Low-$\delta^{18}O$ magmas in the Dabie-Sulu UHP metamorphic terranes (China)

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Recent studies of eclogite and associated metamorphic rocks from the Dabie-Sulu high to ultrahigh-pressure (HP/UHP) terranes, eastern China, indicate that zircons as well as garnets have highly variable $\delta^{18}O$ values (–10.9 to 8.5‰ VSMOW) [1,2]. It is generally proposed that protoliths have undergone subsolidus alteration by heated meteoric water during Neoproterozoic glaciations, prior to the Triassic continental collision and UHP metamorphism. Alternatively, can zircons in the low $\delta^{18}O$ eclogite or associated granitic gneisses indicate the presence of extremely low-$\delta^{18}O$ magmas?

In-situ analysis by CAMECA ims-1280 ion microprobe indicates that both cores and overgrowths of zircons in granitic gneisses associated with UHP eclogites commonly have constrasting oxygen isotope compositions and rare earth element (REE) patterns. Zircon rims may have constant $\delta^{18}O$ values within each rock as low as –6 ‰ in equilibrium with coexisting garnets, and their chrondrite-normalized HREE pattern is relatively flat with no or slightly negative Eu-anomaly, implying HP/UHP metamorphic origin. The case is more complex for zircon cores identified by cathodoluminescence imaging. Zircon cores have $\delta^{18}O$ values varying from –8 to 6 ‰ (average: *ca*. 0 ‰), and some REE patterns are characterized by a steep slope from La to Lu with significant positive Ce- and negative Eu-anomalies. Combined with CL textures, Th/U ratios (0.3 to 1.0) and $\Delta^{18}O$ (core-rim: > 3 ‰), low-$\delta^{18}O$ zircon cores in some rocks investigated are indicated to be of igneous origin.

We propose a two-stage ^{18}O-depletion model, similar to low-$\delta^{18}O$ rhyolites elsewhere [3]. Some igneous zircon cores crystallized in magmas as low in $\delta^{18}O_{WR}$ as *ca*. 1 ‰. These magmas formed by melting of wall rocks that were hydrothermally altered by earlier plutons. The even lower-$\delta^{18}O$ zircon overgrowths and coexisting garnets resulted from extensive interaction (and then UHP metamorphism) of the protolith (i.e. granite) at subsolidus temperatures with heated meteoric water. This is the first evidence for such low $\delta^{18}O$ magmas in the Proterozoic, implying multiple intrusive events in an area of nearly 10^5 km^2.

References

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[2] Zheng Y.-F., et al. (2004) *GCA* **68,** 4145-4165.
[3] Bindeman I., and Valley J.W. (2001) *J Petrol* **42,** 1491-1517.