

A pathway for aromatic hydrocarbon formation

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Though aromatic hydrocarbons, the important components in petroleum, have been studied extensively, their formation mechanism is poorly understood, except for aromatic steranes, aromatic hopanes, and some sulphur-containing biomarker compounds, which are mainly thiophenes[1]. It is difficult to make clear their formation mechanism by studying the natural aromatic hydrocarbons lonely. During researching on the reaction of sulphur with organic matter by experiment, we found another pathway for aromatic hydrocarbon formation besides the aromatization of cyclanes. Though saturated chain compounds are difficult to become aromatic hydrocarbons, they can react quite easily with elemental sulphur and generate almost all kinds of aromatic hydrocarbons found in petroleum or sediments.

Many researchers have studied the mechanism of natural sulphur incorporation into organic matter by simulation or pyrolysis reactions[2], but the role of sulphur to the formation of common aromatic hydrocarbons in petroleum has not been pay great attention to and the action of sulphur on the organic matter in sediment used to be considered incorporating into carbon skeleton and forming sulphur-containing organic compounds even though Tissot *et* noted that the quantities of aromatic hydrocarbons in petroleum were direct proportion to sulphur[3]. From the present simulation experiment, it is clear that the reaction of sulphur and organic matter not only gives rise to sulphur-containing compounds, but also form non-heterocyclic aromatic hydrocarbons. Natural sediments are rich in saturated compounds and sulphur, so the reaction between them may be one of the most important sources of aromatic hydrocarbons.

[1] Jaap S. Sinninghe Damste and Jan W. de Leeuw. *Org Geochem*, 16(4-6): 1077–1101(1990). [2] Eitan B. Krein and Zeev Aizenshtat. *Org Geochem*, 21(10/11):1015–1025 (1994). [3] B. T. Tissot and D. H. Welte, *Petroleum Formation and Occurrence*, (in Chinese, Petroleum Publishing Company, 1989), 279–281.

The P-T-t path of the UHT granulites from Tongbai orogen, Central China

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Although the U-Pb zircon geochronometer has been widely used for dating metamorphism in moderate- to high-grade rocks, it is generally difficult to link the U-Pb age of zircon to pressure-temperature (P-T) conditions. Fortunately, the textures and chemical compositions (e.g. REEs) of zircon may provide qualitative information for correlating radiometric ages with certain stages in the metamorphic history of a rock. Additionally, zircon Lu-Hf isotopes can be used to constrain the nature of the igneous or metamorphic event in which the zircon grew.

Four stages of metamorphism are recognised in the granulites from Tongbai orogen, including a prograde stage (M1, ca.730–820°C at ca. <6 kbar), peak stage (M2, >920°C and 8.5–9.5 kbar), amphibolite facies retrograde stage (M3, ca. 700°C at ca. 7 kbar) and greenschist facies retrograde stage (M4, ca. 500 °C at ca. 5.8 kbar). Correspondingly, four distinct domains in the metamorphic zircons, which ²⁰⁶Pb/²³⁸U age are ca. 443 Ma, ca. 430 Ma, ca. 419 Ma and ca. 400 Ma respectively, are classified based on CL images, trace elements, U-Pb ages and Hf isotopes. The ca. 443 Ma zircons, which are suggested as the M1 minerals, are characterized by flat HREE pattern, indicating presence of garnet during formation of these zircons. The ca. 430Ma zircons from a semi-pelitic granulite are characterized by strongly depleted HREEs, resulting in low HREE partitioning between zircon and garnet (<1.0), which is consistent with the characteristics of the ultra-high temperature metamorphic zircon. The age of ca. 430 Ma is represented the peak metamorphic age. The ca. 419 Ma zircons occur as rim of the ca. 430 Ma or ca. 443 Ma zircons from a semi-pelitic granulite, and are characterized by relatively rich in HREE. This coincides with the fact of that garnet porphyroblasts were replaced by biotite + plagioclase during the retrograde stage (M3). In a mafic rock, the ca. 400 Ma zircon rims have obviously lower initial ¹⁷⁶Hf/¹⁷⁷Hf ratio than ca. 419 Ma zircons. It is extremely possible that hydrothermal fluids with low ¹⁷⁶Hf/¹⁷⁷Hf ratios were added into the rock during greenschist-facies hydrothermal event at ca. 400 Ma. We argue that the Tongbai UHT granulites is possibly related to the mid oceanic ridge subduction.