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Paleozoic Polymetamorphism in North Qinling, Central China: Insights from *in Situ* Titanite and Zircon U-Pb Geochronology and *P-T* Estimation

LI Ye¹, ZHOU Hanwen^{1,*}, Li Qiuli^{3,*}, XIANG Hua^{1,2}, ZHONG Zengqiu¹, LI Jianwei¹ and YAO Shuzhen¹

1 State Key Laboratory of Geological Processes and Mineral Resources, Faculty of Earth Sciences, China University of Geosciences, Wuhan 430074, China

2 Institute of Geology, Chinese Academy of Geological Sciences, No. 26 Baiwanzhuang Road, Beijing 100037, PR China

3 State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China

Two major age groups in Paleozoic have been recognized in the North Qinling orogen, clustering at 470-500 Ma and 400-440 Ma, respectively. However, the relationship between the two events is still in argument. Songshugou area, located at the southern part of the North Qinling orogeny, has been reported to record the two episodes of metamorphism. Studies on metabasic rocks in Songshugou area can potentially provide insights into this issue. In this study, four metabasic rocks from the Songshugou area were selected for a detailed study of *P-T* conditions and U-Pb ages. According to their petrological characteristics, high granulite-facies mineral assemblage (M1-1) is preserved by Jd-rich clinopyroxene and garnet. The following amphibolite-facies metamorphism (M1-2) is recorded by amphibole and plagioclase associated with or without garnet and clinopyroxene. Subsequently, the metabasic rocks retrograded to greenschist or epidote amphibolite-facies (M1-3), which is marked by the occurrence of actinolite or epidote. In addition, another heating event (M2) is represented by the overgrowth of titanite and zoning amphibole, which define the lineation in matrix. LA-ICPMS zircon dating and *in situ* SIMS titanite dating were performed for metabasic rocks. Zircon ages ranging from 482 to 495 Ma are interpreted to reflect the timing of retrogression amphibolite-facies (M1-2). Titanite, which is associated with actinolite, constrains the age of 470 Ma for the upper limit of greenschist-facies metamorphism (M1-3). We further present the titanite U-Pb age of 423 Ma for the overprinting heating event (M2). Based on petrology, *P-T* pseudosections, mineral isopleths and geochronology, we provide a detailed *P-T-t* path for metabasic rocks in Songshugou area. After experiencing

high pressure event ($T > 800$ °C and $P > 1.6$ Gpa) at ~500 Ma, the basic rocks retrograded to amphibolite-facies with metamorphic conditions of ~720 °C and ~0.7 Gpa at the ages of 482 to 495 Ma through near-isothermal decompression process. Then, it further retrograded to greenschist-facies (<400 °C, <0.5 Gpa) at ~470 Ma, implying a near-isobaric cooling process. About fifty million years later, the metamorphic conditions change to temperature of 550 °C and pressure of 0.6 Gpa at ~423 Ma. Due to exhumation to shallow crustal levels in the first event and the long gap between the two events, we prefer to illustrate the two events are isolated and the Silurian to early Devonian event may belong to another metamorphic cycle.

Key words: North Qinling, Songshugou, polymetamorphism, early Paleozoic, *P-T-t* path

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* Corresponding author. E-mail: hwzhou@cug.edu.cn, qiuli8@263.net

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