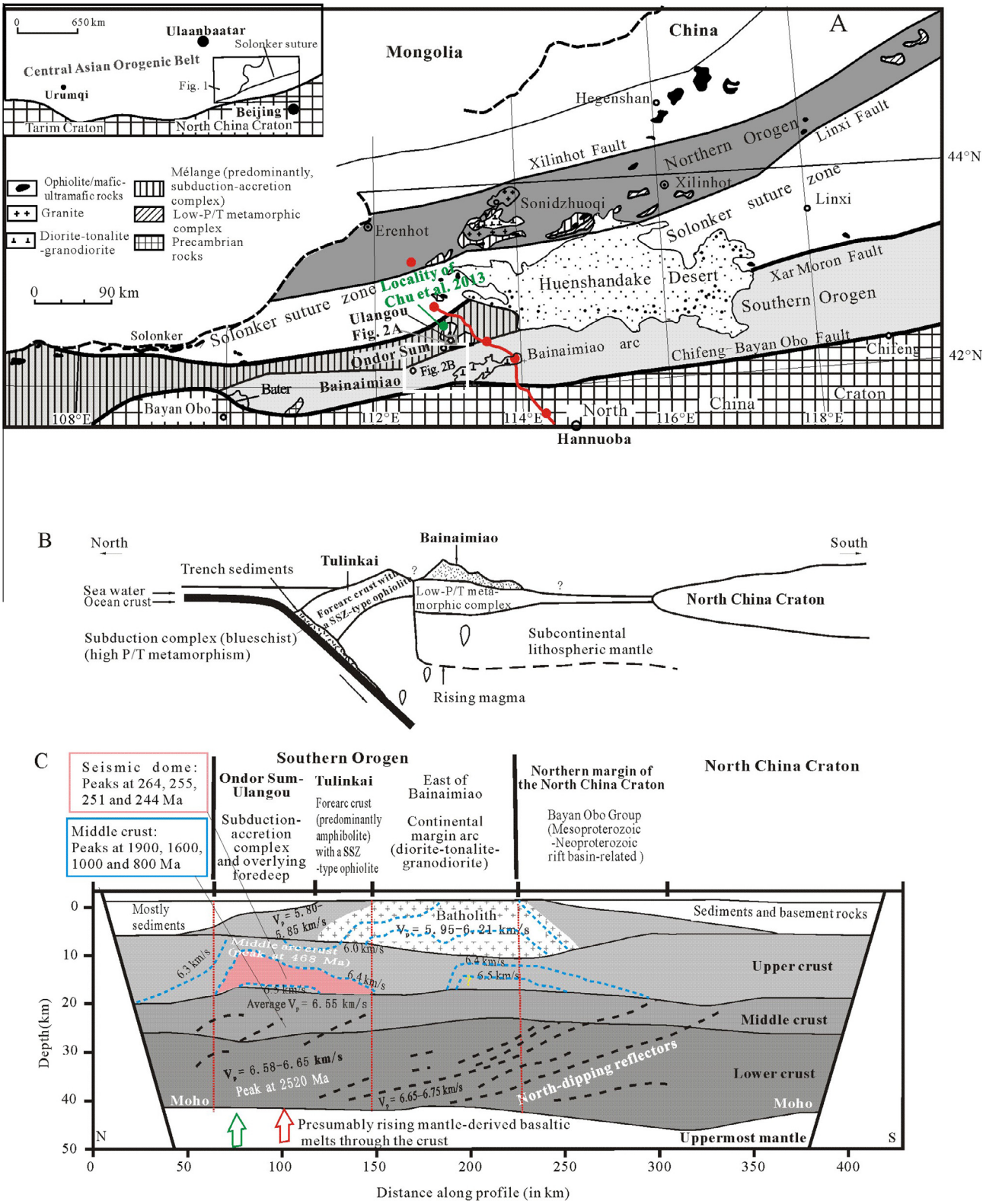

Fig. 1. (A) Sketch map of the geology of Inner Mongolia showing the northern (dark gray) and southern (light gray) early to mid-Paleozoic orogens separated by the Permian Solonker suture (Li, 2006; Jian et al., 2008, 2010; Eizenhöfer et al., 2014, 2015). Positions of the seismic section (red line) and Fig. 2A and B are marked. The Hegenshan mafic–ultramafic massifs in the north (five black areas) have Carboniferous and Cretaceous ages (Jian et al., 2012a). Inset shows the location of Inner Mongolia in the Central Asian Orogenic Belt. (B) Schematic section across the Southern Orogen showing the tectonic development of a convergent margin (Zhang et al., 2013). (C) Interpreted seismic section across the Southern Orogen and the northern margin of the North China Craton (Li et al., 2013). Red arrow marks possible starting point of basaltic melts in the upper mantle, and green arrow shows a starting point of melts according to Chu et al. (2013). The two locations are about 25 km apart. For interpretation see text. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)