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Phase equilibria modelling and zircon dating of pelitic granulites in Zhaojiayao, from the Jining Group of the Khondalite Belt, North China Craton

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The Jining Group occurs in the eastern segment of the Khondalite Belt, North China Craton, and is dominated by a series of granulite facies rocks involving 'normal' pelitic granulites recording peak temperatures of ~850 °C [1] and ultrahigh-temperature (UHT) pelitic granulites recording peak temperatures of 950–1100 °C [2]. The P – T paths and ages of these two types of granulites are controversial [1–5]. Three pelitic granulite samples in the Jining Group involving two sillimanite–garnet gneiss samples (J1208 and J1210) and one spinel–garnet gneiss sample (J1303) were collected from Zhaojiayao, where 'normal' pelitic granulites were supposed to crop out, for determination of their metamorphic evolution and ages. Samples J1208 and J1210 are inferred to record cooling paths from the T_{\max} stages with P – T conditions respectively of ~880 °C/8 kbar and >840 °C/7.5 kbar constrained from the stability fields of the observed mineral assemblages and the isopleths of plagioclase, garnet and biotite compositions in pseudosections. Sample J1303 is inferred to record a pre- T_{\max} decompression from the kyanite-stability field to the T_{\max} stage at ~1000 °C/8–9 kbar and a post- T_{\max} cooling path revealed mainly from the plagioclase zoning and spinel and biotite composition isopleths in pseudosections. The post- T_{\max} cooling stage can be divided into suprasolidus and subsolidus substages. The suprasolidus cooling may not result in an equilibrium state at the solidus in a rock. Therefore, minerals may record different P – T conditions along the P – T path and the maximum temperature condition is commonly higher than the solidus. Various solidi are inferred for different samples from the same outcrop due to experiencing different amounts of melt loss. Plagioclase compositions, especially zoning in plagioclase-rich granulites, are predicted to be more useful than garnet and biotite for recording the higher- T conditions of the granulite thermal history. The three samples studied seem to record the temperature range covering those of the 'normal' and UHT pelitic granulites in the Jining Group, suggesting that UHT conditions may be reached in 'normal' granulites without diagnostic UHT indicators. LA-ICP-MS zircon U–Pb data provide continuous and concordant $^{207}\text{Pb}/^{206}\text{Pb}$ ages from 1.89 Ga to 1.79 Ga for sample J1210, and from 1.94 Ga to 1.80 Ga for sample J1303. These continuous and long age spectra are interpreted to represent a slow cooling and exhumation process corresponding to the post- T_{\max} cooling P – T paths recorded by the pelitic granulites, which may have followed exhumation of deeply buried rocks in a thickened crust region resulting from a collision event at c. 1.95 Ga, as suggested by the pre- T_{\max} decompression P – T path.

References:

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