Research Advances

New Discoveries of the Influence of Sedimentary Environment on Rearranged Hopanes in Source Rocks

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Objective

The distribution of rearranged hopanes in hydrocarbon source rocks is influenced by thermal maturity and original source input, and is also controlled by depositional conditions. Through comparison of lacustrine and coal-bearing source rocks, this work attempted to analyze the composition and origin of rearranged hopanes in hydrocarbon source rocks. Taken the source rocks from the Songliao Basin, Ordos Basin and Kuqa Depression as examples, we aimed to investigate the effect of the redox conditions, water salinity and oxygen content of the source-rock depositional environment on the formation of rearranged hopanes to provide theoretical basis for the genesis of rearranged hopanes.

Methods

This work collected 110 samples including lacustrine source rocks in the Songliao Basin and coal-bearing source rocks in the Ordos Basin and Kuqa Depression to conduct macro- and micro-geochemical analysis. In addition, the qualitative and quantitative research using gas chromatography-mass spectrometer (GC-MS) show the variations of the relative abundance of rearranged hopanes with pristane/phytane (Pr/Ph), gammacerane index (G/C_{30} hopane) and the percentage contents of dibenzofuran(OF/(OF+F+SF)).

Results

The distribution of rearranged hopanes in source rocks in the study area ranges widely from low abundance (C_{30} diahopane/C_{30} hopane <0.2) to abnormally high (C_{30} diahopane/C_{30} hopane >1.0). The oxidation-reduction of sedimentary environment exerts a significant effect on rearranged hopanes. As for lacustrine depositional condition, the source rocks in the Songliao Basin contain highly abundant rearranged hopanes in weak reduction-suboxic condition with Pr/Ph ratios in a range of 0.8–1.2. However, the coal measure source rocks from the Ordos Basin and Kuqa Depression with Pr/Ph ratios of 0.8–3.0 are characterized by high abundant rearranged hopanes, indicating that beside weak reduction-suboxic condition, oxic condition might also contribute to the formation of rearranged hopanes (Fig. 1a). The relative abundance of rearranged hopanes show an initial increases and a following sharp decrease at the maximum value，which suggests that at diagenesis stage oxygen content may control the relative amounts of rearranged precursors and promotes acid catalyzed rearrangement processes, and then the exclusion of oxygen suppresses the acidic catalysis. For both lacustrine source rocks and coal measure source rocks, water salinity greatly affects the formation of rearranged hopanes. High abundant rearranged hopanes mainly exist in fresh-brackish water with G/C_{30} hopane ratios in a range of 0.05–0.3, contributes to the formation of rearranged hopanes in coal measure rocks, indicating that relatively high abundant oxygen is more likely to support the acidic catalysis to form more rearranged hopanes in coal measure rocks. For lacustrine source rocks, saline environments with G/C_{30} hopane ratios >0.6 contain relative high abundant rearranged hopanes (Fig. 1b). The abundance of dibenzofuran in polycyclic aromatic compounds may indicate the oxygen content of water environment, and the percentage of dibenzofuran in fluorene(F), dibenzofuran (OF), and dibenzothiophene(SF) generally acts as indicators. As shown in Fig. 1c, it reveals that the lacustrine source rocks with low oxygen content (OF/(OF+F+SF)< 20%) could form high abundant rearranged

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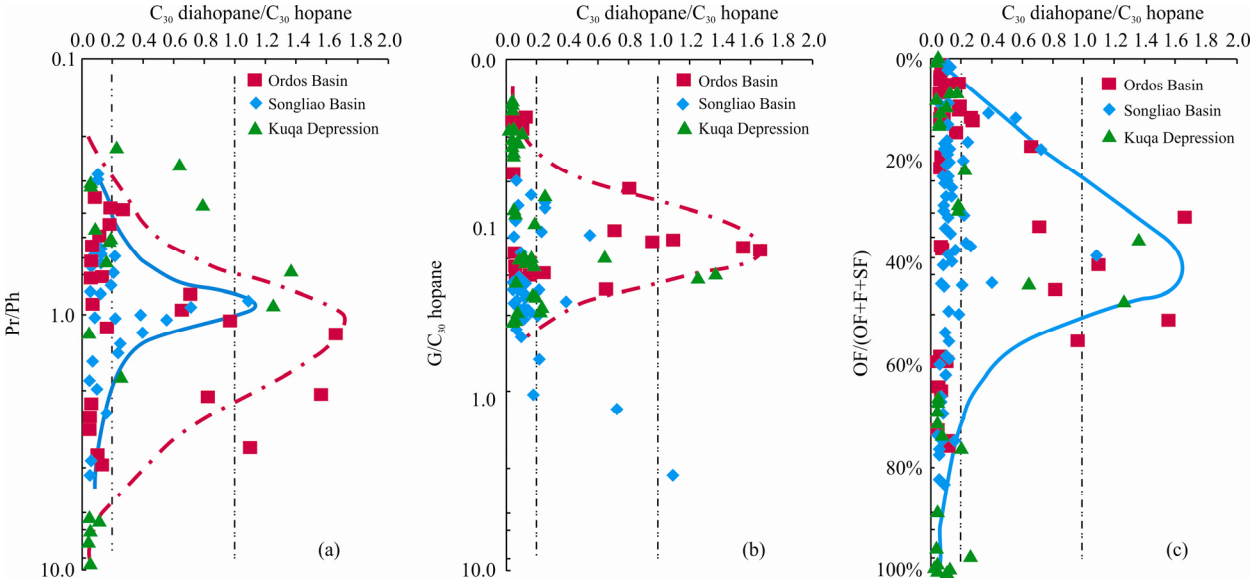

Fig. 1. Relationship of C_{30} diahopane/C_{30} hopane with different depositional environmental parameters.

hopanes. However, only when the oxygen content is high (OF/(OF+F+SF) more than 40%), the coal measure source rocks could form high abundant rearranged hopanes.

As mentioned above, redox condition and water salinity of sedimentary environment in lacustrine source rocks exist no general covariation. Therefore, redox condition and water salinity affect rearranged hopanes by different ways. Water salinity may influence the relative amounts of rearranged precursors by controlling microorganisms in the process of sedimentation and diagenesis to some extent, and then impact rearranged hopanes via an unknown mechanism.

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