

Characteristics and Genesis of Ordovician reservoir bitumen in Shunnan area, Tarim Basin

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Introduction

A large amount of reservoir bitumen has been discovered in Shunnan area of Tarim Basin. The analyses of its characteristics and genesis are helpful to reveal the adjustment and transformation process of oil and gas reservoirs. Through the comprehensive application of polarizing microscope, fluorescence microscope and laser Raman microspectroscopy, the occurrence classification, composition characteristics and thermal evolution features of Ordovician reservoir bitumen in Shunnan area can be studied. And the origin of reservoir bitumen is discussed in combination with previous studies.

Results

The main reservoirs in Shunnan area include Penglaiba Formation (O_{1p}), Yingshan Formation (O_{1-2y}) and Yijianfang Formation (O_{2yj}).

Under microscopic polarized light, it is found that: (i) The bitumen of Middle-Lower Ordovician reservoirs is widely distributed in the stylolite; (ii) In the limestone reservoir of Yijianfang Formation and Yingshan Formation, the dissolution pores and microfractures are also the common reservoir spaces of reservoir bitumen; (iii) In the dolomite reservoir of Penglaiba Formation, the reservoir bitumen is mainly distributed in the stylolite of inherited development, the microcracks and the dolomite crystal.

Under ultraviolet fluorescence, the colour of reservoir bitumen of different strata and occurrence in Shunnan area is black (no fluorescence emission), which indicates that the crude oil accumulated in the early stage of Shunnan area experienced a series of processes of thermal metamorphism and formed the carbonaceous reservoir bitumen with little light component and high degree of evolution.

Using laser Raman technology, we can accurately describe the reservoir bitumen of high evolution degree. According to the results of previous studies, the Raman spectra of reservoir bitumen has two Raman characteristic peaks in 1000~2000cm⁻¹. Among them, the "G" peak in 1580~1600cm⁻¹ represents the regular vibration between carbon and carbon on the plane of aromatic configuration layer, which is also called "graphite peak". The "D" peak in 1350~1380cm⁻¹, called "defect peak", is related to the disordered structure and defects of amorphous graphite (Fig. 1a).

Scholars mainly selected the positions, intensity, saddle index, bandwidths, areas and other related parameters of the characteristic peaks in previous studies on reservoir bitumen (Nakamizo et al., 1974; Jehlička et al., 1999). With the thermal maturity evolution increasing, the intensities of the G and D peaks increase, the bandwidths of the G and D peaks decrease, the shapes of the G and D peaks become sharper, the base line becomes smoother, the position of the G peak is almost unchanged, and the position of the D peak moves gradually to the direction of lower band. In this paper, the difference between the positions of the two peaks (vG-vD), the intensity ratio of the two peaks (D_h/G_h), the bandwidths of the G and D

peaks-full widths at half mean (WD, WG) and the saddle index (Gh/S) are selected to analyze the evolution degree and stage of Ordovician reservoir bitumen in Shunnan area (Fig. 1a). Among them, the $\nu G-\nu D$ is $245\sim 270\text{ cm}^{-1}$, the Dh/Gh is $0.72\sim 0.77$ (Fig. 1b), the Gh/S is $2.7\sim 3.2$. In addition, according to the strong multi-linear correlation between the Raman parameters and the maturity of the reservoir bitumen (Ronald et al., 2014), the maturity of the Ordovician reservoir bitumen in Shunnan area can be calculated and the $Ro\%_{calc}$ is $2.0\sim 2.3\%$ (Fig. 1c).

$$Ro\%_{calc}=7.432\log(\nu G-\nu D)-0.306\log(Gh/S)-2.935\log WG-3.118\log WD-3.291$$

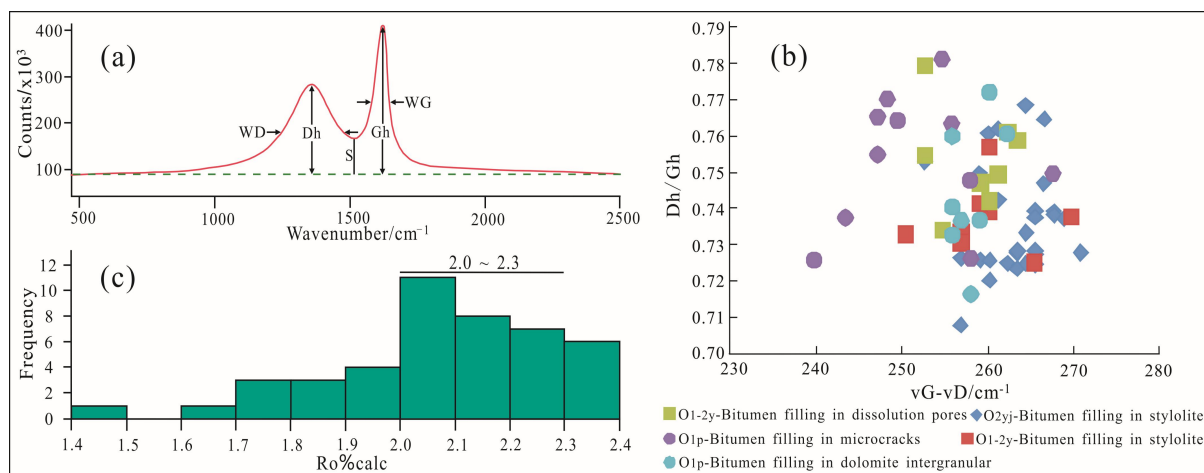


Figure 1:(a) Schematic diagram of Raman spectra and related parameters. (b) The relationship between $\nu G-\nu D$ and Dh/Gh of Middle-Lower Ordovician reservoir bitumen in Shunnan area. (c) The Distribution of the maturity of Middle-Lower Ordovician reservoir bitumen in Shunnan area.

Conclusions

The reservoir bitumen in Shunnan area is over matured and formed in the same geological period. Based on the analysis of geological background, the genesis of reservoir bitumen in Shunnan area include: (i) The crude oil accumulated in the early stage reaches the condition of crude oil cracking with the depth increasing; (ii) The extensive hydrothermal activities also promote the cracking of crude oil.

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