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The western Central Asian Orogenic Belt: A window to accretionary orogenesis and continental growth

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ABSTRACT

The architecture of accretionary orogens is a key to understand continental growth. Here we present an overview of the orogenic components and their amalgamation in the western Central Asian Orogenic Belt (CAOB). The CAOB records the convergence and interactions among various types of orogenic components including the Japan-type, Mariana-type, and Alaska–Aleutian-type arc systems, as well as the active marginal sequences of the Siberia Craton, which incorporated wide accretionary complexes and accreted arcs and terranes. During construction of the CAOB, the Kazakhstan arc chain was characterized by multiple subduction, whereas the northern fringe of the Tarim Craton remained mostly as a passive margin. The multiple convergence and accretions among these various orogenic components generated huge orogenic collages in the late Paleozoic and even in the early Triassic, involving parallel amalgamation, circum-microcontinent amalgamation and oroclinal bending. The preservation of trapped basins played a significant role in orogenesis with some parts of the oceanic plate being subducted and others behaving as rigid units. The orogenesis in the CAOB was long-lived, lasting for more than 800 m.y., involving multiple-subduction and long, continuous accretion, and featuring the complexity of accretionary orogenesis and continent growth.

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1. Introduction

Orogens are the hallmarks of the interaction among lithospheric plates. The formation of orogens along consuming plate boundaries has been broadly classified into accretionary-type (also known as Pacific-type) and collision-type (Maruyama, 1997; Cawood et al., 2009; Santosh and Kusky, 2010; Santosh et al., 2010). Diverse lithospheric responses to plate margin stresses also lead to a third type — the intra-continental or intra-plate orogens (Cawood et al., 2009; Aitken et al., 2013). Investigations in Precambrian terranes have established that most collisional orogens went through a prolonged Pacific-type subduction–accretion history prior to the final collisional stage (Santosh et al., 2009, 2013a,b).

Accretionary orogens have been active throughout Earth history and were responsible for the major growth of the continental lithosphere through time (Cawood et al., 2009). In addition to the building and reworking of continental crust, substantial volumes of continental crust have also been destroyed at convergent margins during accretionary orogenesis (Yamamoto et al., 2009; Stern, 2011). Many of the fundamental aspects of accretionary orogenesis remain controversial and the major questions include the mechanism of construction of these orogens and the duration of the orogenesis. Regarding the mechanism, some workers invoke the collision of multiple blocks (Massakovsky et al., 1993), whereas others propose the duplication of a single long linear arc belt by slicing and bending (Şengör et al., 1993). In the latter case, the duration of the orogenic cycle is also debated, with one school of thought considering a short-lived process (Dewey, 2005), and the other school arguing for a long-lived and global orogenesis (Dalziel, 1997; Dalziel et al., 2000; Cawood and Buchan, 2007).

The Central Asian Orogenic Belt (CAOB) is one of the largest orogenic collages in the world which preserves important evidence for accretionary orogenesis and Phanerozoic continental growth (Şengör, 1991; Şengör and Okurogullari, 1991; Şengör et al., 1993; Chen and Jahn, 2004; Jahn et al., 2004; Kröner et al., 2007; Ota et al., 2007; Safonova et al., 2009, 2011; Wu et al., 2011; Safonova et al., 2012; Kröner et al., 2013; Safonova and Santosh, 2014; Kröner et al., 2014). Notwithstanding the recent debate on the proportion of juvenile material versus reworked older crust involved in the construction of the CAOB (Kröner et al., 2014), this huge Phanerozoic belt offers a natural laboratory to address the mechanisms of accretionary orogenesis, and is a window to explore the processes of formation of accretionary orogens and continental growth. The CAOB occupies an enormous area, bound by the Siberian Craton in the north, the East European Craton in the west, and the cratonic blocks of Tarim and North China in the south (Fig. 1a). The accretionary tectonics in the CAOB is best documented in two key areas, one is in North Xinjiang in China and Kokchetav–Balkash in Kazakhstan in the west, and the other is in Inner Mongolia in the east, together with the neighboring Mongolia and part of southern Russia. The tectonics of these two key areas is characterized by formation of the "Kazakhstan" and "Tuva–Mongol" oroclines, respectively (Şengör and Natal'in, 1996; Xiao et al., 2004a,b, 2008, 2010a; Wilhem et al., 2012; Li, 2013).

The eastern key area characterized by the Tuva–Mongol orocline was tectonically overprinted by the consumption of the Mongol–Okhotsk Ocean in the north. Its subduction elements are generally parallel to those of the CAOB and its termination in the Mesozoic (late Jurassic to early Cretaceous), which might have disrupted and complicated the general orogenic cycles of the CAOB. The western key area characterized by the Kazakhstan orocline retained its termination history mostly in the late Paleozoic to mid-Triassic, and the entire tectonic record is relatively intact including the interactions among the southern Siberian active margin in the north and the Tarim Craton in the south, without considerable overprint from some of the young subduction events. Therefore the western CAOB provides an ideal region to address the mechanism of construction of these orogens as well as the duration of the orogenesis.

In this paper we focus on the western CAOB in North Xinjiang in China and Kokchetav–Balkash areas in Kazakhstan (Fig. 1), a region that was built through continuous and complex accretion along the wide southern active margin of Siberia. The region is characterized by the formation of various components, represented by arc systems and cratonic blocks. We review the major orogenic components and their styles of construction in this part of the CAOB. We also present an overview of the features associated with the commencement and culmination of continent building process in the CAOB, which have important implications for the architecture of accretionary orogens elsewhere on the globe.

2. Multiple arc systems

Accretionary orogens are directly or indirectly related to the subduction of oceanic plate(s), generating different types of arcs (Isozaki, 1996,

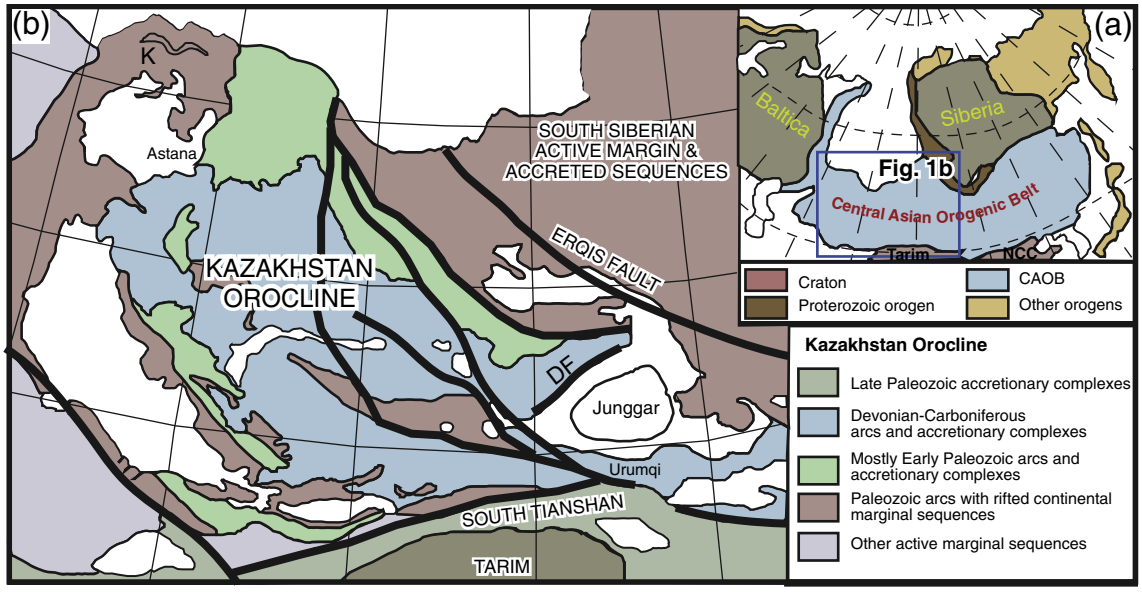

Fig. 1. (a) Location of the Central Asian Orogenic Belt, including the major cratons and orogenic belts of Eurasia. (b) Tectonic map of Kazakhstan-North Xinjiang. DF—Darbute fault; K—Kokchetav; NCC—North China Craton.
Panel b is modified and simplified from Windley et al. (2007) and Choulet et al. (2012).