Low $\delta^{18}O$ zircon grains in deep-seated magmas:An indicator of mantle heterogeneity

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Low $\delta^{18}O$ (<5.0‰) magmatic zircon have commonly been identified in high silicic rhyolites and A-type granites, which are typically ascribed to assimilation of low $\delta^{18}O$ wall rocks or meteoric/sea water-magma interaction. They are rare but important because they provide a direct link between magmatism and upper crustal processes. However, the origin of deep-seated magmatic rocks with low $\delta^{18}O$ values remain elusive.

We combine geochemical and radiogenic isotopic data from the K-rich diorite (KDG), in the Hongzhao region of the Daqingshan Terrane in western North China Craton, to investigate their origin and to understand the evolution process of the low $\delta^{18}O$ deep-seated magma system.

The ca. 2.5 Ga KDG resembles the composition of Archean sanukitoid suites with strongly subchondritic zircon εHf (t) values from -0.8 to -5.6, reflecting the involvement of a mantle component and ancient crustal materials in their petrogenesis. Both zircon magmatic cores and metamorphic rims show consistently low $\delta^{18}O$ values ($\delta^{18}O$ = 4.68-3.63‰). The similarity of $\delta^{18}O$ values in core-rim domains can be explained by the homogenisation of $\delta^{18}O$ in zircon after the re-equilibration process or the sluggishness of oxygen diffusion in zircon or the rim mostly inherit the core precursor. We propose that the KDG derive from a mantle source metasomated by melts from partial melting of ancient terrigenous sediments that were hydrothermally altered by meteoric water near-surface or by sea water during subduction process at high temperature. The crust-mantle interaction via subduction imparts a potential mantle heterogeneity, revealed by anomalously light oxygen isotopes in our samples.

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