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Neoarchaean to Paleoproterozoic high-pressure metapelitic granulites from the Jidong terrane, Hebei Province, North China Craton

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High-pressure metamorphism is rarely discovered in the early Precambrian terranes, which led to the controversy about when did plate tectonics can begin on Earth. In the North China Craton (NCC), retrograded Paleoproterozoic eclogites as well as abundant Paleoproterozoic high-pressure granulites are reported. Until now, only one example of Neoarchean to Paleoproterozoic high-pressure mafic granulites [1] is reported in the Jiaodong terrane. In this contribution, we document Neoarchean to Paleoproterozoic high-pressure metapelitic granulites from the Jidong terrane, Hebei Province, NCC. The high-pressure metapelitic granulites mainly consist of garnet, biotite, two stage sillimanite (the first one as the porphyroblast with appearance of kyanite, while the other one as matrix mineral), K-feldspar, plagioclase, quartz, rutile as well as ilmenite. Except for the outermost edge of the garnet rim, the garnet porphyroblasts show grossular decreasing chemical zoning from the core to the rim. P–T pseudosections are calculated in the NCKFMASHTO model system using THERMOCALC 3.33 [2], based on the internally consistent thermodynamic dataset of tcds 55 [3]. The results suggest that two samples record peak metamorphic P–T conditions of 850 °C/12 kbar and 830 °C/13.5 kbar, which we attribute to the high-pressure granulite facies [4]. Meanwhile, a short decompression P–T path section was also retrieved based on decreasing grossular in the garnet porphyroblasts. High resolution SIMS U−Pb dating of the metamorphic zircons or the metamorphic rims demonstrate that the two metapelitic granulites record metamorphic ages of 2.49 Ga and 2.48 Ga, which is coeval with the Jiaodong high-pressure mafic granulites [1], indicating the peak or near peak metamorphic age. Rare late Archean high-pressure metapelitic granulites are preserved in the Jiodong terrane. Due to the influence of retrograde metamorphism, the speculated kyanite porphyroblasts were translate into sillimanite, which may hint there is more high-pressure metamorphism than we have discovered. The peak metamorphic condition of the high-pressure metapelitic granulites indicate a relatively low thermal gradient of ~20 °C/km, and, thus, rarely low thermal gradients occurred in the Archean indicating a thermal transition around the Archean–Proterozoic boundary. The calculated pressures of 12 kbar and 13.5 kbar imply that the sedimentary precursors of the high-pressure metapelitic granulites once were buried to a depth of ~40–45 km, indicating that thickening of the crust existed in the late Archean. Combining this study with previous studies about high-pressure mafic granulites from the Jiaodong terrane, we may conclude that a high-pressure granulites facies metamorphism showed that the modern Earth-style tectonics were in operation at the Archean–Proterozoic transition in the NCC, which may record the final amalgamation of some micro-blocks during the late Archean [5].

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