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Anticlockwise P–T path and zircon U–Pb dating of HP granulites in the Yushugou granulite–peridotite complex, southern Tianshan, China

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The Yushugou HP granulite–peridotite complex is located at the east of the northern margin of the southern Tianshan, China, which mainly consists of granulite and peridotite units. Because of the rare association of granulite and peridotite, their origin has been debated for a long time. The main controversial points include whether these units represent a complete ophiolite suite [1], a tectonic mélange [2,3] or a continental crust–mantle transition zone [4]. In this study, we propose a hanging wall subduction model for the HP granulites based on petrological study and U–Pb zircon dating. The HP granulites can be further grouped into two types: type I is hypersthene-free and type II is hypersthene-bearing granulite. The mineral assemblage is garnet (33%) – diopside (32%) – plagioclase (30%) for type I granulite; and garnet (22%) – diopside (10%) – hypersthene (14%) – plagioclase (45%) for type II granulite. Garnet in both types exhibits core–rim zoning with increasing grossular and decreasing pyrope. Petrographic observations and phase equilibrium modeling, coupled with pseudosections calculated in the NCFMASHTO system using THERMOCALC for two representative samples suggest that the granulites have experienced three stages of metamorphism. Stage I is characterized by the porphyroblastic garnet core, and the P–T conditions of this stage are 9.4–10.4 kbar and 860–900 °C for type I, and 9.9–10.9 kbar and 875–890 °C for type II granulite, respectively. Stage II (Pmax stage) is identified based on garnet zoning involving increasing grossular and decreasing pyrope; the P–T conditions of this stage, defined using the garnet rim compositions and the Ca content in plagioclase, are 12.1 kbar and 755 °C for type I, and 13.8 kbar and 815 °C for type II granulite, respectively. Stage III, the amphibolite facies, was characterized by an overprint of hornblende amphibole in the granulites. Consequently, the Yushugou HP granulite has recorded an anticlockwise P–T path characterized by cooling related to subduction, with the temperature decreasing and pressure increasing simultaneously. Based on studies of zircon morphology, Th/U ratios and REE patterns, ages of c. 430 Ma are interpreted as dating the protolith of the HP granulites, reflecting Silurian magmatism. Metamorphic rims of zircon yield three groups of ages at c. 390 Ma, c. 340 Ma and c. 320 Ma, interpreted as corresponding to the stage I, II and III metamorphic events, respectively. We conclude that the mafic HP granulites from the Yushugou granulite–peridotite complex were formed by subduction-related cooling of lower crustal rocks in the hanging wall of the central Tianshan plate during the northward closing of the paleo-Asian ocean.

References:

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