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The Metamorphic P-T-t Evolution of the Retrograded Eclogite from Zhaigen Area in the North Qinling Terrane

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The North Qinling terrane (including Kuanping group, Erlangping group, Qinling group and Danfeng ophiolite melange) is located in the central of China, and is classified as a Paleozoic HP/UHP metamorphic zone (e.g., Liu et al., 2003; Yang et al., 2003; Liu et al., 2010; Wang et al., 2011; Cheng et al., 2011, 2012). In the northern of the Qinling group, eclogites were discovered in the Guanpo area with the peak assemblage of Grt+Omp+Phe+Rt+Qtz (e.g., Hu et al., 1994; Zhang et al., 2009). Micro-diamond inclusions are identified in zircons from both eclogite and felsic gneisses in this area, indicating that the rocks have been experienced UHP metamorphism (Yang et al., 2003). In the southern of the Qinling group, eclogites are also found in the Qingyouhe area (Cheng et al., 2011). Previous studies show that the metamorphic ages of these HP/UHP rocks ranges from 485 to 514 Ma (e.g., Chen et al., 2011; Liu et al., 2010; Wang et al., 2011; Cheng et al., 2011, 2012), but the retrograded metamorphic age has not been well constrained. Therefore, the metamorphic pressure-temperature-time (P-T-t) path of these HP/UHP rocks is undefined. In this study, the retrograded eclogite is discovered in the middle part of the Qinling group. We present not only P-T conditions estimates, but also the multistage metamorphic U-Pb ages of the rock. The results bring fresh informations to constrain the distribution of the HP/UHP rocks in the North Qinling, and play significant roles to understand the tectonic evolution of the North Qinling HP/UHP metamorphic belt.

The retrograded eclogite from Zhaigen area occurs as lenses within the garnet - biotite - plagioclase gneiss. The petrographic features and mineralogical compositions show that the rock has been experienced three main metamorphic stages: (1) the early eclogite facies stage (M1): the texture of the clinopyroxene + Na-rich plagioclase and the proportion of plagioclase in the clinopyroxene being up to 33 vol.% are generally inferred

to be resulted from the breakdown of a previous omphacite (e.g., Möller, 1998; Yao et al., 2000; Zhao et al., 2001; O'Brien et al., 2005; Liu et al., 2010), which suggest the rock has been experienced eclogite facies metamorphism; (2) the granulite facies (M2) stage is characterized by the clinopyroxene (Cpx) + orthopyroxene (Opx) + plagioclase (Pl₁) ± ilmenite ± hornblende symplectite surrounding former clinopyroxene + Na-rich plagioclase intergrowths. The P-T condition of this stage is estimated to be P= 0.7-1.0 Gpa, T= 741-845°C; (3) the amphibolite facies stage (M3) is characterized by the hornblende (Hb) + Pl₂ symplectite and coronas surrounding the garnet grain, which is transformed by the Cpx + Opx + Pl₁ symplectite. The estimated P-T condition is P= 0.45- 0.64 Gpa and T= 550- 630°C.

Cathodoluminescence investigation revealed that zircons from the retrograded eclogite display a distinct residual core - metamorphic core - metamorphic rim structure. LA-ICP-MS U-Pb dating and trace element analyses suggest that the residual cores are characterized by high Th/U ratio, negative Eu anomalies and steep HREE pattern, and yield a mean age of 573±40Ma, which is interpreted as the protolithic age of the retrograded eclogite. In contrast, the metamorphic cores and rims show very low Th/U ratio, flat HREE pattern and insignificant Eu anomalies. The metamorphic cores yield a mean ²⁰⁶Pb/²³⁸U age of 489±2Ma, which is interpreted as the age of the eclogite facies metamorphism. The metamorphic rims yield two group ages of 450±4Ma and 427±5Ma, which represent the retrograded metamorphic ages of granulite facies and amphibolite facies, respectively.

Above petrographical, mineral chemical and geochronological studies imply that the Neoproterozoic (~570Ma) protolith of the retrograded eclogite was subjected to continental subduction and eclogite facies metamorphism in the early paleozoic (489±2Ma), and subsequently experienced two stages of retrograded metamorphism during exhumation, granulite facies metamorphism at 450±4Ma and amphibolite facies

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metamorphism at 427 ± 5 Ma, respectively, suggesting a clockwise P-T-t path (Fig. 1) for the retrograded eclogite. The peak metamorphic age of the retrograded eclogite in Zhaigen area is consistent with previous data (~ 500 Ma) of HP/UHP rocks from other area in the North Qinling. Combined with their regional distribution, they should be generated by a simultaneous tectonic event.

Key words: retrograded eclogite, U-Pb dating, clockwise P-T-t path, Zhaigen area in the North Qinling, continental subduction

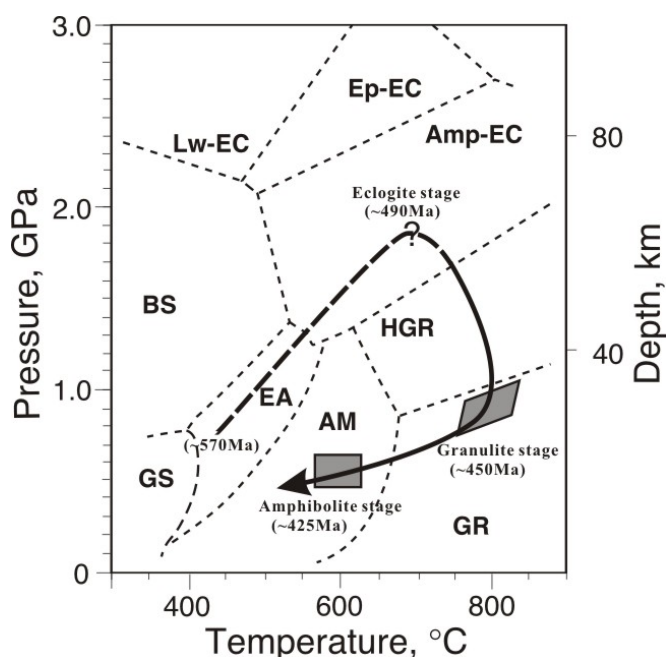


Fig. 1. P-T-t path for the retrograded eclogite in the Zhaigen, North Qinling. The petrogenetic P-T grid is modified from Liou et al. (1998).

Metamorphic-facies abbreviations: AM = amphibolite; Amp-EC = amphibolite-eclogite; BS = blueschist; EA = epidote amphibolite; EC = eclogite; Ep-EC = epidote-eclogite; GR = sillimanite-granulite; GS = greenschist; HGR = kyanite-granulite; Lw-EC = lawsonite-eclogite.

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