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Magma mixing of the Late Paleozoic Tayuan Complex in the Xing'an Block

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Abstract: In recent years, a large number of reports about magma mixing have brought the study of magma mixing in Great Xing'an Range region to a new stage. However, the study of Paleozoic magma mixing in the northern part of Great Xing'an Range area is relatively weak, which restricts our understanding of geodynamic setting. Thus, we undertook zircon U–Pb dating, whole-rock geochemical and zircon Hf isotopic compositions analyses of the Tayuan complex in the northern Xing'an Block, with the aim of addressing the above mentioned question. Through the field geological survey and petrographic study, we find that the Tayuan complex is composed of the host granites (monzogranites) and the mafic microgranular enclaves (MMEs; gabbro-diorites enclaves). The MMEs are unevenly distributed within the host granites, some of which have plastic rheological characteristics. And some MMEs preserve chilled margins and acicular apatite. Zircon U-Pb ages data show that the diagenetic ages of the host granites in Tayuan complex were 319 Ma, and those of the MMEs were 320 Ma, suggesting they were both formed during the Late Carboniferous. According to the study results of chronology and petrography of the host granites and the MMEs, it can preliminarily determine that the Tayuan complex was the product of the Late Carboniferous magma mixing. The analyses of mineral composition of plagioclase in MMEs show that the plagioclase is composed of andesine, with resorption zone, suggesting a mineral disequilibrium texture which is further support the role of magma mixing in the petrogenesis of the Tayuan complex. Geochemical and zircon Hf isotope data show that the host granites are characterized by high SiO_2 (66.16~74.18wt%) and K_2O (3.89~4.86 wt%), low MgO (0.07~0.49 wt%), CaO (0.14% ~0.60%) and P_2O_5 (0.01%~0.08%). The host granites are enriched in large ion lithophile elements (LILEs; e.g., Rb, Th, and U) and light rare earth elements (LREEs), and depleted in high field strength elements (HFSEs; e.g., Nb and Ta) and heavy rare earth elements (HREEs), with total rare earth elements of 65.53~152.81 ppm, LREE/HREE ratios of 4.44~13.40 and $(La/Yb)_N$ values of 5.51~54.96. Zircons from the host granites yield $\varepsilon_{Hf}(t)$ values of −0.46 to +7.1, and two-stage Hf model ages of 899~1382 Ma. Taken together the above chronological, geochemical and zircon Hf isotope characteristics, it is shown that the host granites were derived from the partial melting of Mesoproterozoic–Neoproterozoic lower crust and belong to I-type granitoids. In addition, the MMEs have a restricted range of SiO_2 (46.29~61.94 wt.%) together with high $Mg^{\#}$ values (46–66), and high concentrations of Ni, Co, and Cr. These MMEs are also characterized by enrichments in LILEs and LREEs, and depleted in HFSEs and HREEs, with total rare earth elements of 161.17~313.39 ppm, LREE/HREE ratios of 6.69~11.27 and $(La/Yb)_N$ values of 6.88~17.04. Zircons of the MMEs yield $\varepsilon_{Hf}(t)$ values of −0.69 to +5.33, and single-stage Hf model ages of 748~1076 Ma. Combined with the above whole-rock geochemical and Hf isotopic features, it is suggested that the MMEs in the Tayuan complex were the products of partial melting of mantle wedge that had been metasomatized by slab-derived fluids. Based on related study of the spatial variation characteristics of contemporary igneous assemblages and the history of regional tectonic evolution in the study area, we suggest that the Late Carboniferous Tayuan complex from the northern Xing'an Block was emplaced in an active continental margin setting, which was probably related to the northward subduction of the Paleo-Asian oceanic plate between Xing'an Block and Songnen Block.

Keywords: Xing'an Block, Granite, Enclaves, Magma mixing, Late Paleozoic

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