

# High-pressure granulites in North China Craton and its implications for the Columbia supercontinent evolution

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High-pressure (HP) granulites are widely distributed within the Paleoproterozoic Jiao-Liao-Ji Orogenic Belt (JLJB), Trans-North China Orogen (TNCO), and Khondalite Belt (KB) of the North China Craton (NCC). HP granulites in the SW segment of the JLJB in the eastern part of the NCC occur as irregular lenses or dike swarms in the Paleoproterozoic metamorphic complex, which extend from NE Yantai to SW Anqiu about 300 km in length. Petrographic examination has revealed that HP granulites record a peak HP granulite-facies assemblage ( $M_1$ ) of Grt + Cpx + Pl + Qtz, and a subsequent decompression assemblage ( $M_2$ ) of Opx + Cpx + Pl  $\pm$  Amp  $\pm$  Fe-Ti oxides, which formed at 755–866 °C and 1.28–1.44 GPa, and 780–840 °C and 0.5–0.8 GPa, respectively. U–Pb dating of distinct zircon domains revealed the protolith ages of 2.2–2.0 Ga, the timing of the peak HP granulite-facies metamorphism at 1.95–1.9 Ga, and the subsequent retrogression at 1.86–1.84 Ga, respectively. Comprehensive petrographic and geochronological investigations of the HP granulites defined a clockwise P–T–t path involving a near-isothermal decompression and near-isobaric cooling process. The TNCO is a nearly north-south-trending ~1200 km long and 100–300 km wide belt in the centre part of the NCC. HP granulites mainly distribute in Hengshan, Huai'an, Xuanhua and Chengde areas, which record a similar metamorphic history characterized by near-isothermal decompressional clockwise P–T paths with peak metamorphic conditions of 800–870 °C and 1.05–1.6 GPa. Geochronological data of the HP granulites in the TNCO reveal two group metamorphic ages of 1.95–1.92 Ga and ~1.85 Ga, representing the timing of peak metamorphism and subsequent retrogression, respectively. HP granulites from the KB in the western part of the NCC occur as irregular lenses within granitic gneisses and Khondalite series, which outcropped from Xiaoshihao to Baiyuanhua about 100 km in length. The HP mafic granulites preserve a typical HP granulite-facies assemblage of Grt + Cpx + Pl + Amp  $\pm$  Qtz  $\pm$  Fe-Ti oxides. Pseudosection modeling and conventional thermobarometers constrain the peak HP granulite facies metamorphic conditions of 760–845 °C and 1.25–1.4 GPa, and a subsequent retrogression of 825–860 °C and 0.72–0.8 GPa with a typical clockwise P–T path. In-situ U–Pb dating of zircons show the protolith ages of 2.1–2.0 Ga, peak HP granulite-facies metamorphism at 1.96–1.94 Ga, and subsequent retrogression at 1.86–1.82 Ga, respectively.

The consistency of the petrography, clockwise P–T–t path and metamorphic timing for the HP granulites of the JLJB, TNCO and KB within the NCC indicate that the micro-blocks occurred continent-continent (or arc) collision at the Paleoproterozoic (1.96–1.9 Ga), resulting in the final amalgamation of the NCC. This newly summarized result has an important significance for the studies in-depth of the global Columbia supercontinent evolution.

Keywords: HP granulite, P–T–t path, Paleoproterozoic orogenic belts, North China Craton