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Devonian granitoids and their hosted mafic enclaves in the Gorny Altai terrane, northwestern Central Asian Orogenic Belt: crust-mantle interaction in a continental arc setting

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Abstract: Granitoids are a major component in the upper continental crust and hold key information on how did the continental crust grow and differentiate. This study focuses on the Yaloman intrusive complex from the Gorny Altai terrane, northwestern Central Asian Orogenic Belt (CAOB). The association of granitoids and mafic enclaves can provide important clues on the source nature, petrogenetic processes and geodynamic setting of the Yaloman intrusive complex, which in turn will shed light on the crustal evolution in the northwestern CAOB.

Zircon U-Pb dating shows that the granitoids, including quartz diorites and granodiorites, were emplaced in ca. 389-387 Ma. The moderate $Na_2O + K_2O$ contents and low A/CNK values indicate that these rocks belong to the sub-alkaline series with metaluminous to weakly peraluminous compositions. The granitoids yield two-stage zircon Hf model ages of ca. 0.79-1.07 Ga and whole-rock Nd model ages of ca. 0.90-0.99 Ga, respectively, implying that they were mainly sourced from Neoproterozoic juvenile crustal materials. The mafic enclaves show an almost identical crystallization age of ca. 389 Ma. The identification of coarse-grained xenocrysts and acicular apatites, together with the fine-grained texture, makes us infer that these enclaves are likely to represent magmatic globules commingled with the host magmas. The low SiO_2 and high MgO contents of the mafic enclaves further suggest that substantial mantle-derived mafic melts were probably involved in their formation. Importantly, the SiO_2 contents of the granitoids and mafic enclaves are well correlated with other major elements and most of the trace elements. Also a broadly negative correlation exists between the SiO_2 contents and whole-rock epsilon Nd (390 Ma) values of the granitoids. Given the observation of reversely zoned plagioclases within the granitoids and the common occurrence of igneous mafic enclaves, we propose that magma mixing probably played an important role in the formation of the Yaloman intrusive complex. Our data imply that mantle-derived melts not only provided heat to melt the pre-existing Neoproterozoic crustal materials but also served as an important component in controlling the geochemical diversity of the granitoids. The mineral assemblages and compositions suggest that the Yaloman intrusive complex was possibly crystallized from a relatively oxidizing and water-enriched magma chamber, indicative of a continental-arc related tectonic setting in stead of a collisional origin as previously proposed. Collectively, our study suggests that the widespread Devonian granitoids within the Gorny Altai terrane signify significant vertical crustal growth and differentiation via underplating of subduction-related mafic melts.

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