

U-Pb age, trace-element, and Hf-isotope compositions of zircon in a quartz vein from eclogite in the western Dabie Mountains: Constraints on fluid flow during early exhumation of ultrahigh-pressure rocks

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ABSTRACT

Quartz veins in high-pressure (HP) to ultrahigh-pressure (UHP) rocks are the products of fluid-rock interaction, and thus provide insight into fluid processes in subduction zones. In this paper, we report an integrated study of mineral inclusion, trace-element, U-Pb age, and Lu-Hf isotope compositions of hydrothermal zircon grains from a quartz vein within an UHP eclogite outcrop from the Hong'an area, western Dabie Mountains. These data are used to decipher the age, conditions of formation, and source of fluid for zircon formation during the exhumation of UHP rocks. Zircon grains from the vein have perfect euhedral shape, and show sector zoning or weak zoning, indicating that they precipitated from the aqueous fluid responsible for the vein formation. Raman spectroscopy analysis reveals that the zircon grains contain inclusions of garnet, omphacite, rutile, quartz, and H₂O, implying that they crystallized from aqueous fluid under HP eclogite-facies conditions. The zircon grains show low Th/U and Lu/Hf ratios, nearly flat HREE patterns, absent Eu anomalies and low LREE contents. These characteristics are consistent with their precipitation in the presence of garnet and epidote, and absence of feldspar, and thus suggest that trace-element concentrations in hydrothermal zircon are controlled by co-precipitation of mineral assemblages. Crystallization temperatures of 670 to 712 °C, which were calculated using the Ti content of zircon, are consistent with their formation under eclogite-facies conditions and may correspond to the temperature of the infiltrating fluid. The weighted mean ²⁰⁶Pb/²³⁸U age of 224.7 ± 1.3 Ma is taken as the best estimate for the age of quartz-vein formation and records aqueous fluid flow during the early exhumation stage of UHP rocks. The zircon grains in the quartz-vein have Hf compositions similar to those in the host eclogite, which demonstrates isotopic equilibrium between fluid and rocks and that the fluid-rock ratio was likely low.

Keywords: Hydrothermal zircon, trace element, Lu-Hf isotope, U-Pb age, HP-UHP metamorphism, quartz vein, western Dabie Mountains