Quantitative characterization of extractable organic matter in lacustrine shale with different occurrences

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1. Introduction:

Lacustrine shale has extractable matters (OMs) that can be classified into free, adsorbed or miscible states. The quantitative study on different occurrence the OM has an important sense for the oil/gas resources evaluation, hydrocarbon generation mechanism and oil /gas occurrence. In this study, two lacustrine shales with of eastern China were successively extracted by solvents with different polarities, three different occurrence states of soluble OM have been obtained, which are free, kerogen adsorptive–miscible and mineral surface adsorption state which have been carried out for FT-IR spectra and GC-FID analysis. The results showed that soluble OM of adsorbed or miscible by kerogen accounts for a large proportion, followed by free OM. Free soluble OM was dominated by light compounds, and fracturing is conducive to precipitation of light components; the OM of kerogen adsorptive–miscible state, mainly has heavier components, also contains lower portion of light fractions; surface adsorbed OM of rocks and minerals are mainly comprised of oxygen-contained compounds.

2. Samples and Experiments

Two lacustrine shale samples were collected from the Fourth upper and the Third lower sections of Shahejie Formation, Jiyang depression, eastern China (Table 1). The first sample came from well Wang 127 cores (Fourth upper section) of Shahejie Formation of Dongying sag, is typical laminated shale, gray laminae rich, and has higher oil generating potential than the second sample, which was collected from well Luo 69 drilling cores (Third lower section) of Shahejie Formation in Zhanhua sag was a dark grey massive shale. Both of the two samples were matured (Ro% ≈ 0.7-0.8%), and represented typical lacustrine shale samples.

After surface cleaning, the two fresh core samples were cut into cubes about 1 cm edge-length and were ultrasonically extracted by two mixtures of different solvents (Culec, 1977; Grist, 1975; Schwark, 1997) at ambient temperature. The weak polar solvent was a mixture of dichloromethane and methanol (93/7, V/V), and the solvent of high polarity was composed by tetrahydrofuran, acetone and methanol (2/1/1, V/V).

3, Results and Discussion

The extraction products in Step1 and Step2 using weakly polar solvent are proven in the free state of soluble OM (Schwark, 1997). The extraction product in step 3 is a soluble OM adsorbed on the inner and outer surface of the rigid macromolecular framework of the kerogen and the small molecule of the internal network structure of the kerogen(Yang Kun,2007), and also some weak polar soluble OM, mainly composed of alkanes and aromatic hydrocarbons, which is physically adsorbed on the surface of some rock minerals[named adsorbed（A）]. In step 4, the extraction product is mainly the soluble OM which contains a large number of polar groups on the surface of rock minerals[named adsorbed（B）].

Free state of soluble OM has a higher proportion in lacustrine facies shale (accounted for 29%), whereas the proportion is smaller in a massive shale (only accounted for 4%). Adsorption and dissolved OM is the main occurrence of soluble OM in lacustrine shale (accounted for 49% and 72% of the total), While in lacustrine facies shale, is mainly of adsorbed and dissolved by kerogen. The content of soluble OM varies in different lithofacies

shale. For laminated shale, the soluble OM is mainly in the adsorption state of kerogen and partly in free state of Interlayer fracture. Whereas for massive shale, the soluble OM is mainly in matrix pore and partly in the micro cracks in the layer.

Free state of soluble OM in aliphatic structures with higher abundance, mainly for short chain alkanes and part of the long chain alkane structure; in kerogen, adsorbed and miscibility of soluble OM, mainly for aromatic and aliphatic structures, rock and mineral adsorption of polar molecules mainly containing - OH and C-O structure of alcohols, phenols, ethers.

4, Conclusion

1) The amount of soluble OM is significantly different between the lacustrine facies and the massive shale.

2) The free state are mainly composed of light component, kerogen adsorption state of soluble OM, mainly - heavy component in contains some light components at the same time, while mineral surface adsorption mainly in heavy group, also contains some light component.

3) Change in solvent or extraction methods is likely to cause changes in the experimental data.

Table 1 The basic geochemical information of two shale samples

No.	Sample	lithology	Depth(m)	Age	S_1 (mg/g)	S_2 (mg/g)	Tmax (C°)	HI	TOC (%)
1	W127	laminated shale	3044.74	upper E2s4	8.90	65.45	441	766	8.54
2	L69-1-A	massive shale	2991.42	lower E2s3	4.49	14.03	443	538	2.61

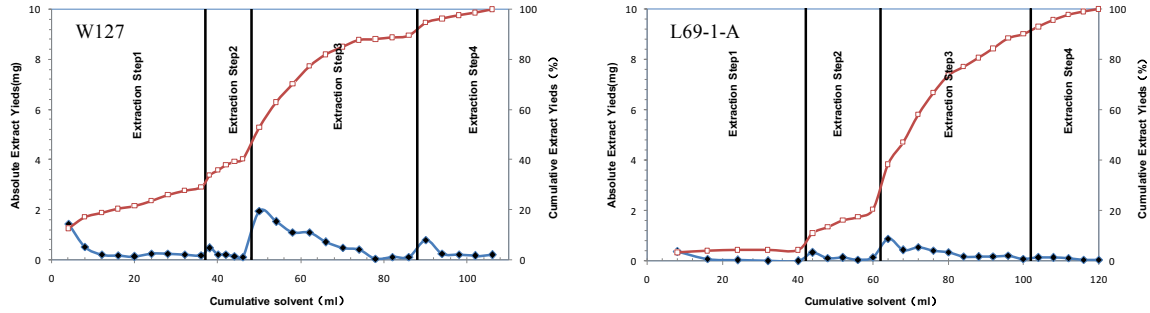

Fig1 The results of different steps extraction of two samples

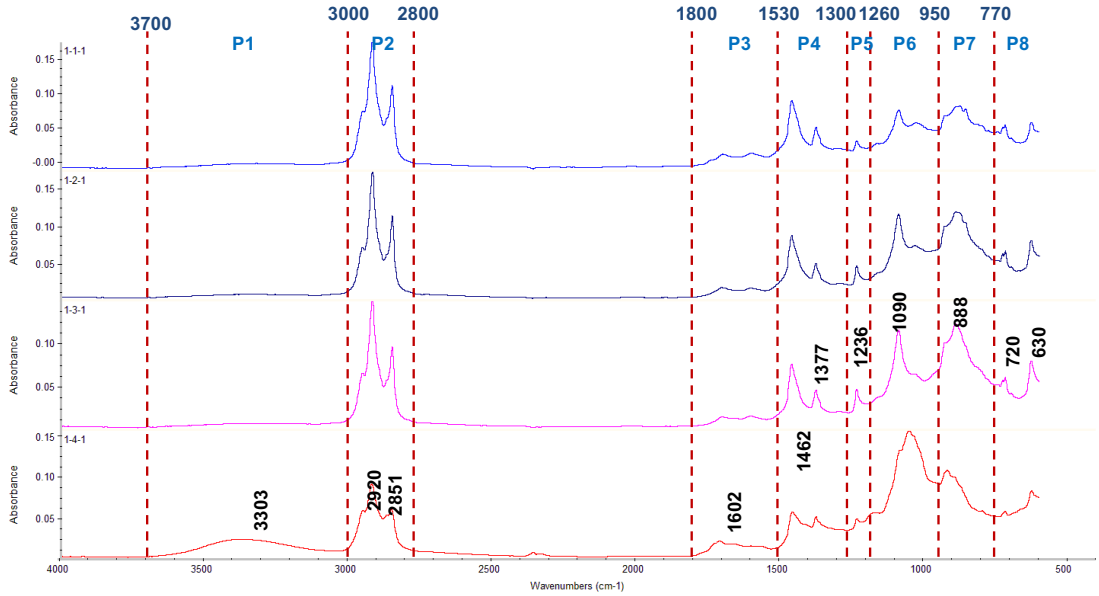

Fig 2 The FT-IR characteristics of of successive extract products of W127 sample