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Multi-Factors matching Theory for Hydrocarbon Accumulation and Its Application on the Hydrocarbon Exploration in Junggar Basin

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Abstract: Junggar basin is an inland basin with a roughly triangular shape. Since the formation of the basin from the Late Carboniferous, sedimentary formation developed in Upper Carboniferous to Quaternary.The exploration area in the hinterland of Junggar basin is huge. The prediction of favorable area of exploration activity in the next step becomes a crucial question. Multi-factor matching model for hydrocarbon accumulation is an effective and reliable method to predict the favorable distribution area of hydrocarbon reservoir, in this paper, we will use the multi-factor matching model for hydrocarbon accumulation, we set up a quantitative mathematical model of controlling reservoir of each main controlling factor and weighted average of four single factor controlled reservoir probability to get the functional factors integrated control of possession probability index and the favorable accumulation area of the Jurassic reservoir in Junggar basin is predicted.

Keywords: Junggar Basin; Jurassic system; Multi-factor recombination model; Quantitative analysis; Prediction of favorable reservoir areas.

INTRODUCTION

Junggar basin is one of the three major basins in Xinjiang,located in the northwest of China and clamped between the Tianshan Mountains and the Taishan mountains, is an inland basin with a roughly triangular shape. Its area is $13.6\times10^4 km^2$ [1-3]. Since the formation of the basin from the Late Carboniferous,sedimentary formation developed in Upper Carboniferous to Quaternary,and the maximum thickness of the sedimentary formation is 15000m.The exploration area in the hinterland of Junggar basin is huge(Area of about $54300km^2$). The prediction of favorable area of exploration activity in the next step becomes a crucial question[4-7].Multi-factor matching model for hydrocarbon accumulation is an effective and reliable method to predict the favorable distribution area of hydrocarbon reservoir,in this paper,we will use the multi-factor matching model for hydrocarbon accumulation,we set up a quantitative mathematical model of controlling reservoir of each main controlling factor on the basis of the study of the regional cap rocks, sedimentary facies, palaeohigh and hydrocarbon source rocks in the area of the four major controlling factors on geological characteristics of reservoir control in Jurassic in hinterland of Junggar Basin.And weighted average of four single factor controlled reservoir probability to get the functional factors integrated control of possession probability index,according to this index, the favorable accumulation area of the Jurassic reservoir in Junggar basin is predicted.

ANALYSIS AND QUANTITATIVE CHARACTERIZATION OF ESSENTIAL FACTORS OF RESERVOIR FORMING

1. Hydrocarbon source range

Hydrocarbon source rocks in the Junggar Basin have development in Mahu depression, basin 1 well west Sag, Changji sag, Shinan sag and Dongdaohaizi sag and such depression. And the hydrocarbon source rocks development in the depression is mainly under the Permian system of Fengcheng group, in the Permian Wuerhe formation and Jurassic coal measure strata in three sets.According to the study of the multi-factor matching model for hydrocarbon accumulation combined with the actual geological conditions of Junggar Basin,Three geological conditions of hydrocarbon source rocks control the distribution of hydrocarbon reservoir,They are hydrocarbon expulsion intensity of hydrocarbon source range gas supply center in Junggar Basin (qe), the distance between the basin hydrocarbon kitchen exhaust hydrocarbon intensity center and the reservoir(L), the distance between the Hydrocarbon source range expulsion threshold and the reservoir (l) .Its quantitative characterization formula is as follows:

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

In the formula,YS—Probability of hydrocarbon accumulation under single factor control in the basin;L—Distance from the standard oil and gas

reservoir to the hydrocarbon expulsion Center;l—Distance from the standard oil and gas reservoir to the hydrocarbon expulsion boundary; q_e—Maximum hydrocarbon expulsion intensity of hydrocarbon source in the basin,10^6t/km^2.

According to the above quantitative representation formula, the probability map of Jurassic hydrocarbon source rocks in Junggar basin is calculated.

2. Sedimentary facies

This time,we use the method of assigning values to quantitative characterization of the phase control function,assignment of the sedimentary facies which found the largest number of oil and gas reservoirs to 1,by the ratio of the largest sedimentary facies to the other sedimentary facies and hydrocarbon accumulation,the relative probability of hydrocarbon accumulation can be obtained,the quantitative standard between sedimentary facies and hydrocarbon reservoir controlling probability can be established.Based on statistical results,established the relationship between different sedimentary facies and reservoir formation probability in the Jurassic in Junggar basin(Table 1).Visible from the table,in various facies belts of the Jurassic in Junggar Basin,the largest number of oil and gas reservoirs were found in the delta front,therefore, it's Reservoir controlling probability assigned to 1; next is delta plain facies and fan delta facies,corresponding,it's Reservoir controlling probability assigned to 0.6;the shallow lake and semi deep lake facies are not found in oil and gas reservoirs,it's Reservoir controlling probability assigned to 0.According to the sedimentary facies of Jurassic in Junggar Basin and in accordance with the above valuation method,the probability map of sedimentary facies of Jurassic sedimentary facies in Junggar basin has drawn.

Table 1: Assignment of sedimentary facies controlling of the Jurassic system in the Junggar Basin

Sedimentary facies	Number of oil and gas reservoirs have been discovered	Facies controlled reservoir forming probability
Delta front	33	1
Delta plain	20	0.6
Fan delta	20	0.6
Meandering river	13	0.4
shore-shallow lake	0	0
Half deep lake	0	0

3. Palaeohigh

The relationship between the single factor controlling reservoir probability of the palaeohigh and the distance from the oil and gas reservoir to the peak of the palaeohigh,can quantitative characterization of the probability of paleohigh. According to statistics the relationship between the quantity and reserves of oil and gas reservoirs and the paleohigh in this paper,the analysis showed that the Oil and gas reservoir formed a maximum number of parts is on the top of the hill and slope on Paleohigh in Junggar Basin,but the reserves are mainly enriched in the paleo uplift slope.By normalizing the Paleohigh,and then according to the above statistical relationship,the distribution frequency of oil and gas reservoirs is transformed into the probability of hydrocarbon accumulation,according to the Junggar basin geological period palaeohighs distribution map, the probability of Jurassic paleo uplift in Junggar basin is calculated,the probability value of controlling reservoir in the uplifted area of the land is obviously higher than that of the control.

4. Regional cap rocks

Regional cap rock plays an important role in oil and gas enrichment degree and vertical distribution in basin or depression,the relationship between the thickness of the cap layer and the oil and gas abundance is directly proportional.The relationship between the thickness of the cover and the sealing ability is mainly reflected in the continuity, the greater the thickness, the lateral continuity of the layer is good,so a basin which is provided with the thickness of the horizontal continuous distribution can seal the large amount of oil and gas.The Junggar Basin mainly develop three sets of stable regional cap rock, they are the Baijiantan formation in the upper Triassic、three River Formation in the Lower Jurassic and Tugulu group in the Lower Cretaceous Series,they continuous and stable distribution in the entire basin,and play an important role in Sealing oil and gas.

QUANTITATIVE PREDICTION RESULTS OF MAIN CONTROLLING FACTOR ACCUMULATION PROBABILITY

Junggar basin in geological process mainly experienced three important accumulation period,They are Indo Chinese epoch (T_3), Yanshan period(J_3) and Himalayan stage (E_2).The Jurassic has mainly experienced the last two stages of formation,according to the principle of superposition and compound control of element matching and the quantitative methods of the above discussion,the favorable hydrocarbon accumulation areas of the Jurassic target strata are predicted.The most favorable hydrocarbon accumulation areas of Jurassic in Jurassic are the area

of the uplift of the land and the beam、 Chemo palaeohigh area and sand North Fault Zone.

CONCLUSIONS

(1) Jurassic oil and gas resources are rich in Junggar Basin, it has been found that the oil and gas plane is mainly distributed in the area of the basin in the hinterland of the Mobei uplift and the Three Springs uplift in the uplift of the land、Shinan step-fault and Jidong structure and other second order structure zones.Vertical is mainly distribution in the hydrocarbon accumulation assemblage in the vicinity of source rocks; and 90% of the oil and gas distribution in the facies belt with high porosity and permeability like Delta, fan delta and meandering river, conform to the multi-factor matching model for hydrocarbon accumulation(T-CDMS).

(2) Prediction results show that:the most favorable hydrocarbon accumulation areas of the Jurassic are the areas of the uplift of the land and the beam、Chemo paleohigh area and Shabei step-fault. It has been approved that the oil and gas reservoirs have been found to fall into the forecast zone with a probability of more than 90%, that is to say this method is effective and feasible.

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