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Fine crustal structure and deformation beneath the Great Xing'an Ranges, CAOB: Revealed by deep seismic reflection profile

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ABSTRACT

A crustal seismic reflection profile across the Great Xing'an Ranges (GXAR) was recorded in 2011 revealed features of crustal structure and deformation at the eastern margin of the Central Asian Orogenic Belt (CAOB). The reliability of crust and upper mantle image was improved by rigorous regulations of seismic data acquisition and a series of special procedures for seismic data processing. The diversiform seismic reflection fabrics within deep-crust to mantle transition zone (TWT (Two-way time), 12–14 s, approximately 36–42 km) beneath GXAR reflects the complicated products of tectonic and magmatic interaction of lower-crustal and mantle components during evolution of GXAR. Preliminary processing result shows the contact relationship of the GXAR and adjacent basins. We can identify lots of curved reflection phases from volcanic rock and opposite Moho reflection events. This scenario may suggest multi-times tectonic transformation from contraction to extension. Presumably, its cause of formation reflects the comprehensive dynamic action of the Mongolia-Okhotsk tectonic system and the Circum Pacific tectonic system.

1. Introduction

The Great Xing'an Ranges (also called the Daxing'anling Mountains, Da Hinggan Ling ranges in some literatures, or called Greaker Khingan Range in Wikipedia, short for GXAR in this text) (Fig. 1b) as the eastern part of the CAOB (Central Asian Orogenic Belt) (Sengör et al., 1993; Sengör and Natal'in, 1996a, 1996b; Jahn et al., 2000, 2001; Xiao et al., 2009, Fig. 1a) with much broader in the north (306 km) than it is in the south (97 km) is one of the remarkably reworked crustal Phanerozoic accretionary belts in the world (Sengör et al., 1993; Wilde and Wu, 2001; Windley et al., 2001; Badarch et al., 2002; Xiao et al., 2003, 2008, 2009, 2010). The eastern sector of the Central Asian Orogenic Belt includes Northeast China and adjacent regions of the Russian Far East and is characterized by the collision of micro-continental blocks during the Phanerozoic time marking the broad collision zone between the North China craton and Siberian craton (Fig. 1b). Compared with the crowded investigations performed on the middle and western segments of the CAOB under the enthusiasm of the international geological community (Dobretsov et al., 2003, 2006; Xiao et al., 2003, 2004, 2008, 2009, 2010; Xiao et al., 2011, 2013, 2014; Buslov et al., 2004; Buslov, 2011; Klemd et al., 2005; Charvet et al., 2007, 2011; Windley et al., 2001,2007;Gao et al., 2009; Han et al., 2010a, 2010b; Kröner et al., 2010, 2012; Lehmann et al., 2010; Long et al., 2010, 2012;), there were some researches conducted long-held studies on the eastern sector of the belt (Wu et al., 2000, 2002, 2007a; Li et al., 2009; Xu et al., 2009; Liu et al., 2010; Zhou et al., 2009a,b, 2010, 2011). Some geophysical studies intended to obtain the crustal and upper mantle structure in this region (Lu and Xia, 1993; Yang et al., 1996; Fu, 1996; Fu et al.,1998; Huang and Zhao, 2006; Tian et al., 2011; Zhao and Tian, 2013; Zhang et al., 2013, 2014a, 2014b; Pan et al., 2014). Seismic studies from P-wave, S-wave and ambient noise tomography have provided lots of significant findings covering the entire lithosphere and asthenosphere, especially the images of some important boundaries inside the earth, such as the Moho, the lithosphere–asthenosphere boundary (LAB), 410-km, and 660-km discontinuities. However, the ongoing convergence between micro-continental blocks in Northeast China not only resulted in the fluctuant inner boundaries, but also deformed the interior of the plate causing a more complex crustal structure. Thus a fine crustal image beneath GXAR is fundamental for understanding the deformation and dynamics of intercontinental orogeny.

Deep seismic reflection imaging is effective to understand crustal and upper-mantle structures, which has been proven particularly successful all over the world (Brown, 2013) in the studies of

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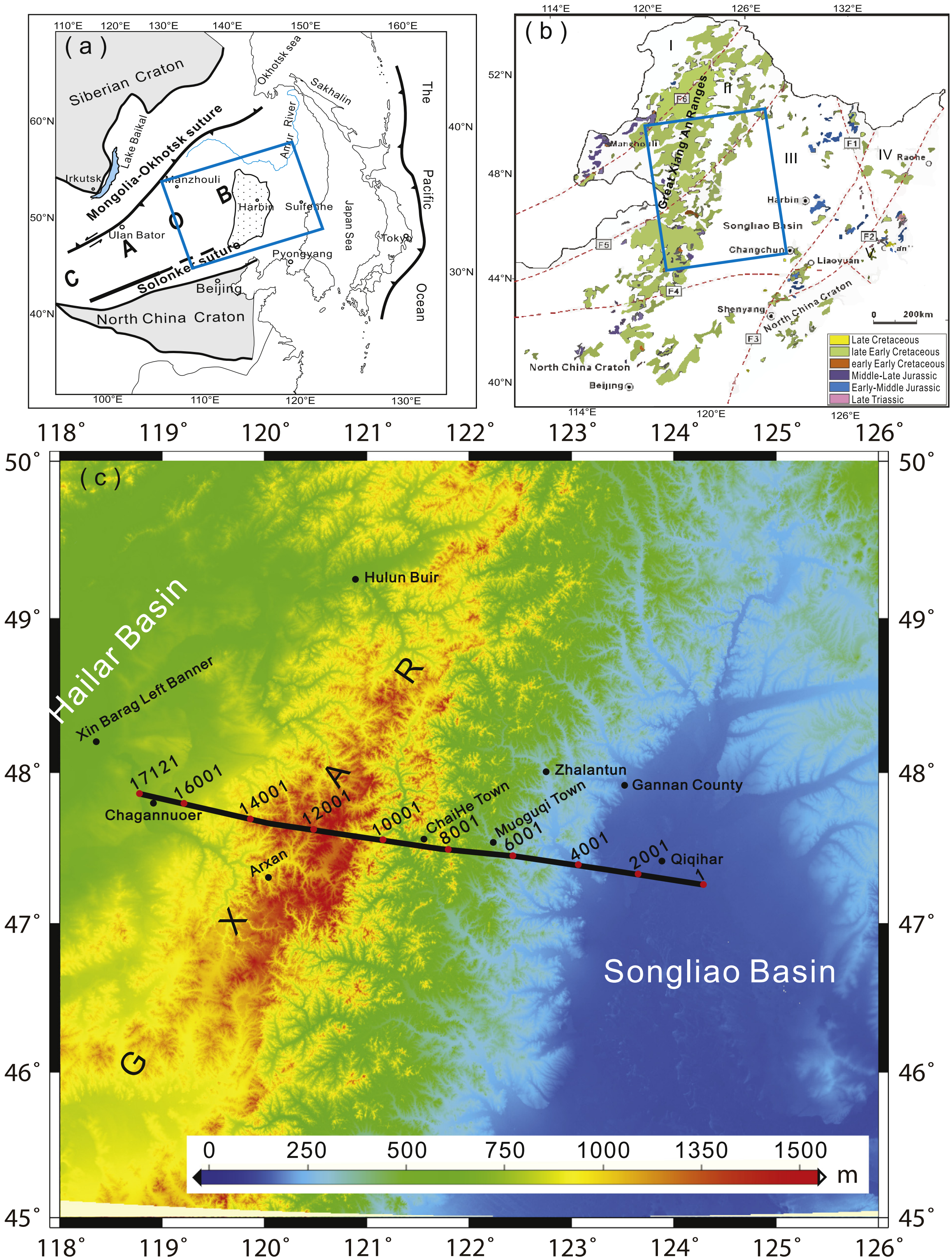

Fig. 1. (a) Shows the tectonic outlines of NE China, modified after Tong (2012). Fig. 1b is outlined by a rectangle. (b) Tectonic subdivisions of northeastern (NE) China and distribution of Mesozoic volcanic rocks in NE China, modified after Xu et al. (2013). F1: Jiayin–Mudanjiang fault; F2: Dunhua–Mishan fault; F3: Yilan–Yitong fault; F4: Solonker–XarMoron–Changchun suture; F5: Hegenshan–Nengjiang–Heihe fault; F6: Tayuan–Xiguitu fault; and F7: Monogol–Okhotsk belt. I: Erguna; II: Xing'an; III: Songnen–Zhangguangcai Range; IV: Jiamusi; V: Khanka. The location of Fig. 1c is outlined by a rectangle. (c) Topography map of GXAR and adjacent area. Black line represent the location of deep seismic reflection profile.