PS Geochemical Characterization of Daanzhai Shales in Fuling Area, Eastern Sichuan Basin, China*

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Abstract

The Fuling Area is located in the eastern Sichuan Basin. Lacustrine shale of the Daanzhai Member of the Mid-Jurassic Ziliujing Formation (J2zD) in the Fuling Area serve as good source rocks and produces both oil and gas. To figure out the geochemical characteristics and determine the petroleum potential of the Daanzhai shales, forty-one shale samples from two wells and six oil samples from six wells were characterized via multiple geochemical approaches. Vitrinite reflectance (Ro), total organic carbon (TOC) content, and rock-eval pyrolysis of shale samples were carried out. Saturate and aromatic fractions of shale extracts and oil samples were evaluated by gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS). More than 70% of the samples have the TOC over 1 wt%. The kerogen content and rock-eval parameters indicate the organic matter of the Daanzhai shales are mainly Type II. Vitrinite reflectance data suggest that most samples are mature for hydrocarbon generation. Combining all the factors, the Daanzhai shales are classified as good source rocks. Vertically, the second bed of the Daanzhai Member seems the best target because of favorable geochemistry characteristics. Compared through the whole research area, the northeast performs better than the southwest. The quantities of the group components of shale extracts and oil samples show that most of the samples are characterized by high content of alkanes. With a Ro range between 1.1 and 1.3, it is odd that there are few biomarkers in alkanes, even after the n-alkanes were expelled. We tried a number of common and uncommon sterane and terpane hydrocarbons but they are not there. However, the aromatic parameters of maturity and organic type are regular and consistent with the former results.

Geochemical characteristics of Jurassic source rocks

The abundance of organic matters

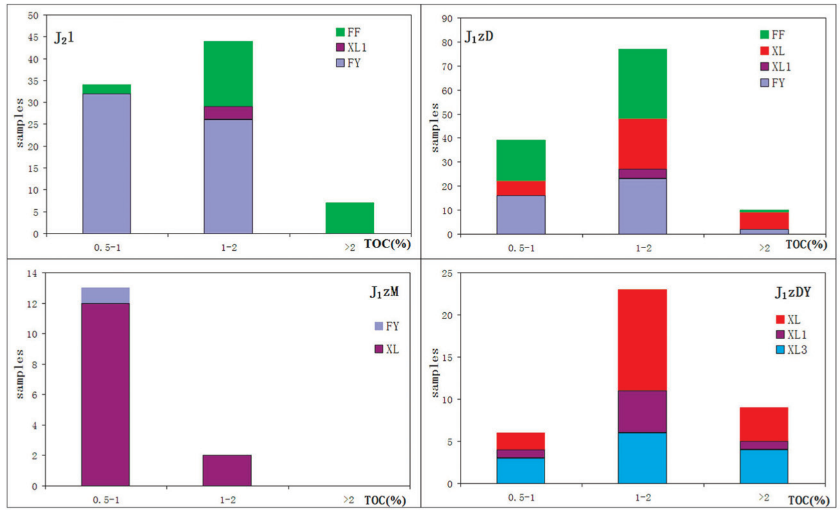
The abundance of organic matters could be characterized by present total organic carbon (TOC) content and Rock-Eval potentiality (S_1+S_2).

TOC content

The TOC content results suggest that the source rocks in J_1D and J_1DY could be good source rocks but insufficient to be excellent source rocks.

S_1+S_2

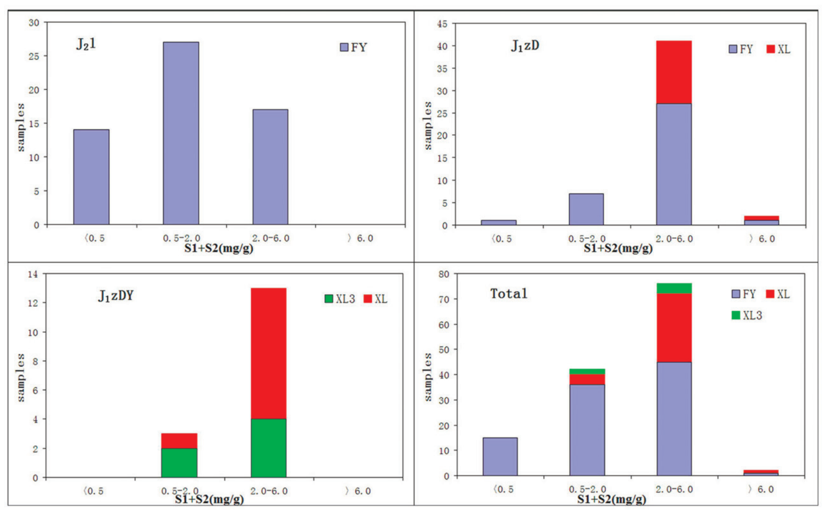
The J_1zD and J_1zDY shale exhibits the high hydrocarbon generative potential as most of the (S_1+S_2) values are over 2mg HC /g rock.



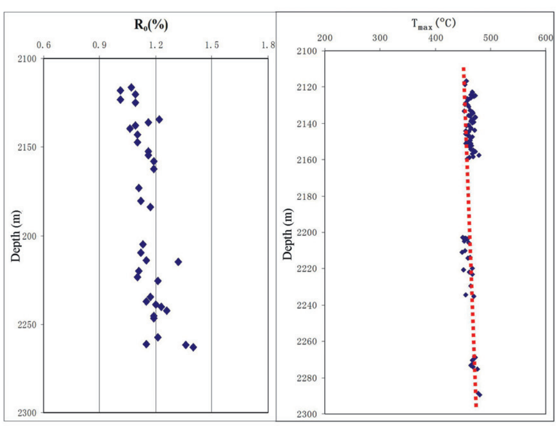
Histogram of present TOC content in Jurassic source rocks

The maturity of organic matters

Vitrinite reflectance (Ro) data suggest that most samples are mature for hydrocarbon generation (Ro 1.0~1.3%).



Histogram of (S_1+S_2) values in Jurassic source rocks



Ro(%) and Tmax(℃) plotted versus depth

Conclusions

The kerogen quality and Rock-Eval parameters indicate the organic matters of Jurassic source rocks were mainly Type II , which is capable of generating both oil and gas. Ro data suggest that most samples are mature for hydrocarbon generation. Combined all the factors, Daanzhai shale is classified to good source rocks. Vertically, the J_1zD seems the best target with most favorable geochemistry characteristics.

Reference

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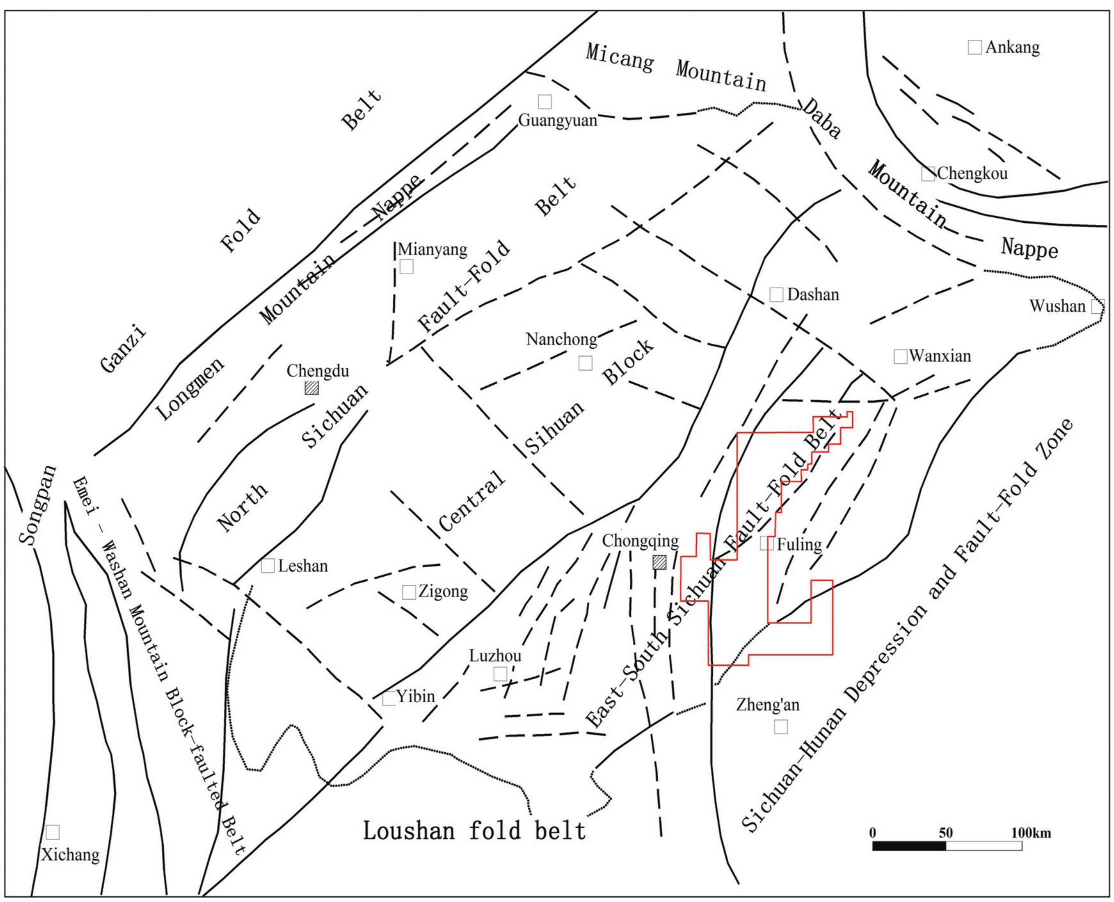
Introduction

Fuling Area is located in Eastern Sichuan Basin. The .Jurassic lacustrine rocks (J_1zDY, J_1zM, J_1zD, J_2L) in Fuling are demonstrated as potential source rocks. To figure out the geochemical distribution characteristics and determine the source potential of Lower-Middle Jurassic strata, forty-one (41) shale samples from two wells and six oil samples from four wells were tested and analyzed via multiple geochemical approaches. From this several conclusions were drawn.

Geologic background

Sichuan basin is an irregular rhombus shaped sedimentary basin in southwest China. It covers an area over 2.3×10^5 km^2 and can be divided into several structural units.

Fuling area is located in the East - South Fold Belts

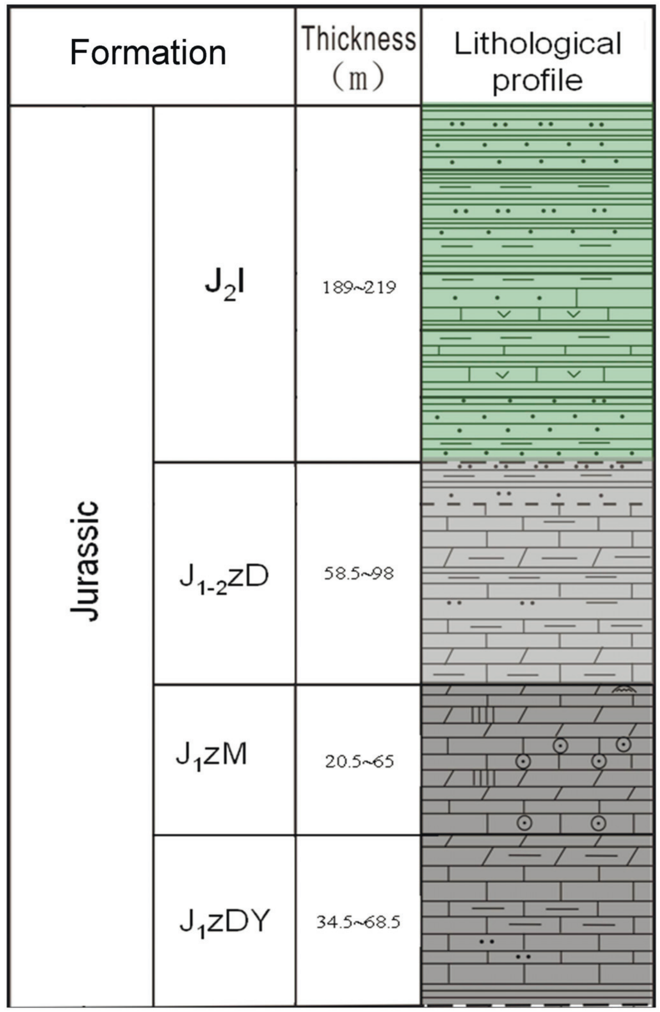


Sketch map of the Structural location of Fuling area

Geologic background

The aimed strata of study area consist of Lower-Middle Jurassic lacustrine rocks, which include Lianggaoshan Formation (J_2l) and Ziliujing Formation (J_1z).

Ziliujing Formation is divided into Daanzhai Member (J_1zD), Maanshan Member (J_1zM), and Dongyuemiao Member (J_1zDY). The lithological composition of these strata is mainly mudstones, sandstones and carbonates. Gases and condensate oils are found in J_1zD.



Summary stratigraphy column of the aimed strata in Fuling area

Sampling and methodology

42 pieces of core samples and 6 oil samples from 4 wells were analyzed for kerogen elements/ compositions, TOC contents, and Rock-Eval pyrolysis in geochemical department of Yangtze University. Vitrinite reflectance (Ro), total organic carbon (TOC) content, and Rock-Eval pyrolysis of shale samples were carried out. Saturate fractions of shale extracts and oil samples were evaluated by Gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS) in the Key Laboratory of Tectonics and Petroleum Resources of China University of Geosciences, Ministry of Education, Wuhan.

Other samples were tested by Jianghan Oil Field of SINOPEC.

Details of rock samples selected for geochemical studies

Item	Rock-Eval		Kerogen elements (C/H/O/N/S)		Kerogen isotope		Kerogen composition		TOC		Ro		GC/GC-MS		
Sample type	core		core		core		core		core		core		core		oil
Well	FY	XL	FY	XL	FY	XL	FY	XL	FY	XL	FY	XL	FY	XL	FY/FF/FS/XL
Quatity	22	20	9	6	9	6	9	6	22	20	9	6	9	6	6
	42		15		15		15		42		15		21		

Geochemical characteristics of Jurassic source rocks

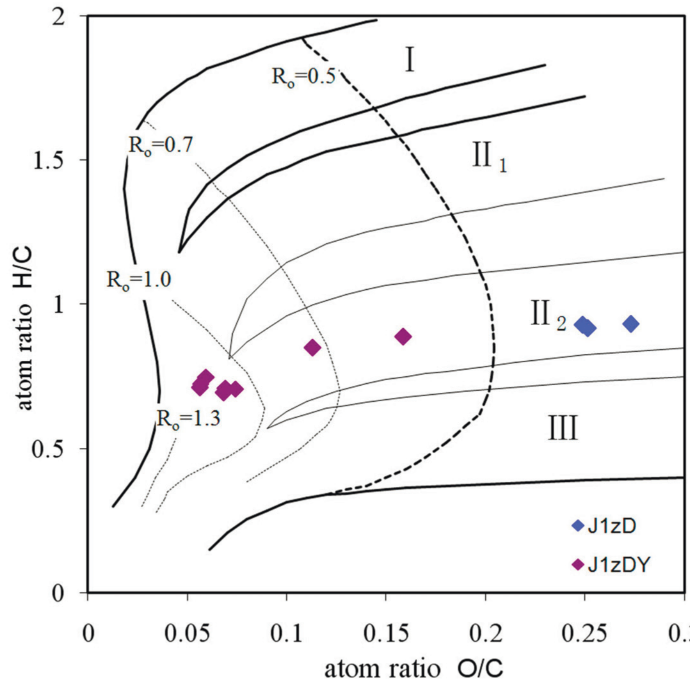
Based on the tests, we characterized the geochemical conditions of Jurassic source rocks as following:

The types of organic matters

Kerogen analysis generally includes element analysis, microscopy identification, Rock-Eval pyrolysis, etc.

Element analysis

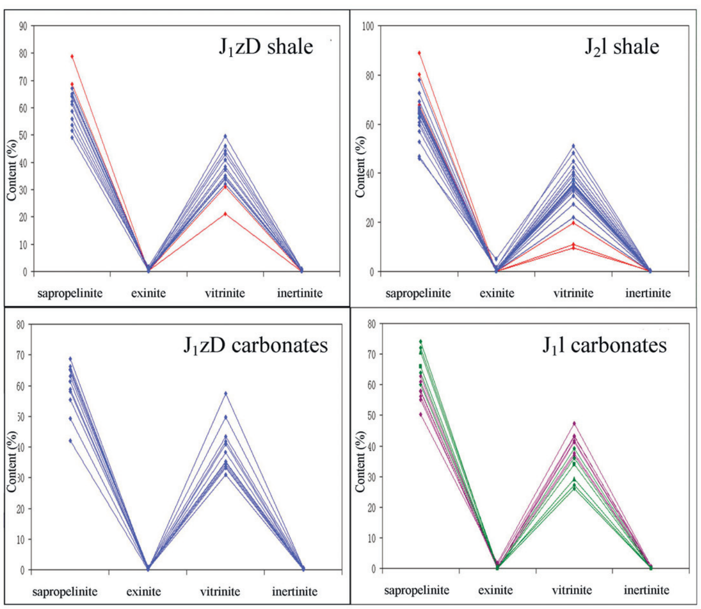
Test data of the XL101 Jurassic sample in Fuling area suggest that the kerogen type in J_1zDY and J_1zD source rocks is Ⅱ$_2$: H/C between 0.6~0.8, O/C 0.05~0.3.



Kerogen element analysis from XL rock samples

Microscopy identification

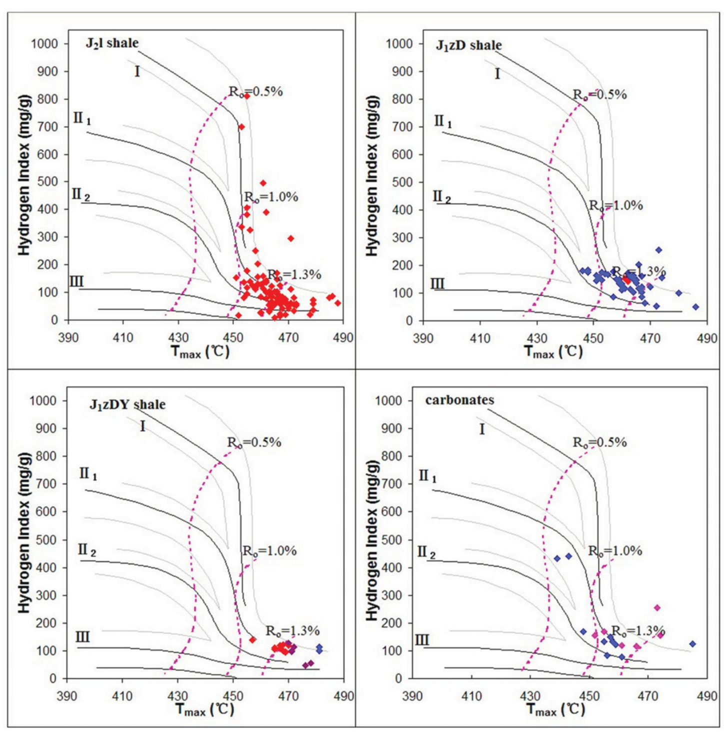
Both in J_2l and J_1zD source rock samples, the major ingredients of kerogen are sapropelic group (oil-prone) and vitrinite (gas-prone), This proportion feature corresponds to the organic matters type Ⅱ$_1$ and Ⅱ$_2$.



Kerogen microscopy composition characteristics in

Rock-Eval pyrolysis parameters

The organic matters in Jurassic lacustrine source rocks are generally type Ⅱ$_1$ and Ⅱ$_2$.



Rock-Eval pyrolysis parameters of Jurassic source rock samples