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Geochronology and geochemistry of early Paleozoic intrusive rocks from the Khanka Massif of the Russian Far East

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Abstract

The Russian Far East and Northeast (NE) China are located in the eastern part of the Central Asian Orogenic Belt (CAOB), which consists of a series of micro-continental massifs including the Erguna, Xing'an, Songnen–Zhangguangcai Range, Bureya, Jiamusi, and Khanka massifs. The Khanka Massif is located in the easternmost part of the CAOB, mainly cropping out in the territory of Russia, with a small segment in NE China. To the north and west of the Khanka Massif are the Jiamusi and Songnen–Zhangguangcai Range massifs, respectively. The boundary between these massifs is marked by the Dunhua–Mishan Fault. To the south lies the North China Craton, and to the east is the Sikhote–Alin Orogenic Belt separated by the Arsenyev Fault.

However, the early Paleozoic evolution and tectonic attributes of the Khanka Massif are debated. These conflicting ideas result from the lack of systematic research on early Paleozoic igneous rocks from the Russian part of the Khanka Massif.

It is generally accepted that the CAOB represents the largest known Phanerozoic accretionary orogenic belt. However, questions remain concerning the nature of the deep crust beneath the Khanka Massif, and whether Precambrian crust exists within the massif itself.

In this paper, we report new zircon U–Pb ages, Hf isotopic data, and major- and trace-element compositions of the early Paleozoic intrusive rocks from the Khanka Massif of the Russian Far East, with the aim of elucidating the early Paleozoic evolution and the tectonic attributes of the Khanka Massif, as well as the nature of the underlying deep crust.

New U–Pb zircon data indicate that early Paleozoic magmatism within the Khanka Massif can be subdivided into at least four stages: ~502 Ma, ~492 Ma, 462–445 Ma, and ~430 Ma.

The ~502 Ma pyroxene diorites show negative Eu anomalies, and the ~492 Ma syenogranites, intruding the ~502 Ma diorites, show positive Eu anomalies. These observations indicate that the primary parental magmas of these rocks were derived from different origins.

The 462–445 Ma magmatism is made up of syenogranites and tonalites. The ~445 Ma Na-rich tonalites contain low REE concentrations, and are enriched in Eu and Sr. These observations, together with the positive εHf(t) values, indicate that they were derived from magmas generated by partial melting of cumulate gabbros.

The ~430 Ma I-type granodiorites and monzogranites from the northern Khanka Massif, and the A-type monzogranites from the central Khanka Massif display zircon εHf(t) values ranging from –5.4 to +5.8. This suggests that they formed from magmas generated by partial melting of heterogeneous lower crustal material.

Zircon Hf isotopic data reveal the existence of Precambrian crustal material within the Khanka Massif. The geochemistry of the Middle Cambrian intrusive rocks is indicative of formation in an extensional setting, while Late Cambrian–middle Silurian magmatism was generated in an active continental margin setting associated with the subduction of a paleo-oceanic plate beneath the Khanka Massif. Regional comparisons of the magmatic events indicate that the Khanka Massif has a tectonic affinity to the Songnen–Zhangguangcai Range Massif rather than the Jiamusi Massif.

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