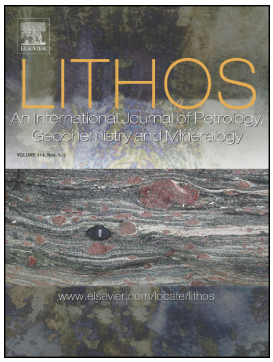

Petrology, geochemistry, and zircon U–Pb–Hf isotopes of late Triassic enclaves and host granitoids at the southeastern margin of the Songnen–Zhangguangcai range massif, Northeast China: Evidence for magma mixing during subduction of the Mudanjiang oceanic plate

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Petrology, geochemistry, and zircon U–Pb–Hf isotopes of Late Triassic enclaves and host granitoids at the southeastern margin of the Songnen–Zhangguangcai Range Massif, northeast China: evidence for magma mixing during subduction of the Mudanjiang oceanic plate

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Abstract

We report zircon U–Pb ages and geochemistry (major and trace elements, mineral compositions, and Hf isotopic compositions) for the Hailin pluton in the southeastern Songnen–Zhangguangcai Range Massif, northeastern China, to constrain the role of magma mixing in its petrogenesis and to reconstruct the tectonic evolution of the Mudanjiang Ocean. Zircon U–Pb dating yields ages of 215 ± 1 Ma, 217 ± 1 Ma, and 219 ± 1 Ma for the host granitoids of the Hailin pluton, and 221 ± 1 Ma for mafic microgranular enclaves (MMEs) within the granitoids, indicating they were emplaced coevally. The host granitoids are characterized by 63.18–70.44 wt.% SiO_2 and 0.69–1.94 wt.% MgO, and are depleted in high field strength elements (HFSEs; e.g., Nb, Ta, and Ti) and heavy rare earth elements (HREEs), and enriched in large ion lithophile elements (LILEs; e.g., Rb, Sr, and Ba) and light rare earth elements (LREEs). The zircons in the host granitoids yield two-stage model ages of 1058 Ma to 1770 Ma, together with $\varepsilon_{Hf}(t)$ values of –6.6 to +3.1. These results indicate that the host granitoid magmas were generated by partial melting of Mesoproterozoic lower crust contaminated by ancient crustal material. The MMEs have a restricted SiO_2 range (47.61–57.4 wt.%), high contents of Ni, Co, and Cr, and high $Mg^{\#}$ values (42–54). They have higher $Fe_2O_3^T$, MgO, Cr and Co contents than the host granitoids, as well as higher total rare earth element (REE) concentrations. Their REE patterns are sub-parallel to those of the host granitoids, characterized by enrichments in LILEs and