Dissolution and reprecipitation of protolith zircon during continental subduction-zone metamorphism: insights from Lu-Hf isotope systematics

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In-situ analyses of zircon Lu-Hf isotopes, U-Pb ages and trace elements were carried out for UHP eclogite and its enclosed leucocratic vein in the Dabie orogen, China. The results provide insights into the origin of eclogite protolith and the geochemical behavior of Lu-Hf isotopes during protolith formation and subduciton-zone metamorphism, respectively. Zircon U-Pb dating indicates that eclogite protolith were formed at 769 ± 15 Ma, with minor incorporation of 1802 ± 62 Ma crustal relics. Initial Hf isotope ratios for the metamorphosed zircon of Neoproterozoic U-Pb age are categorized into two groups, one with positive $\varepsilon_{Hf}(t)$ values of 5.8±2.8 to 12.7±1.6 and young Hf model ages of 832 ± 62 to 1106 ± 77 Ma, and the other with negative $\varepsilon_{Hf}(t)$ values of -3.6±2.0 to -3.1±1.4 and old Hf model ages of 1895 ± 120 Ma. Therefore, reworking of both juvenile and ancient crustal rocks would have contemporaneously occurred in the northern margin of the South China Block during the middle Neoproterozoic.

Zircon from the vein exhibits concordant U-Pb ages for the Triassic metamorphism. Most of the Lu-Hf analyses yield consistently negative $\varepsilon_{Hf}(t)$ values of -3.3±1.2 and Hf model ages of 1877 ± 75 Ma at t = 770 Ma, indistinguishable with those for the metamorphosed zircon of Neoproterozoic U-Pb ages. Some analyses give positive $\varepsilon_{Hf}(t)$ values with rare relics of Neoproterozoic U-Pb ages. The metamorphic zircon of negative $\varepsilon_{Hf}(t)$ values is interpreted to form by dissolution and reprecipitation of ancient protolith zircon in the absence of garnet effect. While the Neoproterozoic zircon relics of positive $\varepsilon_{Hf}(t)$ values would have survived during fluid dissolution, those of negative $\varepsilon_{Hf}(t)$ values were dissolved by the metamorphic fluid to cause element Hf transport and its isotope homogenization. The ancient Hf isotopic characteristics were inherited by the newly grown zircon of metamorphic origin in the vein. Therefore, the Hf isotopes uptaken in the metamorphic zircon may be as an effective mean to trace not only the protolith origin but also the dissolution and reprecipitation of protolith zircon.