

## EXPERIMENTAL RESEARCH ON THE RESIDUAL HYDROCARBONS OF TRIASSIC CHANG7 LACUSTRINE SHALE IN THE ORDOS BASIN, CHINA

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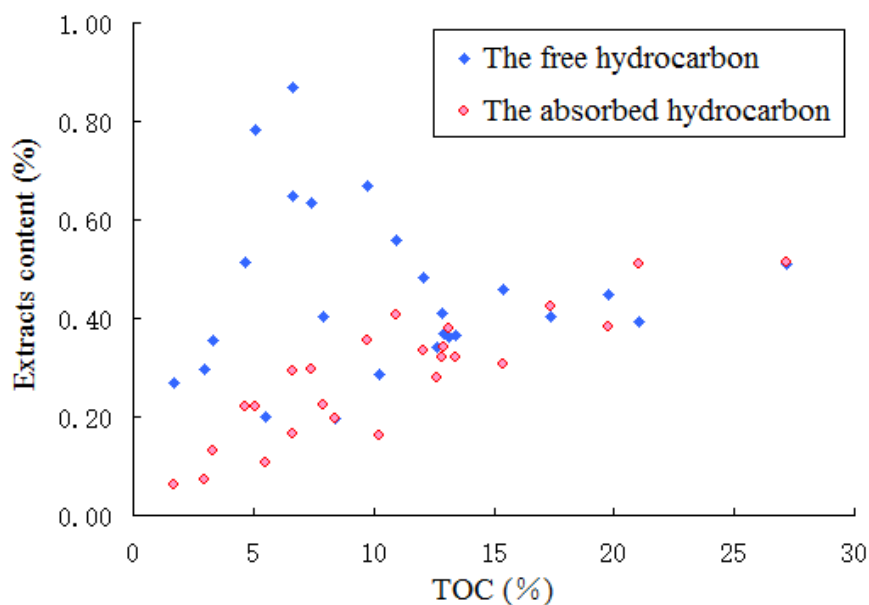
China has begun to explore shales of lacustrine basins since 2010. Although shale oil exploration in lacustrine basins was not promising, industrial shale oil flows were obtained in some strata, especially in the Chang7 member of the Ordos Basin that may reach 21.4 tons one day (e.g., in well Geng295, 2655m). One of the most significant questions now being asked focuses on the fluid hydrocarbon contents those may be produced. The Chang7 shale has high abundance of residual hydrocarbons with an average content of 0.84% (bitumen "A"). However, it should be noted that the polar components account for a large percentage (about 40%) of the residual hydrocarbons. Therefore, whether the shale oil is valuable and which part of the shale oil can be produced is vital for shale oil commercial assessment. This study focuses on the occurrence states, properties and quantities of different hydrocarbons in the shale.

The residual hydrocarbons are present in shale mainly in free and absorbed states. Free oil, the more valuable part, is stored in the micro pores and fractures, while the absorbed oil is mainly absorbed by the kerogens and minerals. In theory, the free hydrocarbons are easier to be extracted by the organic solvents. Therefore, 3 shale samples were selected for extraction experiments in order to separate the free oil and the absorbed oil. Each sample was divided into 4 parts, which were extracted by the dichloromethane for soon, 15 min, 30 min and 60 min, respectively. Combined with other analytical tests, the results suggested that the soluble hydrocarbons extracted by the dichloromethane were mainly free parts and the free hydrocarbons could be extracted by the dichloromethane immediately. So the free hydrocarbon contents of 25 selected shale samples were observed by this method, and then the residues were extracted by the trichloromethane to obtain the absorbed hydrocarbons. Contrast between the properties of the free hydrocarbon and the absorbed hydrocarbon (Table 1) proposed that the absorbed hydrocarbons were abundant in polar components such as the asphaltene, whereas the free hydrocarbons were rich in saturates, which are more flowable. Furthermore, the free hydrocarbon content is mainly controlled by the reservoir quality, while the absorbed hydrocarbon content is mainly related to the organic matter content (Figure 1). As the Chang7 shale samples are not rich in clay minerals, the majority of the absorbed hydrocarbons should be absorbed by the kerogens during the initial hydrocarbon expulsion stage, so high abundance of the polar component (the asphaltene) would not affect the fluidity of the shale oil.

The free hydrocarbon content of the Chang7 shale samples is high with an average content of 0.4%. The flowable hydrocarbon content may be higher adding up the volatile parts of the absorbed hydrocarbons. Chang7 shale extends widely with large thickness, the burial depth is between 1200 and 2600 m, and it has high content of brittle minerals those are favorable for shale oil exploration.

**Table 1** The contents of the dichloromethane extracts and the trichloromethane extracts of the residues.

Well name	Depth (m)	Member	Lithology	Dichloromethane extracts					Trichloromethane extracts of the dichloromethane extracted residues				
				Extract content (%)	Saturate (%)	Aromatic (%)	Non hydrocarbon (%)	Asphaltene (%)	Extract content (%)	Saturate (%)	Aromatic (%)	Non hydrocarbon (%)	Asphaltene (%)
Li57	2330.2	Chang7	Shale	0.483	37.72	38.89	21.64	1.75	0.335	8.77	11.11	19.88	52.63
Li57	2338.7	Chang7	Shale	0.286	37.89	42.63	17.89	1.58	0.163	6.21	12.42	17.39	61.49
Yue67	2029.3	Chang7	Shale	0.298	80.08	9.96	9.96	0.00	0.074	42.86	23.38	20.78	20.78
Yue67	2047.8	Chang7	Shale	0.509	25.24	42.81	15.65	9.27	0.513	4.68	9.65	6.73	73.68
Yan56	3037.3	Chang7	Shale	0.869	58.91	28.03	11.56	1.50	0.292	15.14	11.95	17.13	54.18
Yan56	3057.4	Chang7	Shale	0.648	50.81	33.63	14.13	1.43	0.167	14.38	12.33	19.86	52.74
Luo196	2659.0	Chang7	Shale	0.557	23.91	36.30	14.57	7.17	0.406	8.76	12.37	10.82	71.13
Luo196	2663.6	Chang7	Shale	0.634	34.27	35.78	15.52	5.39	0.297	11.11	14.81	15.43	60.49
Luo196	2667.4	Chang7	Shale	0.670	38.81	41.89	13.55	5.54	0.354	9.13	12.61	13.04	65.65
Luo196	2670.7	Chang7	Shale	0.781	50.18	34.36	12.55	2.18	0.220	16.92	17.69	26.15	39.23



**Figure 1** The relationship between the organic carbon content and the contents of the dichloromethane extracts (the free hydrocarbon) and the trichloromethane extracts (the absorbed hydrocarbon).