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Quantitative Analysis on Reservoir Controlling Factors and Prediction of Favorable Reservoir Areas, Cretaceous system in the Junggar Basin

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Abstract: The Cretaceous reservoir is the main oil and gas bearing stratum in the Junggar Basin, which contains enormous resource potential. But the exploration degree of the Cretaceous reservoir was very low. The pattern of oil and gas accumulation was very complex. Based on this model, the author of this paper studied the geological characteristics of the four controlling factors of Cretaceous reservoirs in the Junggar Basin and established the quantitative mathematical model of four controlling factors. The comprehensive index was weighted average probability of single controlling factor. According to this comprehensive index, we predicted the favorable accumulation areas of the Cretaceous system in Junggar Basin. The result showed: the most favorable areas of Cretaceous system were Luliang uplift, Chepaizi-Mosuowan paleo-uplift and Zhangbei fault zone. More than 84% of oil wells were found in the predicted favorable areas. It proved the validity and feasibility of this model.

Keywords： *Junggar Basin; Cretaceous system; Model of functional elements matching controlling on hydrocarbon accumulation; Quantitative analysis; Prediction of favorable reservoir areas*

I. INTRODUCTION

Junggar Basin underwent transformations of Hercynian, Indosinian, Yanshan and Himalayas tectogenesis, and now became a typical large-scale composite superimposed hydrocarbon bearing basin. The hinterland area included Wulugu depression, Luliang uplift and Central depression [1-3] (fig. 1). Reservoir exploration in Cretaceous in Junggar basin began in the mid 50 "s. Since 2000 years, million tons of oil filed was found in Luliang uplift. The Cretaceous system become an important oil bearing system in the basin.

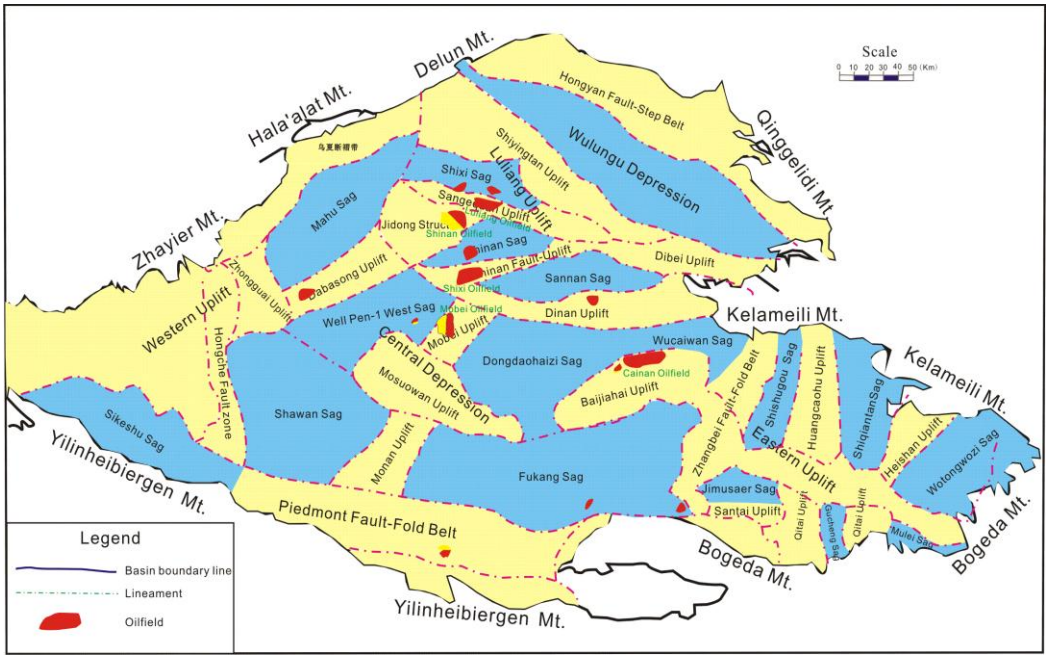

Fig. 1 Tectonic units in hinterland area of the Junggar Basin

II. FUNCTIONAL ELEMENTS ANALYSIS AND QUANTITIVE CHARACTERIZATION

2.1 Source

In the 27 oil and gas fields that have been found in Junggar basin, mostly fields were found around the source rocks, Such as Karamay Oilfield that was located western margin of Mahu sag. The result showed that the formation and distribution of oil and gas reservoir was controlled by source. This conclusion matched the "source control theory" [4, 5].

According to the Model of functional elements matching controlling on hydrocarbon accumulation and actual geological conditions of Junggar basin, the research showed that distribution of reservoir was controlled by three geological conditions of source rock [6]. The formula was characterization as follows:

$$Y_S = 0.046\, e^{0.12 q_e} - 0.16 \ln(L) + 0.65\, e^{-8.2357 (l+0.1)^2} + 0.1345$$

According to the hydrocarbon expulsion intensity of Cretaceous system in Junggar basin and the formula, the hydrocarbon accumulation probability of source rock was calculated [7]. The result showed that 90% of reservoirs was located in the uplift or slope that around hydrocarbon-generation sag with probability greater than 0.5.

2.2 Mountain

Ancient uplifts were formed and developed in Permian and Jurassic in Junggar Basin. Controlled by the tectonic, oil and gas accumulated along the ancient uplift and the ancient bridge of the nose [8]. The author of this paper studied the relationship between the quantity of reservoir and paleo uplift, most reservoirs have formed on the top and slope of the mountain and the reserves were mainly enriched on the top of the paleo uplift. At the same time, it also shows that the controlling probability is closely related to the distance between the reservoir and the top of mountain. This can be used to quantitatively characterize the controlling probability of mountain. Firstly, normalizating the paleo uplift, and then according to the analysis result, we can conversed the distribution and quantity of reservoir to the controlling probability. The formula was characterization as follows:

$$Y_M = E^{-1.5225\, X_M}$$

According to the distribution of paleo uplift in Junggar Basin and the foumula, the hydrocarbon accumulation probability of mountain was calculated. The result showed that the mountain controlling probability was higher in the area of Luliang uplift and Chepaizi-Mosuowan paleo-uplift.

2.3 Deposition

Under the paleo tectonic setting, the early period of Cretaceous deposition was controlled by the Northern Durham hill, Carat beautiful source system and Eastern Qitai source systems. Five sedimentary facies were mainly developed: delta, braided river, alluvial fan, shore shallow lake and semi-deep lake [9,10]. The author of this paper studied the relationship between the quantity of reservoir and sedimentary facies. The research showed that 90% reservoir distributed in the area of delta, fan delta and alluvial fan that with high porosity and permeability. By the way of assignment, we established the quantitative standard of the sedimentary facies (table 1).

Table 1 Assignment of sedimentary facies controlling in the Junggar Basin

deposition	number of reservoirs	sedimentary facies controlling
Delta	32	1
Alluvial fan	19	0.6
Braiede river	19	0.6
Shore shallow lake	0	0
Semi-deep lake	0	0

According to Sedimentary graph of Cretaceous, the hydrocarbon accumulation probability of deposition was calculated. The result showed that the deposition controlling probability was higher in the area of Luliang uplift.

2.4 Cap cover

Junggar Basin mainly developed three sets of stable regional cap rock : the Baijiantan formation in upper Triassic, the Sangonghe Formation in Jurassic Lower Jurassic and the Tugulu group in Cretaceous system. With the stable distribution in the entire basin, they play an important role in sealing of oil and gas [11].

In this paper, the method of geological statistics is mainly used in the quantitative analysis of sealing oil and gas in the area. According to the relationship between the thickness of the cap rock and the number of

the industrial oil and gas wells in Junggar basin, we converse the number of oil and gas wells into hydrocarbon accumulation probability.

$$Y_C = 0.166 \ln X_C - 0.162$$

According to formula, the hydrocarbon accumulation probability of cap cover was calculated. The cover almost distributed in the Junggar basin. Probability of cap controlling in the hinterland area of basin was higher than 0.5, the cap rock controlling was well.

III. PREDICTION OF FAORABLE AREA

Junggar Basin mainly experienced three important accumulation stages in geological processes: Indosinian (T3), Yanshan period (J3) and Himalayan period (E2)[12, 13]. Cretaceous System underwent the last two stages. According to the model of functional elements matching controlling on hydrocarbon accumulation, recovering the geological characteristics of Cretaceous System and quantitativing the controlling factors, the author predicted favorable area of Cretaceous System in Junggar basin. The favorable area in the first accumulation stage of Cretaceous System were west of Dabasong uplift, south of Zhongguai uplift, Well pen-1 west sag, Mobei-Maqiao uplift, south of Shinan Sag, southeast of Lunan uplift and west of Zhangbei fault zone. The favorable area in the second accumulation stage of Cretaceous System was Luliang uplift.

The accumulation probability of two accumulation stages in Cretaceous System were showed in Fig. 9. According to this result, the author predicted the comprehensive favorable area in the present period of the Cretaceous System. The result showed that the most favorable areas of Cretaceous system were Sangequan uplift in Luliang Uplift and Shinan Uplift, and favorable areas were Mobei uplift and Mosuowan uplift in Chepaizi-Mosuowan paleo-uplift and Zhangbei fault zone.

IV. CONCLUSION

1）Model of functional elements matching controlling on hydrocarbon accumulation indicated that the formation and distribution of hydrocarbon reservoirs are mainly controlled by four factors (cap cover, deposition, mountain and source). Orderly combination in section and superimposed in plane of the four elements controlled the favorable hydrocarbon accumulation, and the found reservoirs in the Cretaceous System in Junggar basin also can explain the model well.

2）Based on this model, the author of this paper predicted the favorable area of Cretaceous System in Junggar basin: the most favorable areas of Cretaceous system were Luliang Uplift and Shinan Uplift, and favorable areas were Chepaizi-Mosuowan paleo-uplift and Zhangbei fault zone.

3）The application of model of functional elements matching controlling on hydrocarbon accumulation in Cretaceous System of Junggar basin indicated: the higher the controlling probability, the more oil and gas wells are found, the higher production capacity of oil and gas wells. And More than 84% of oil wells were found in the predicted favorable areas. It proved the validity and feasibility of this model.

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