Garnet geochemistry records multistage processes of hydration and dehydration at a continental rift during Rodinia breakup

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Continental rifts are an important site to transfer high heat flow from the asthenospheric mantle to the crust, resulting in low-pressure metamorphism and water-rock interaction at high geothermal gradients. However, geochemical records of such processes is commonly lacking in crustal rocks at rifted continental margins. This contribution presents a combined study of petrography, mineral chemistry, garnet in-situ O isotopes, zircon U-Pb ages and in-situ O isotopes for Neoproterozoic metagranites in the Beihuaiyang zone, which is located in the northern margin of the South China Block that was separated from Rodinia supercontinent. The results allow the distiniction between three types of garnets (Grt-I, Grt-II and Grt-III) in response to continental rifting. They would have grown in different processes through high temperature (HT) hydrothermal alteration, HT metamorphism and albitization, respectively, at low pressures. The HT metamorphism postdates the HT hydrothermal alteration to satisfy the inheritance in ^{18}O depletion, though both of them would have occurred at the peak stage of continental rifting. The albitization took place at the very last stage as the temperature was going down. The three types of garnets all have unusally negative $\delta^{18}O$ values of −18.1 to −16.0‰ for Grt-I, −17.8 to −14.5‰ for Grt-II and −19.0 to −18.3‰ for Grt-III, indicating the infiltration of continental deglacial water in the rift setting. Zircon U-Pb dating yields apparent $^{206}Pb/^{238}U$ ages varying from 781 to 755 Ma, suggesting a prolonged period for rifting magmatism. The zircons are of magmatic origin and show positive $\delta^{18}O$ values of 3.3 to 6.2‰, in contrast to the negative $\delta^{18}O$ values for the coexisting garnets. While the garnets would have acquired their negative $\delta^{18}O$ values through hydration and dehydration reactions of the hydrthermally altered granite, the zircons have retained their magmatic $\delta^{18}O$ values despite the water-rock interaction at high temperatures. The hydration reaction is directly recorded by Grt-I and Grt-III and the dehydration reaction is recorded by Grt-II. Therefore, these garnets provide insights into the continental rift processes during the Rodinia breakup.