When did Plate Tectonics Begin on the North China Craton? - A Metamorphic Perspective

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Understanding when and why plate tectonics began on Earth is one of the most important unresolved problems in earth sciences. As a final result of plate tectonics, continental collisional orogens are regarded as a milestone in recognizing the operation of plate tectonics in Earth's history. Metamorphism of collisional belts is generally characterized by clockwise P-T paths involving isothermal decompression following the peak metamorphism. Therefore, clockwise P-T paths involving isothermal decompression are considered as a hallmark of plate tectonics, especially in the early history of the earth. As one of the oldest continental blocks in the world, the North China Craton is considered as a promising area for applying the large-scale synthesis approach of metamorphic P–T paths to understand tectonic settings or processes. Tectonically, the North China Craton composes three small continental blocks (Eastern Block, Yinshan Block and Ordos Block) and three Paleoproterozoic tectonic belts (Trans-North China Orogen, Khondalite Belt and Jiao-Liao-Ji Belt). Metamorphism of late Archean basement rocks in the Eastern and Yinshan Blocks is characterized by anticlockwise P-T paths, mostly involving isobaric cooling, reflecting the underplating or intrusion of large volumes of mantle-derived magmas, possibly related to the uprising of mantle plumes. Metamorphism of the basement rocks in the Khondalite Belt and the Trans-North China Orogen is both characterized by clockwise P-T paths involving isothermal decompression, suggesting that the two orogens underwent initial crustal thickening followed by rapid exhumation/uplift tectonic processes. Such tectonic processes are typical indicators of collisional orogens that accommodate plate tectonics. The Paleoproterozoic Jiao-Liao-Ji Belt can be divided into the southern and northern zones, of which the former is characterized by anticlockwise P-T paths, whereas the latter is characterized by clockwise P-T paths, constituting paired metamorphic belts, which also indicate a regime of plate tectonics. The time of the initiation of plate tectonics in the North China Craton can be approximated by the age of the earliest juvenile crustal components in the three Paleoproterozoic tectonic belts. So far, the convincing oldest, subduction-related, juvenile crustal component in the North China Craton is the 2.56 Ga Wutai granitoids in the Trans-North China Orogen, which can be used to approximate the timing of the onset of plate tectonics in the North China Craton.