Orogeny of the intra-continental collage in the Central Asia

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Triangular block zone surrounded by Siberian craton, North China craton and Kazakhstan Block, often called the Central Asian Orogenic Belt (CAOB, e.g., Jahn et al., 2000), has been paid attention by many geologists to clarify the long-term subduction-collisional orogeny during Phanerozoic (e.g., Sengor et al., 1993).

Currently, two-types of orogeny has been accepted; Pacific-type and collision-type (Dewey and Bird, 1970; Matsuda and Uyeda, 1971). The early Pacific-type (or Miyashiro-type, Maruyama, 1997) is characterized by formation of subduction-accretion complexes and extensive calc-alkaline volcani-plutonism, resulting in voluminous continental growth, whereas the following collision-type strongly modifies pre-existing structure. At the orogenic climax in both stages, regional high-pressure (HP) or ultrahigh-pressure(UHP) metamorphic belts are exhumed. Thus, orogenic elements can be proposed as follows; the Pacific-type associates the HP metamorphic belt and TTG batholith belt, and the collision-type contains the metamorphic belt with UHP relics, which often associates the foreland fold-and-thrust belt.

In the CAOB, three Pacific-type orogens, formed at 650Ma, 560Ma and 440Ma, are present. The best example at 560Ma can be found in Gorny Altai (e.g., Buslov et al., 1993); it consists of an accretionary complex with Vendian-Early Cambrian seamounts, and Cambrian calc-alkaline volcano-plutonic rocks covered by fore- and intra-arc basin sedimentary rocks. The accretionary complex is overlain by a thin slab of HP metamorphic rocks and further by the island arc sequences. Granite-gneiss dome has intruded into the island arc complexes. The accretionary complex is composed of limestone without terrigenous materials, greenstones, and a trace amount of chert. Protoliths of the HP metamorphic rocks include serpentinite, basaltic rocks, and minor carbonate, chert and hemipelagite. The protolith assemblage of the Altai subduction-accretion complex is comparable to those of the Pacific-type orogenic belt. However, the absence of materials derived from a matured continent and thick pelagic sediments suggests that the subduction-accretion complex has formed at a mid-oceanic environment where an intra-oceanic arc was developed through a subduction of oceanic plate with seamounts or oceanic plateau (Ota et al., 2007).

A typical example of the collision-type can be recognized in Kazakhstan (Dobretsov et al., 1995), where is composed of several Precambrian units, Cambro-Ordovician island arc-related volcano-sedimentary rocks, and Devonian volcanic molasses, intruded by multi-stage granitic series. The Precambrian units include collisional complex, in which the Kokchetav UHP metamorphic belt is sandwiched between an overlying feeby metamorphosed and an underlying low-pressure metamorphic units with subhorizontal fault contacts. Their protoliths contain quartzo-feldspacic rocks, peraluminous sediments, graphite-bearing mudstone and sandstone, carbonate, and basaltic rocks. The sedimentary protoliths, without bedded chert that often appears in the Pacific-type, are characteristic in the passive continental margin setting, i.e., collision-type orogenic belt. These features suggest that the Kazakhstan subduction-collision complex has been formed by subduction of a matured oceanic lithosphere with a fragmented continental crust, followed by the Paleozoic island arc collisions (Maruyama et al., 2002).

The recognition of two kinds of orogens suggests that two orogenic culminations of the Pacific at 560Ma and 440Ma seem to have occurred in the oceanic domain before the final closure of the Paleo-Asian Ocean. The collision and subduction of the Kokchetav occurred also within the oceanic domain under an island arc. The Paleo-Asian Ocean may be analogous to the modern western Pacific.