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Review

Late Jurassic–Early Cretaceous continental convergence and intracontinental orogenesis in East Asia: A synthesis of the Yanshan Revolution

Shuwen Dong [a,*], Yueqiao Zhang [a], Fuqin Zhang [b], Jianjun Cui [a], Xuanhua Chen [c], Shuanhong Zhang [a], Laicheng Miao [b], Jianhua Li [a], Wei Shi [a], Zhenhong Li [a], Shiqi Huang [a], Hailong Li [a]

[a] Institute of Geomechanics, Chinese Academy of Geological Sciences, Beijing 100081, China
[b] Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China
[c] Chinese Academy of Geological Sciences, Beijing 10037, China

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ABSTRACT

The basic tectonic framework of continental East Asia was produced by a series of nearly contemporaneous orogenic events in the late Middle Jurassic to Early Cretaceous. Commonly, the Late Mesozoic orogenic processes were characterized by continent–continent collision, large-scale thrusting, strike-slip faulting and intense crustal shortening, crustal thickening, regional anatexis and metamorphism, followed by large-scale lithospheric extension, rifting and magmatism. To better understand the geological processes, this paper reviews and synthesizes existing multi-disciplinary geologic data related to sedimentation, tectonics, magmatism, metamorphism and geochemistry, and proposes a two-stage tectono-thermal evolutionary history of East Asia during the late Middle Jurassic to Early Cretaceous (ca. 170–120 Ma). In the first stage, three orogenic belts along the continental margins were formed coevally at ca. 170–135 Ma, i.e., the north Mongol–Okhotsk orogen, the east paleo-Pacific coastal orogen, and the west Bangong–Nujiang orogen. Tectonism related to the coastal orogen caused extensive intracontinental folding and thrusting that resulted in a depositional hiatus in the Late Jurassic, as well as crustal anatexis that generated syn-kinematic granites, adakites and migmatites. The lithosphere of the East Asian continent was thickened, reaching a maximum during the latest Jurassic or the earliest Cretaceous. In the second stage (ca. 135–120 Ma), delamination of the thickened lithosphere resulted in a remarkable (>120 km) lithospheric thinning and the development of mantle-derived magmatism, mineralization, metamorphic core complexes and rift basins. The Middle Jurassic–Early Cretaceous subduction of oceanic plates (paleo-Pacific, meso-Tethys, and Mongol–Okhotsk) and continent–continent collision (e.g. Lhasa and Qiangtang) along the East Asian continental margins produced broad coastal and intracontinental orogens. These significant tectonic activities, marked by widespread intracontinental orogeny and continental reconstruction, are commonly termed the Yanshan Revolution (Movement) in the Chinese literature.

Contents

* Corresponding author at: Institute of Geomechanics, Chinese Academy of Geological Sciences, 11 Minzudaxue Nanlu, Beijing 100081, China.
E-mail addresses: swdong@cags.ac.cn, shuwen.dong@gmail.com (S. Dong).

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1. Introduction

The Middle Jurassic to Early Cretaceous tectonic evolution of the East Asian continent was characterized by intense syn-orogenic crustal shortening, thickening, anatexis and metamorphism (Ren et al., 1984; Zhao et al., 1994; Yin and Nie, 1996; Dong et al., 2000; Zhang et al., 2007; Shi et al., 2012; S.Z. Li et al., 2012, 2013; L.H. Li et al., 2013), and subsequent (post-orogenic) crustal extension, rifting and magmatism (Wu et al., 2005a; S.Z. Li et al., 2012; J.H. Li et al., 2013, 2014). These Late Mesozoic tectonothermal events in East Asia are commonly called the Yanshan Revolution (or Movement) in the Chinese literature (Davis et al., 2001; Davis and Darby, 2010; Deng et al., 2004a; Dong et al., 2007). Despite a great deal of attention being paid to the Jurassic orogenesis in East Asia since the 1920s (e.g. Wong, 1927, 1929; Konno, 1928; Maruyama et al., 1989; Yin and Nie, 1996; Dong et al., 2008), controversy still exists regarding its nature and the geodynamic framework in which it occurred.

In general, the Late Mesozoic (ca. 170–120 Ma) tectonic evolution (Yanshan Revolution) in East Asia can be divided into two stages. In the first stage (ca. 170–135 Ma), the continent underwent extensive orogenic activity (Maruyama et al., 1989; Dong et al., 2007; Y.Q. Zhang et al., 2009; Lim and Cho, 2011; Charvet, 2013), as expressed by the following tectonic processes: (1) Formation of the north Mongol–Okhotsk orogen, the east paleo-Pacific coastal orogen, and the west Bangong–Nujiang orogen; (2) formation of extraordinarily long accretionary mélange belts (>5000 km) along continental margins (Maruyama et al., 1997; Wu et al., 2007a; Isozaki et al., 2010); (3) intracontinental deformation involving thrusting and overthrusting, regional metamorphism and magmatism (Davis et al., 2001; Y.Q. Zhang et al., 2008; J.H. Li et al., 2013); (4) widespread development of molasse-like sediments in the forelands of most orogenic belts (Eberth et al., 2001; P. Yang et al., 2007; Z. Li et al., 2007; Qu et al., 2009; S.F. Liu et al., 2010; Z.H. Li et al., 2013); and (5) pervasive development of a regional unconformity beneath the Lower Cretaceous strata (Yang, 1984; Zhao et al., 2002, 2004b; Y.Q. Zhang et al., 2008; J. H. Li et al., 2014). In the second stage (ca. 135–120 Ma), a remarkable delamination of the thickened continental lithosphere resulted in asthenospheric mantle upwelling, large-scale crustal extension (Deng et al., 2004b; Wu et al., 2005a; Zhai et al., 2007; Lin et al., 2013) and widespread magmatism and mineralization (Jahn et al., 2001; Zhai et al., 2002; Hart et al., 2002; Yang et al., 2003, 2006; Mao et al., 2003, 2008; F. Wang et al., 2006). This crustal extension also formed numerous pull-apart and rifted basins (Gilder et al., 1991; Tian et al., 1992; Li et al., 1995; Ren et al., 2002; Meng et al., 2003; J.H. Li et al., 2012), metamorphic core complexes and domal structures (Davis et al., 1996; J. Liu et al., 2005; T. Wang et al., 2011, 2012; J.H. Li et al., 2013).

There are many important unresolved problems related to the Late Mesozoic tectonic and magmatic processes in East Asia. These include the ages of the three continental marginal orogenic belts, the timing and structural styles of the intracontinental deformation, the timing and cause of the transition from syn-orogenic compression to post-orogenic extension and whether there was a genetic relationship between Jurassic orogenesis and destruction of the Early Cretaceous craton.

This paper attempts to summarize and synthesize existing multi-disciplinary geological data related to Late Mesozoic tectonic deformation, sedimentation, magmatism and metamorphism in the East Asian continent. On the basis of this summary, we present a global tectonics view of the Jurassic orogenesis and the subsequent extension. We describe the dynamic setting of the Yanshan Revolution, and the tectonic significance of the simultaneous multi-plate convergence in East Asia.

1.1. The late Middle Jurassic to Early Cretaceous orogenic belts along the East Asian continental margins

1.1.1. Mongol–Okhotsk collisional orogenic belt of northern East Asia

Located in the northern part of Mongolia and the Transbaikal regions of Russia, the Mongol–Okhotsk orogenic belt is the youngest of the Central Asian Orogenic Belts (Figs. 1 and 2). It formed during closure of the Mongol–Okhotsk Ocean and subsequent collision of the surrounding landmasses, such as the Siberian Block (SIB), the Amur Superterrane (AST) and the North China Block (NCB) (Fig. 1). The ophiolite belt associated with this orogen passes through central Mongolia and Transbaikalia and extends to the sea of Okhotsk (Tomurtogoo et al., 2005). Late Jurassic and Early Cretaceous magmatic rocks are widely distributed in a zone within the belt (Zorin et al., 2001; Berzina et al., 2014), and their location relative to the ophiolites in the orogen indicates that the Mongol–Okhotsk Oceanic plate was subducted beneath the Siberian Block (Vander Voo et al., 1999). Many different views exist on the time