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Timing of orogenic exhumation processes of the Qinling Orogen

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The Qinling Mountains is a giant orogenic belt formed by the convergence between the North China Block (NCB), South Qinling micro-continent and South China Block (SCB) along the Shangdan suture in the north and the Mianlue suture in the south. The Shangdan suture is suggested to represent the major suture separating the NCB and SCB. According to detailed investigations on the geology, geochemistry and geochronology of the ophiolitic mélanges along the Shangdan suture, and subduction-related magmatic rocks and sedimentary successions in adjacent areas, it has been well documented that the Shangdan suture was resulted from closure of the Paleozoic Shangdan Ocean. However, the timing and processes of convergence between these blocks along the Shangdan suture have been disputed in conflicting tectonic models. The 40Ar/39Ar dating technique is not only widely used to date low-grade metamorphism and related deformational events, but also has become one of the most commonly applied tools for assessing the tectonothermal cooling and exhumation history of crystalline basement complexes of orogenic belts.

Our new 40Ar/39Ar geochronological data of amphibole, white mica and biotite reveal the different exhumation and cooling histories of the major units in the North Qinling Belt (NQB) and South Qinling Belt (SQB), which constrain the multiple orogenic processes. The exhumation of the Qinling Group in the NQB started before 432 Ma, through about 500 °C during 432.3 ± 3.4 – 405 ± 15 Ma, followed by a rapid cooling below 425 °C at 388.9 ± 1.1 Ma and slow cooling through about 300 °C during 333.3 ± 0.73 – 329.5 ± 0.66 Ma. Similar exhumation history of the Kuanping Group started from about 383 Ma, cooled below 425 °C at 364.9 ± 1.2 Ma and 300 °C at 341.8 ± 1.3 Ma. The metamorphic fore-arc sedimentary wedge cooling below 500 °C occurred during 322 ± 1.3 – 311.2 ± 5.6 Ma, below 425 °C at 306.3 ± 2.8 Ma, and 300 °C at 249 ± 2.8 Ma. However, the white mica 40Ar/39Ar ages of 349.4 ± 5.1 Ma and 363.2 ± 2.5 Ma constrain the syntectonic metamorphic crystallization age of the Devonian Liuling Group in the northern SQB, whereas 228.2± 0.7 Ma indicates a delayed cooling of the Wudang Group in the southern SQB. Together with previous cooling ages and regional geology, our new data support a tectonic model of Early Paleozoic Andean-type orogeny with subsequent Late Paleozoic continental subduction in the Qinling orogen.