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Crustal Accretion and Reworking within the Khanka Massif: Evidence from Zircon Hf Isotopes of Phanerozoic Granitoids

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1 ABSTRACT

The Central Asian Orogenic Belt (CAOB) is one of the largest Phanerozoic accretionary orogen. (Windley et al., 1990, 2007; Jahn et al., 2000a, b, c; Yakubchuk, 2002, 2004; Xiao et al., 2003, 2004). It is the optimal study area for revealing the accretion and reworking processes of the continental crust. The Khanka Massif is located in the most eastern part of the CAOB, and mainly crops out in the territory of Russia, with a small segment in NE China. In addition, a large number of multi-stage granitic rocks are formed in geological evolution in this area, recording amounts of information about crustal accretion and reworking processes (DePaolo et al., 1991; Rudnick, 1995; Wu et al., 2011). In view of this, this paper uses the spatial-temporal variations of trace elements and zircon Hf isotopic compositions of phanerozoic granitoids within the Khanka Massif as a case to reveal the crustal accretion and reworking processes of micro continental massifs from the orogenic belt, further to understand the formation and evolution processes and mechanisms of the global continental crust.

According to the statistics of zircon U-Pb ages of granitoids in the Khanka Massif, indicate that the granitic magmatisms in the Khanka Massif have eleven peaks: 492 Ma, 460 Ma, 445Ma, 430Ma, 425Ma, 302Ma, 287Ma, 258Ma, 249 Ma, 216Ma and 213Ma, it can be divided into eight main stages: Late Cambrian, Middle-Late Ordovician, Middle Silurian, Late Carboniferous, Early Permian, Middle-Late Permian—Early Triassic, Late Triassic-Early Jurassic, Early Cretaceous.

The Phanerozoic granitoids in Khanka massif are selected in this paper as a suite of granodiorite-monzogranite-syenogranite. The SiO_2 contents of the Phanerozoic granitoids exceed 65%, and has high Al_2O_3, low $Mg^{\#}$, TFe_2O_3, Cr, Co and Ni contents. This suggests that mixture with mantle-derived magma did not occur, and it should be a typical crustal source (Lu and Xu, 2011). Combined with evident characteristics of light rare-earth elements (LREEs) and large ion lithophile elements (LILEs) enrichment, and heavy rare-earth elements (HREEs) and high field-strength elements (HFSEs) loss, we suggest that the primary magma was derived by partial melting of lower crustal material (Xu et al., 2009), and geochemical properties of the Phanerozoic granitoids essentially reflect the nature of the magmatic source region.

According to the temporal variation of zircon Hf isotopic data of Phanerozoic granitioids, zircon Hf isotopic compositions of Phanerozoic granitoids have a obvious correlation with age. With the decrease of formation time of the Phanerozoic granitoids (Late Cambrian~Middle-Late Ordovician~Middle Silurian~Early Permian~Middle-Late Permian–Early Triassic~ Late Triassic-Early Jurassic), ε_{Hf} (t) values of zircons gradually increase, whereas their T_{DM2} ages gradually decrease (Paleoproterozoic–Neoproterozoic), suggesting that the generation of granitic magmas from the Khanka Massif could have experienced the change from the melting of the ancient crust to the juvenile crust during Paleozoic to Mesozoic.

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According to the sample location, it can be found that $\varepsilon_{Hf}(t)$ values of Phanerozoic granitoids have the tendency to decrease with latitude increase, showing that components of the ancient continental crust gradually increase from south to north. However, at the same latitude range, the $\varepsilon_{Hf}(t)$ values of Phanerozoic granitoids also inconsistent. Taken together, these differences reveal the horizontal and vertical heterogeneity of the lower continental crust within the Khanka Massif.

According to the relative probability of two-stage model (T_{DM2}) ages of zircon Hf isotope from Phanerozoic granitoids within the Khanka massif, it could be divided into three stages: (1)Late Paleoproterozoic (2) Mesoproterozoic (3) Neoproterozoic. It reveals that the main part of the continental crust within the Khanka Massif were formed in Late Paleoproterozoic–Neoproterozoic. The Phanerozoic granitoids in the Khanka Massif reworked from the source rocks with different ages(Paleoproterozoic–Mesoproterozoic–Neoproterozoic).