

Identification of multiple orogenic cycles experienced by granulites from the Dabie orogen by multi-mineral dating

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ABSTRACT

This study conducted a systematic investigation on the petrology and geochronology of granulites exposed in the Huangtuling area in the Dabie orogen, China. The results demonstrate that the rocks experienced at least two periods of granulite facies metamorphism (GFM), including an older high-pressure (HP) GFM and a younger low-pressure (LP) GFM related to two orogenic cycles in the Paleoproterozoic and Cretaceous, respectively. Dating of different accessory minerals yielded two groups of metamorphic ages: ~2.0 Ga recorded by zircon and ~120 Ma recorded by rutile and apatite. Combined with their trace element compositions, it is suggested that zircon ages represent the timing of older GFM and rutile and apatite record the timing of younger GFM. This demonstrates that accessory minerals can differentially record the timing of different periods of GFM. Zircon retains comprehensive information about the older event but lacks information on the younger one, while rutile and apatite exhibit the opposite pattern. The high temperature and low melt/fluid activity of LP GFM may be potential factors driving contrasting responses of accessory minerals to thermal overprinting, given their different Pb closure temperatures and limited Zr reactivity in the bulk rock during Cretaceous metamorphism. Therefore, this study supports petrologic evidence that the Huangtuling granulites experienced two periods of GFM. Based on the well-constrained regional background, it can be concluded that the Paleoproterozoic GFM was produced by a collisional orogeny associated with the assembly of the Columbia Supercontinent, and the Cretaceous GFM was induced by extension and collapse of a Triassic orogen. This study highlights the importance of simultaneously dating accessory minerals with different closure temperatures in U-Pb isotopic systems to distinguish between multiple orogenies, especially in ancient rocks preserving multi-stage granulite-facies mineral assemblages.

Keywords: Granulite facies, metamorphic overprinting, multiple orogenies, accessory minerals, Dabie orogen