Protolith nature of deeply subducted continent: Zircon U-Pb age, Hf and O isotope constraints from UHP eclogite and gneiss in the Dabie orogen

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Zircon U-Pb dating, Hf and O isotope analyses were carried out for UHP eclogite and felsic gneiss from the Dabie orogen in China. The results provide constraints on their protolith origin, with significance for continental growth by rift magmatism during breakup of the supercontinent Rodinia. Mafic and felsic protoliths formed as a bimodal volcanic suite at about 750 Ma, with incorporation of ca. 2.15 Ga crust into the felsic protolith. $\delta^{18}O$ values of −4.1 to 4.4‰ suggest differential involvement of meteoric water in protolith magmas. Initial Hf isotope ratios are subdivided into two groups, with positive $\varepsilon_{Hf}(t)$ values of 12.9±0.7 to 5.9±0.9 and neutral $\varepsilon_{Hf}(t)$ values of 2.3±0.3 to −2.7±0.6, respectively. The positive $\varepsilon_{Hf}(t)$ values correspond to depleted mantle Hf model ages of 0.82 to 1.24 Ga, whereas the negative $\varepsilon_{Hf}(t)$ values correspond to crust Hf model ages of 1.82 Ga. A few zircons from the gneiss have strongly negative $\varepsilon_{Hf}(t)$ values of −22.6±0.6, which are associated not only with consistent depleted mantle and crust Hf model ages of 2.2 Ga but also with the old U-Pb ages falling on a 2147±22 Ma discordia line. Thus the felsic protolith contains Paleoproterozoic crustal relicts, some of which were originally derived from coeval depleted mantle. On the other hand, strongly positive $\varepsilon_{Hf}(t)$ values are associated with young U-Pb ages falling on the ~750 Ma discordia lines. This suggests that both eclogite and gneiss protoliths principally formed from mid-Neoproterozoic juvenile crust, with contrasting features only in petrochemistry. The highest $\varepsilon_{Hf}(t)$ values of 12.7 to 14.4 for the eclogite correspond to the youngest Hf model ages of 0.75 to 0.82 Ga relative to the depleted mantle reservoir. These Hf model ages are not only close to the timing of zircon growth from the mafic magma, but also similar to ages for bimodal magmatism in the periphery of the Yangtze Block. This demonstrates new addition of the depleted mantle material to the continental crust by rift magmatism in the northern margin of the Yangtze Block, with coeval crust-mantle interaction in the mid-Neoproterozoic rifting tectonic zone. Therefore, the bimodal magmatism at about 750 Ma transports both heat and material from the mantle to the crust, resulting in remelting of both the Paleoproterozoic old crust and the meteoric-hydrothermally altered juvenile crust along the active rifting zone. Because this episode of rift magmatism is temporally associated with growth of juvenile crust along a volcanic rifted margin, it marks splitting of the Yangtze Block from the supercontinent Rodinia.