The heat source for rapid ultra-high temperature metamorphism: an example from east Khondalite belt, North China Craton

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The extensive exposure of ultrahigh temperature (UHT) granulites throughout the geological history has been widely documented, but the heat source for this extreme thermal condition is still unclear, especially for rapid one. Some Mg-Al riched UHT granulites in east Khondalite belt are characterized by short-lived duration, and associated with a large volume of garnet-bearing orthogneiss and minor gabbronorite [1, 2, 3, 4]. An integrated study of petrography, geochronology, mineral geochemisty, phase equilibria modeling and heat flow calculation is carried out to explore the heat source for this rapid UHT metamorphism. SIMS zircon and monazite U-Pb dating results show that granite emplaced at *c*. 1.94 Ga, and experienced metamorphism together with peraluminous granulite at *c*. 1.92, which is consistent with the emplacement age registed by gabbronorite. D_{HREE}(zircon/garnet) plots and array plots from garnet-bearing orthogneiss show metamorphic zircon is in equilibrium with garnet, indicating the garnet metamorphic origin [5]. Two and four stages of mineral assmeblage are recognized from garnet-bearing orthogneiss and spinel-bearing granulites, respectively. Phase equilibria modeling result illustate that the garnet-bearing orthogneiss and spinel-bearing granulites registed a similar UHT peak *P-T* condition and clockwise *P-T-t* path. Based on the heat flow calculation, advection heat from mafic magmatism is most probable heat source for rapid ultrahigh temperature metamorphism in study area, and ductile shearing might contribute to elevating temperature in the early stage.

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