

Zircon U-Pb geochronological and Hf-O isotopic constraints on protracted incremental construction of Mesozoic plutons and extensive porphyry-Mo mineralization in the southern margin of North China Craton

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The southern margin of North China Craton is the most important molybdenum ore belt in China, representing a unique type of porphyry Mo system related to intracontinental orogen which is significantly different from the typical subduction-related and rift-related porphyry Mo systems. The total Mo reserves of the ore deposits in the belt are over 10 million tons, and almost all of the reserves come from porphyry (-skarn) type deposits that are closely related to the small-sized granite porphyries occurring around or inside of the Late Mesozoic granite batholiths (158–101Ma). Petrochemical and isotopic geochemical investigations demonstrate that the ore-bearing porphyries and barren batholiths are comagmatic in origin, with similar geochemical and Sr-Nd isotopic signatures. Zircon LA-ICPMS and SHRIMP U-Pb dating results showed that the granitic plutons were built up through protracted incremental construction, as exemplified by the fact that the magmatic zircon grains have concordant ²⁰⁶Pb/²³⁸U ages varying in ranges of up to 30 Ma, suggestive of extended periods of zircon crystallization. Crustal Hf model ages of the granitic rocks are mainly in ranges of 2.0–2.4 Ga, whereas the majority of the continental crust in the belt was formed before 2.5 Ga with crustal Hf model ages of 2.8 to 3.2 Ga. The mantle-like zircon $\delta^{18}\text{O}$ values of 4.78–7.24‰ (average 6.07‰) and $\varepsilon_{\text{Hf}}(t)$ values mainly in range of -10 to -30, and the abundant inherited zircons with Neoproterozoic U–Pb ages, which are consistent with the history of crustal growth of the northern margin of the Yangtze Block, demonstrate that these granitic rocks were probably derived from partial melting of the subducted northern Yangtze continental crust beneath the North China Craton. Hence, the molybdenum source for the extensive Mo mineralization was most likely derived from the Mo enriched subducted supracrustal materials of the Yangtze Block, while the over ~10 myrs slow and protracted incremental construction of the plutons may also critical for the massive porphyry Mo mineralization in the region.