The study of Hydrocarbon Accumulation Processes in the Chalu River Fault Depression

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Abstract

In order to further understand the Chalu river fault depression's reservoir forming process and to guide oil and gas exploration for the next step. Based on the previous research on the Chalu river fault depression, the authors have used the geology, geophysics and geochemistry methods and the numerical simulation technology of oil and gas basins to restore the kinetic process of the hydrocarbon expulsion and reservoir forming in the Chalu river fault depression. The results show that the oil and gas are initially migrated during the sediments of the Sheling group, and the secondary migration begins in the primary structure of the Qijia group. Because at this time, the structure of the basin has been finalized, oil and gas has been accumulated, and the stable oil and gas reservoirs have also been formed, until now.

Keywords

Chalu river fault depression, basin modelling, oil and gas migration, hydrocarbon expulsion process

1. Reginal Geological Suvey

The Chalu river fault depression is located in the middle of Jilin Province, where between Jilin City and Changchun City. It is located in the northeastern part of Yitong Basin and becomes the second largest tectonic unit with the largest sedimentation area and an area of about 1350km^2.

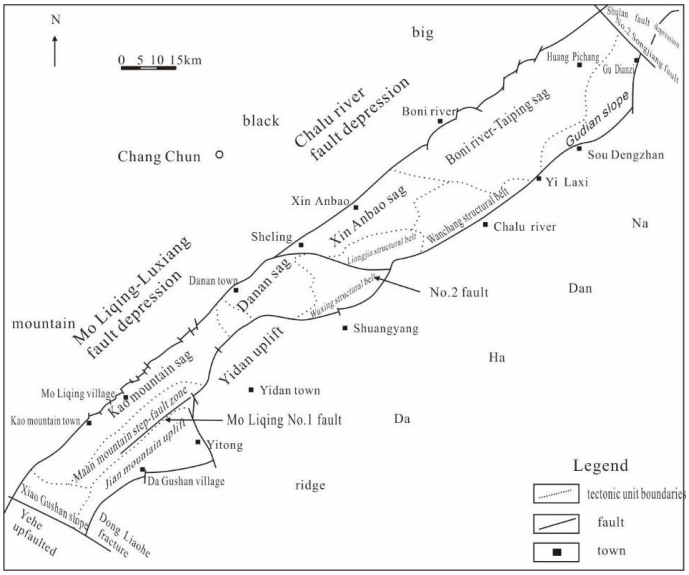

Fig.1 The tectonic location of Chalu river fault depression

the Chalu river fault depression was experienced the tectonic cycles such as Caledonian, Hercynian, Indosinian, Yanshan tectonic and so on before it formed the basin, and the corresponding strata and

granites formed the basement of the basin[1]. The distribution of the large area of the base is mainly the Hercynian and Yanshanian granites, and the granite age is 67～152Ma. Paleozoic metamorphic rocks are distributed in small areas. In order from bottom to top, The uplift strata developed from Paleogene, Neogene and Quaternary. Paleogene, from top to bottom, mainly developed Shuangyang group, Sheling group, Yongji group, Wanchang group, Qijia group. Neogene is mainly the Miocene series' Chalu river group. In the Paleogene and Neogene strata, plankton, animal and plant fossil are rare, While plant debris and coal line are generally developed, particularly rich in algae and sporopollen fossil. Lithology mainly consist of sand conglomerate, sandstone and black, gray, gray - green mudstone.

2. Analysis of hydrocarbon expulsion threshold and hydrocarbon expulsion history in the Chalu river fault depression

1) Expulsion threshold of hydrocurbon and model of expulsion amount of hydrocarbon in the Chalu river fault depression.

According to the theory of hydrocarbon expulsion threshold [2-4], and the relationship between hydrocarbon generation potential index (S1 + S2 / TOC) and depth (Fig. 1), The point at which the hydrocarbon generation potential index (S1 + S2 / TOC) begins to decrease is the hydrocarbon removal threshold. The threshold of hydrocarbon expulsion is 2600 ~ 2700m, and the corresponding hydrocarbon threshold is 0.7% (Fig. 2). In addition, as shown in Fig. 1, the difference between the hydrocarbon generation potential index and the maximum hydrocarbon generation potential index (the reduced magnitude) of the hydrocarbon expulsion threshold can be considered as the amount of hydrocarbon discharge:

$$Q_e = Q_p - HCI$$

In the formula, Qe——expulsion amount of hydrocarbon,mg/g； Qp—The maximum hydrocarbon potential index of source rocks, mg/g; HCI—S1+S2/TOC Hydrocarbon potential index, mg/g。

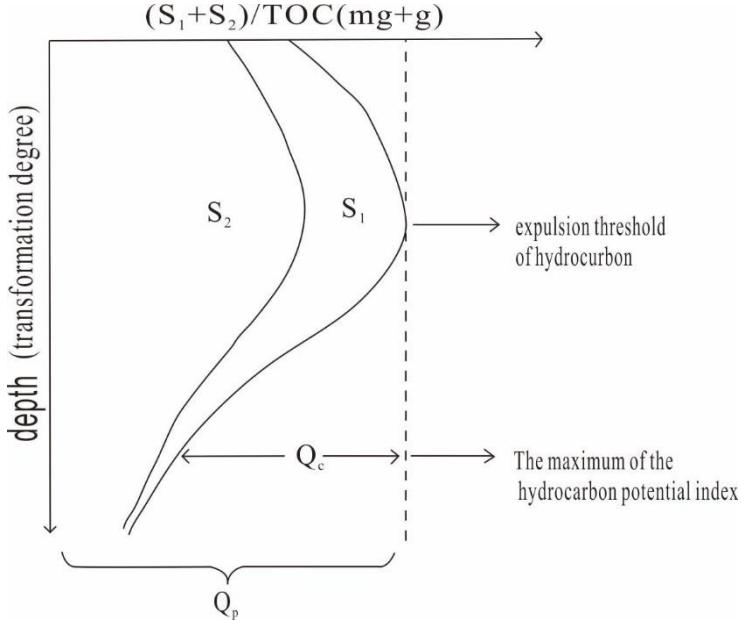

Fig.2 The determination principle model of row hydrocarbon threshold [2]

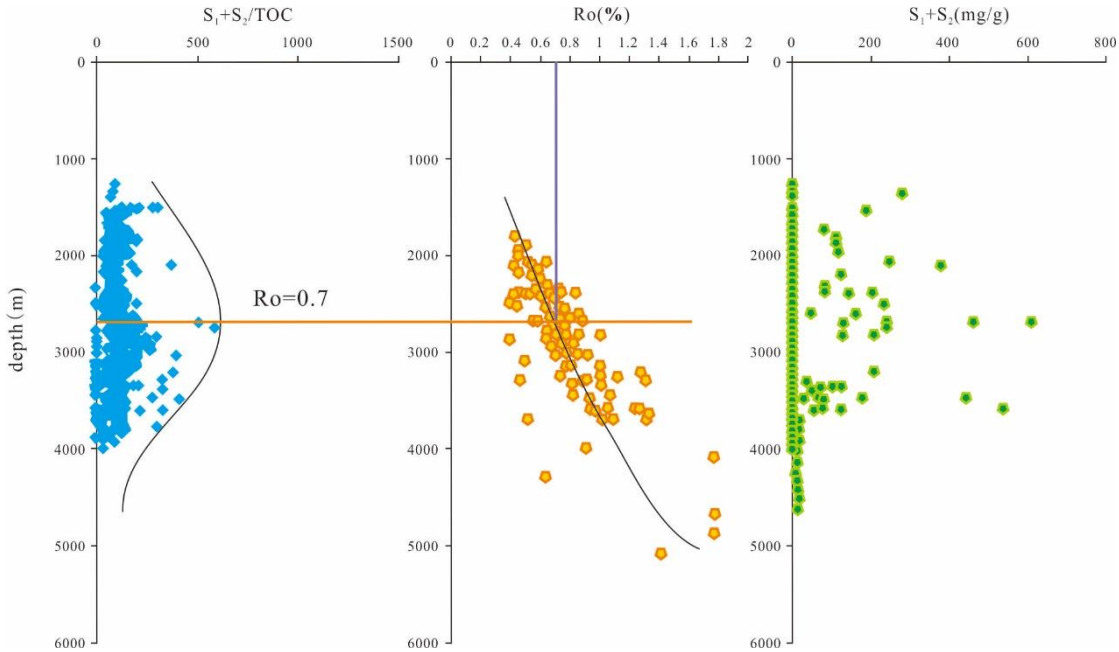

Fig.3 Expulsion hydrocarbon threshold for Chalu river depression

2) hydrocarbon expulsion history

Based on the study of hydrocarbon threshold, applying the basin simulation technology, Recovering the history of burying, the geothermal history, and confirming the corresponding hydrocarbon expulsion time (Fig. 3). In the figure, Ro ≥ 0.7% of the space-time domain, which is the initial migration of oil and gas space-time domain, according to the figure, The Chalu river fault depression began to discharge hydrocarbon in the period of accumulation of the Sheling group.

3) secondary migration

According to the basic theory of petroleum geology, the time of large-scale secondary migration is often occured after the initial migration in the study area, the first tectonic movement period, that is, the end of Qijia group.

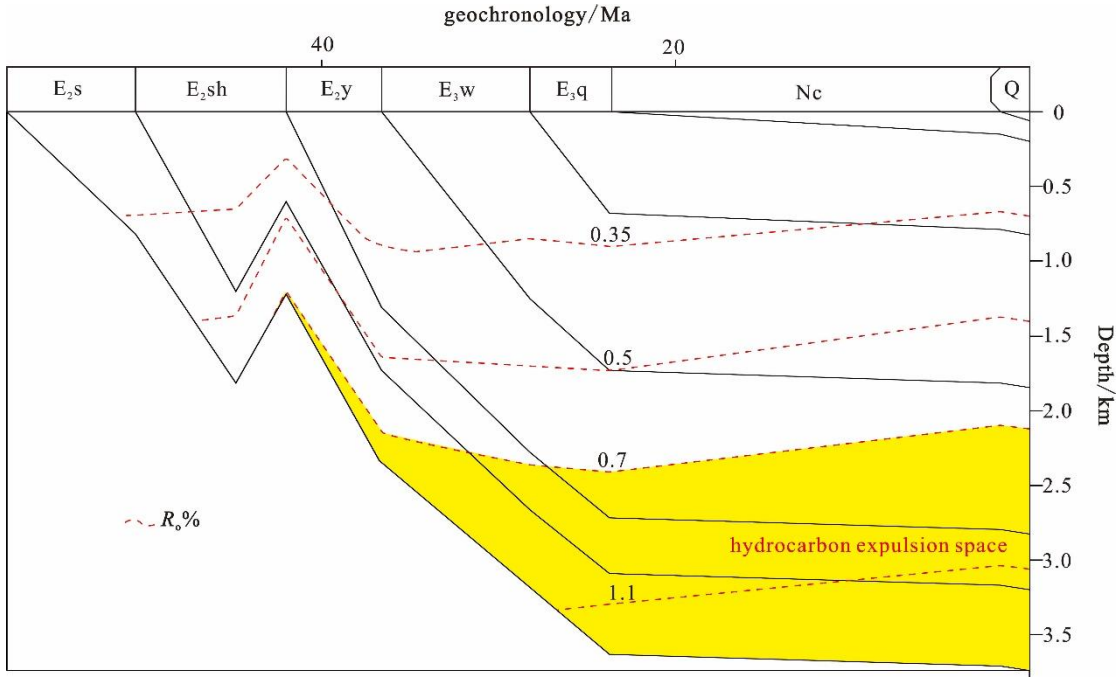

Fig.4 History of organic matter evolution of Chang 13 well in Chalu river fault depression

3. Dynamic analysis of hydrocarbon expulsion process and simulation of hydrocarbon accumulation history

Selecting Line400 for the Chalu river fault depression to simulate, By calculating the hydrocarbon rate eta in the history period of this section, the hydrocarbon distribution history and accumulation history of the section are restored[5-7] (Fig. 4).

During the sedimentary period of the Sheling group, Part of the organic matter of the source rocks Ro≥0.7% in the Shuangyang group , and a large number of the mature stage of hydrocarbon generation was obtained; In the deep sag area of the basin, the organic matter Ro of the source rock is even more than 1%, When it reaches the peak of the oil, with large amount of oil and gas generated, organic acids and CO_2 are formed, which solubled in water and become acidic hot fluid, dissolved in the aluminosilicate feldspar and carbonate cements, secondary pores are formed, The reservoir is in the middle stage of the middle diagenesis, and the main development is the mid -solution phase; The cap rocks has a good sealing capacity. In the region of the source rock Ro ≥ 0.7%, it entered the hydrocarbon threshold, oil and gas began to discharge a large number of hydrocarbons, hydrocarbon discharge ratio can reach 100mg / gCorg. The period of hydrocarbon expulsion have a good match with the structural stage, and the oil and gas reservoirs are formed on a large scale. The oil and gas generated by the source rocks of the Shuangyang Group are continuously filled in the adjacent lithologic traps, stratigraphic traps and fault traps.

During the deposition period of Yongji group, the organic matter of the source rocks Ro ≥ 0.7% in the lower part of Shuangyang group, and in the deep sag area of the basin, the organic matter Ro is more than 1%. In the mature stages of a large amount of hydrocarbon generation, a large number of oil and gas generated at the same time, forming organic acids and CO_2, dissolved in water, and forming acidic hot fluid, The aluminosilicate feldspar and carbonate cements in the eroded reservoir form secondary pores, and the reservoir is in the phase A2 phase of the mesogenetic rock phase, which is mainly in the medium phase of the phase dissolution phase. The cap rock has a good sealing capacity. Source rock Ro>0.7%, entering the row hydrocarbon threshold, the initial migration occurred, oil and gas began to discharge in a large number, hydrocarbon expulsion rate≥100mg/gCorg, oil and gas generated in Shuangyang group constantly filled in the vicinity of the lithology traps, stratigraphic traps and structural traps, oil and gas reservoirs began to form.

During the deposition period of Qijia group, The organic matter of the main source rocks in the bottom of Sheling group which located in the deep sag area of the basin and Shuangyang group are Ro ≥ 0.7%, and in the deep sag area of the basin, Shuangyang group at the bottom of the source rock the organic matter Ro even more than 1%, reached the peak of oil generation, a large number of oil and gas generated, at the same time, forming organic acids and CO_2, dissolved in water, and forming acidic hot fluid, The aluminosilicate feldspar and carbonate cements in the eroded reservoir form secondary pores, and the reservoir is in the phase A2 phase of the mesogenetic rock phase, which is mainly in the medium phase of the phase dissolution phase. The cap rock has a good sealing capacity. Source rock Ro≥0.7%, below the hydrocarbon threshold, oil and gas discharged in a large number. At this time, Chalu river fault depression occurred structural inversion, forming a large number of structural traps. At the same time, the reservoir is inclined and the oil and gas are in the secondary migration. The period of oil and gas migration have a good match with the structural stage, oil and gas generated in Shuangyang group constantly filled in the vicinity of the lithology traps, stratigraphic traps and structural traps, Oil and gas reservoirs were formed in a large scale.

Now, the organic matter of the main source rocks of the Shuangyang group and the Sheling group in the deep sag of the basin are Ro ≥ 0.7%, and came into a large number of hydrocarbon generation in the mature stage, a large number of oil and gas generated, at the same time, forming organic acids and CO_2, dissolved in water, and forming acidic hot fluid, The aluminosilicate feldspar and carbonate cements in the eroded reservoir form secondary pores, and the reservoir is in the phase A2 phase of the mesogenetic rock phase, which is mainly in the medium phase of the phase dissolution phase. The cap rock has a good sealing capacity. Source rock Ro≥0.7%, below the hydrocarbon threshold, oil

and gas discharged in a large number. The period of hydrocarbon expulsion have a good match with the structural stage, and the oil and gas reservoirs are formed on a large scale. The oil and gas generated by the source rocks of the Shuangyang Group are continuously filled in the adjacent lithologic traps, stratigraphic traps and structural traps, and has been preserved so far. In the deep sag of the basin, The organic matter Ro at the bottom of the Sheling group and the partial source rock of Shuangyang group is between 1% and 1.3%. a large number of oil and gas generated, at the same time, forming organic acids and CO2, dissolved in water, and forming acidic hot fluid, The aluminosilicate feldspar and carbonate cements in the eroded reservoir form secondary pores, and the reservoir is in the late stage of the phase A2 phase of the mesogenetic rock phase, which is mainly in the medium phase of the phase dissolution phase. The cap rock has a strong sealing capacity.

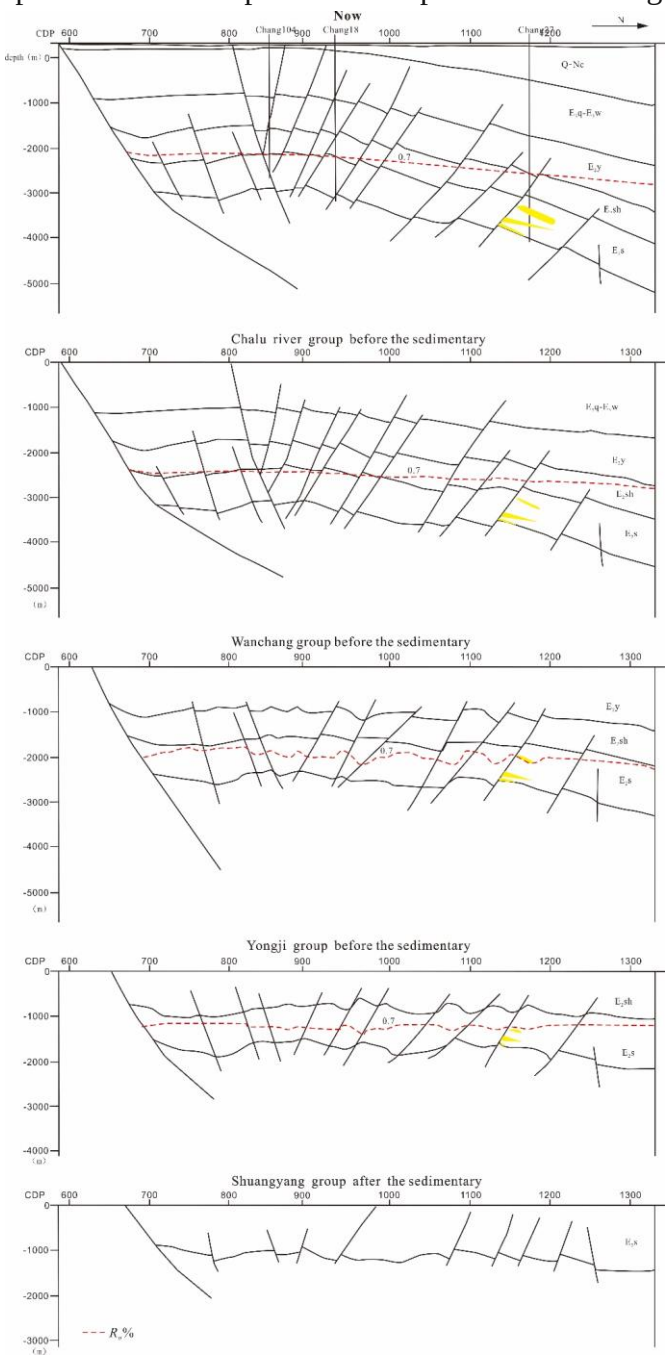

Fig.5 hydrocarbon expulsion and accumulation of Chalu river depression

4. Cognition and Conclusion

The depth of hydrocarbon expulsion threshold for Cha-Lu River fault depression is from 2600 meters to 2700 meters and the value of R for corresponding hydrocarbon expulsion threshold is 0.7%. At the end period time of Qi-Jia Group, Margin fault fold belt will form and finally formalized in the north area of Cha-Lu River fault depression, as a result of structural inversion influenced by the action of area extrusion. At the same time, oil and gas has the second transfer while the transferring period has a good match with structural shaping period. The oil and gas produced by Shuang-Yang Group will continually charging into the surrounding structure closed loop, ductility closed loop and group closed loop which result in the large-scale group of oil and gas reservoir.

Acknowledgments

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