

Study on Pool-forming Pattern of Fu Yang Oil Layer in Northern Songliao Basin

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Abstract

Using seismic, logging, coring, oil testing data of Fuyang fault characteristics and movement stage, reservoir sedimentary characteristics of oil and gas into a comprehensive study on the main control factors of reservoir shows that the hydrocarbon accumulation period of oil source fault activities for the majority of fault concentrated belt boundary fault; theoretical calculation of overpressure driving oil and gas. The depth and the actual oil bottom envelope statistics of Fuyang oil thickness is about 200m; Mingshui formation Qingshankou source rocks reached the peak of oil, oil and gas in the overpressure along the dense open fault zone boundary fault episodic lower after rising plate along both sides of the channel sand body for short distance lateral migration, namely the intensive fault both sides of graben or Horst block for oil and gas enrichment area, and the intensive fault zone is a graben combination, is not conducive to the accumulation of oil and gas, and pointed out the direction for the exploration and development of Fuyang reservoir in northern Songliao Basin.

Keywords - reservoir -forming model, Songliao Basin, source rock, Fu Yang oil layer

I. INTRODUCTION

"Oil and gas accumulation model" is one of the hot research of domestic oil and gas geology field in recent years. This concept in the text has 40 years of history the, over the years people according to their own knowledge and experience, from different aspects, different angles to understand it and apply it, on the one hand, as of known oil and gas reservoir forming mechanism and the temporal and spatial distribution of the model of analysis and synthesis, on the other hand as unknown oil and gas reservoir prediction in analogy to the reference^[1-2]. The hydrocarbon accumulation process includes the formation, migration, accumulation and preservation of oil and gas. Continental petroliferous basin structure style and sedimentary characteristics of the complexity of the accumulation pattern of diversity, with the deepening of the exploration and development of oil and gas, many petroleum geologists to oil and gas reservoir formation mechanism and distribution of fruitful research, put

forward a series of innovative awareness, and establish the corresponding hydrocarbon accumulation model, enrich the China continental oil and gas exploration theory^[3-4]. Fuyang reservoir as an important field of exploration in the Songliao Basin three Zhao sag for increasing reserves and production, has carried out research, comprehensive petroleum geology prediction technology of fine reservoir description and reservoir sand bodies of earthquake, but due to the fault characteristics of complex, multi sources and reservoir sand body prediction, oil and gas exploration has been no major breakthrough, therefore how to control, clear main controlling factors of hydrocarbon accumulation and prediction of oil and gas rich region become the key of research, the author from the Fuyang reservoir fault characteristics, study of reservoir sedimentary characteristics of sequence stratigraphic framework based on that the oil source fault and sand body matching is a key factor in enrichment of oil and gas reservoir control the theory, to guide the oil and gas exploration in the northern Songliao Basin Fu Yang oil has important theoretical significance and practical application value.

II. REGIONAL TECTONIC BACKGROUND

In the basin in the shallow layer, according to the Mesozoic tectonic evolution of Songliao Basin, combined with basement morphology, cap rocks and tectonic characteristics etc., Songliao basin can be divided for the western slope zone, the North dip area, central depression depression area, northeast uplift area, southeast uplift area and southwest uplift with six first-order tectonic units (Fig.1). Each of these structural units has its own unique structure. The exposed strata in the eastern uplift are generally older, and the local structure is more NE to or NEE to the arrangement, and more narrow and long, the formation of large dip angle, fracture development. The structure of the central depression area is more than NNE, it is similar to the box, with large area and high amplitude. The western slope zone, on the contrary, small amplitude, area of small irregular arrangement, less directional nose like structure and a dome shaped structure^[5].

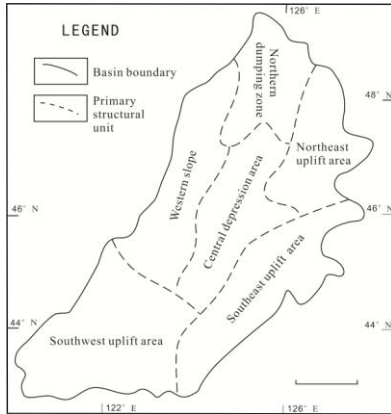


Fig.1 Primary Tectonic Unit Of Songliao Basin

Inside the basin formation bottom-up sequentially for the upper Jurassic and Upper Cretaceous and the tertiary and Quaternary, the Cretaceous maximum thickness up to 7.5 km, is in the world the most typical and the most complete Cretaceous continental sedimentary basin. Cretaceous is the most important reservoir forming assemblage and hydrocarbon exploration target in northern Songliao Basin, and has accumulated rich geological and geophysical data. Lower Cretaceous from bottom to top into Huoshiling formation, Shahezi group and camp group of the city, boarded the Denglouku formation and Quantou group, the group of the upper Cretaceous Qingshankou, Yao Jiazui, Nenjiang Formation, Sifangtai group and Mingshui group^[6].

III. HYDROCARBON SOURCE ROCK CONDITION

Qing 1 member high mature hydrocarbon source rock is the premise of Fuyang reservoir. Green a period of deposition is Songliao basin for the first time the maximum flooding period, deposits are widely distributed, organic rich deep lake semi deep lake facies mudstone, as a central depression depression is zonal distribution, mudstone thickness is 40 ~ 110 meters, with an average of 80 meters, mostly in the mature stage, vitrinite reflectance general in 0.9% ~ 1.3%, Qijia Gulong sag maturity is the highest value reached 1.5%, to the east of Daqing placanticline in Sanzhao sag lies mostly in the range of 0.9% to 1.3%. Anda area RO value is less than 0.9%. Oil source correlation shows that the Fuyu and Yangdachengzi oil from green cover a source rock and its migration mechanism is black and dark mudstones with the increase of buried depth, forming internal overpressure. In the internal cracks, oil and gas generated through the crack and fracture downward migration to Fuyang reservoir. Studies have shown that green section of oil and gas

row to a depth of up to 100 meters of above, after entering the reservoir oil and gas along the reservoir to the low potential area migrates. At present, the oil and gas accumulation zone of Fu Yang oil layer is mainly distributed in the range of RO value greater than 0.9%. Therefore, the formation of oil and gas reservoirs in the Fu Yang oil layer, which is relatively lower in the lacustrine mudstone, has a macro control function, and the huge thick mudstone is directly covered on the reservoir (Fig.2).

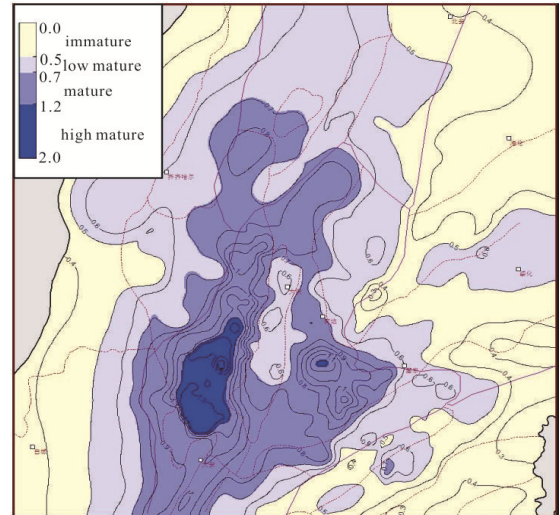


Fig.2 Ro Distribution Map of Qing 1 Member Mudstone

IV. RESERVOIR CONDITION

At the lower part of the Quantou formation 3 member in the north of Songliao basin is two main sequence of provenance from the north and northeast, sedimentary north and south to extend, thickness of strata are in 50 ~ 120 meters, sand body was zonal distribution, bandwidth of channel sand body, sand body cumulative thickness is large. The articles with sand body all to Qijia ancient dragon sag and Sanzhao sag sink and dealt with sand body morphology differences between the north and south is larger, northern resolution braided river and meandering river development area is wide strip, south of anastomosing River Development Zone is narrow strip belt formed reticular. Spring three in the middle of the stratigraphic thickness in 60 ~ 120 meters, sand body thickness significantly thinner, more than 40 meters of sand bodies of the cumulative thickness already not much, most of the sand body in the 10 to 30 meters and sandstone percentage than the average is less than 40%, mostly in the 30 ~ 20%, sand body cumulative thickness of the southern than northern. Spring upper two sequence stratigraphic thickness in 50 ~ 80 meters, central depression area of thin sand body, sandy than in 30 to 20 percent, and the surrounding local area have banded thick sand body, sandy than in 40% ~ 50%.

The sand body of Quantou formation 4 member has the same strip to the Qijia Gulong sag and Sanzhao sag is characterized by convergence, cumulative thickness of strata thickness and sandstone decreases obviously, the river has not the is the north south to development, central depression are widely distributed in the area of braided channel sand body, in the central basin subsidence areas outside the development of braided river and meandering river sand body. Spring four lower Q4 - SQ1 sequence stratigraphic thickness in 20 ~ 40 meters, sand body cumulative thickness is generally not more than 20 meters, sandy than the average 35 ~ 45%, less than 20% of the area is very small, spring four central Q4 - SQ2 sequence stratigraphic thickness of 30 to 25 meters, thickness of sand body is generally not more than 10 meters, central depression area of sandy ratio does not exceed 20%, with braided and sporadic shallow lakes, small delta sand body. Spring four upper Q4 - SQ3 sequence stratigraphic thickness in 30 to 20 (Figure 8 - 8) m, sand body cumulative thickness 5 to 15 meters, Sandy in the central depression basin of Eastern than does not exceed 20% of the and sandstone percentage is more than 40% of the sand body was very narrow band, network node shaped area expanded northward to Damien water order and blackfish bubble sag.

Quantou formation 3 and 4 member by to the as deposited datum rise sand body is reduced gradually thin, sand body types are composed of braided river, meandering river to and shallow water delta evolution, the plane around the basin developed braided river sand body, inward gradually evolution of meandering river sand body, in depressed area in the center of the development of shallow water delta distributary channel sand body, overall level is zonal and vertical positive cycle characteristics.

Reservoir physical property is an important factor of oil and gas accumulation in the Fu Yang oil layer. Fuyang reservoir belongs to the river and shallow water deltaic depositional environment, channel sand body is the best, followed by the mouth bar sand, according to the statistics of Gaotaizi area, river sand accounted for 68% of the number of industrial oil reservoir, river mouth bar sand body accounted for 11%, crevasse channel and ceasing fan other types of sand body only 21%. Therefore, sedimentary facies belt and sandstone type are the material base of reservoir physical property and oil and gas accumulation. Fuyang reservoir is deeply buried, in depressed area in the center of an average of more than 1700 meters, applied to stripping method for restoration of denuded strata thickness, calculated the central depression area of

Fuyang reservoir geological maximum burial depth of more than 3000 meters, diagenesis reaches into diagenetic stage B, resulting in storage layer Cape times lower, 12% of average porosity, permeability is generally less than 10mD, the formation of low porosity and low permeability reservoirs. Therefore, diagenesis has an important influence on reservoir physical properties, oil and gas accumulation and single well productivity of Fu Yang oil layer, but the higher diagenesis causes secondary pore development zone, which is favorable for hydrocarbon accumulation. Such as North Qijia area ancient 708 well in Fuyang reservoir 213.66 to 2143.2 interval porosity value amounted to 19.3%, than the normal reservoir compaction curve is 8% higher than that by casting thin section analysis, sandstone grain boundaries and grain storage inside with dissolution, formation solution enlarged pores among the particles. Therefore, the formation of sandstone type, diagenesis and secondary porosity is an important control factor for the physical properties, reservoir and single well productivity of the Fu Yang reservoir.

V. OIL AND GAS MIGRATION PATHWAY

Fault plays a key role in the forming process of the Fu Yang oil layer. Due to the overlying Qingshankou group mudstone directly covered in Fuyang oil layer, as burial depth increased, the mudstone formation overpressure, and reached the peak of hydrocarbon generation of oil and gas through faults and fractures downward migration to the Fu Yang oil layer reservoir. Cut through green section of hydrocarbon source rocks and Fu Yang oil layer of T2 faults are widely distributed, the western region of T2 layer fracture 1392, Sanzhao area in the eastern part of T2 layer fracture 1810. On the one hand, it is oil and gas migrating downward channel, and with structure, sand body with the formation of traps. The T2 fault in the slope zone makes the formation of the green and the support of the oil bearing sandstone in the fault plane direct contact, can play the role of oil and gas lateral migration. Therefore, the T2 fault zone is the favorable area for the formation of the Fu Yang oil layer. Such as long Xi, Bayan check dry areas found in the reservoir mainly distributed in Hala sea fracture zone, Bayan check stem fracture belt and Taihe near the fault zone. North Qijia area Fuyang oil and gas reservoir of enrichment zone and NNW trending fracture with close relationship. In addition to the ancient 708 wells, the industrial production capacity of the ancient 701, the ancient 702, the ancient 704 and gold 81 wells were distributed in the area of fracture density. Therefore, the T2 fault is the key factor for the oil and gas migration and accumulation in the Fu Yang oil layer(Fig.3).

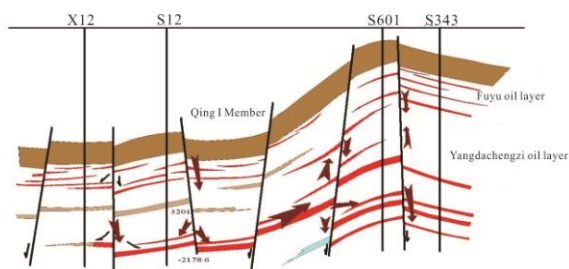


Fig.3 Oil And Gas Migration Pattern of Fu Yang Oil Layer

VI. OIL POOL TYPE

Sand ratio determines Fuyang reservoir type. Sand ratio reflects the degree of enrichment unit in stratigraphic thickness of sand bodies, it can indirectly reflect the connectivity of sand bodies. Generally speaking, high ratios of sandstone, reservoir sand bodies are well developed, single sand body thickness, sand body internal as well as between single sand body connectivity opportunities it. On the contrary, connectivity is poor. Therefore, sand ratio and sand body connectivity was positively correlated. Research shows that when sandy ratio is greater than 50% is difficult to form lithologic traps, 50% ~ 35% to structural lithologic complex trap based, 35% ~ 20% to lithologic structural combination traps mainly, less than 20% of lithologic reservoir. The research of sedimentary facies shows that the central depression area of Fuyang reservoir belongs to the shallow water delta distributary channel and shallow lake facies, sand ratio from 10% to 30%, less than 20% of the area accounted for 90% (Figure 10 - 1 - 10 - 8), only reached 30% in the middle of the Changyuan Gu 432 well area, Gulong sag and new Zhao ancient nose structure 621 well area in the central sag area beyond the edge of the basin area is alluvial fan, braided river and meandering stream development area, sand body thickness, large scale, the development of contiguous whole, sand than is generally higher than 50%, the vertical spring three segment Q3 - SQ1, Q3 - SQ2 order due to development of a large area of braided river and meandering river sand sand ratio is relatively high, generally more than 60%, Q3 SQ3 5 as the sequence of sedimentary base level rising, the anastomosing River and shallow water delta area gradually expanded, sand ratio from 40% to 20 gradually decreased %, in the fourth member of the Quantou Lake area expanded rapidly, basin range area development network knot River and shallow lakes and sandstone percentage ratio decreased from 30% to 15%. Therefore, the lower part of the Fu Yang oil reservoir is mainly in the development of the structural reservoir, and the middle and upper part of the reservoir is mainly lithologic oil reservoir.

VII. PREDICTION OF FAVORABLE EXPLORATION AREA

The existence and distribution of oil and gas reservoirs in the oil and gas bearing basin have certain distribution law under certain geological conditions. The oil and gas reservoirs are divided into different zones according to the similarity of reservoir forming conditions and the main controlling factors. Fu Yang reservoir is divided into three zones according to the trap type, that is, the marginal structural reservoir of the basin, the structure of the slope area, the lithologic reservoir type development zone and the lithologic reservoir development zone of the central depression zone. The central depression belt of lithologic reservoir types due to distribution in mature oil source area is the most favorable reservoir belt, found that the current oil and gas reservoir more than 95% distribution in the area, such as in Sanzhao sag and Daqing placanticline. Belt slope area of lithologic reservoir types due to close to the oil source is favorable zone. Currently, it has been found that the part of the oil field, such as Linjiang and Long Xi. The edge of the basin structural reservoir development zone, the oil source is far away, the accumulation rate is small, only a few well found industrial oil flow, most see display. Longitudinal on quan4 member Fuyu oil layer and green period of hydrocarbon source rocks in direct contact, oil and gas can be in the overpressure under direct row to reservoir, and is therefore the most powerful horizon, the exploration practice showed that Fuyang reservoir of oil and gas reservoirs because of the existence of restricted by the oil and gas exhausting pressure a envelope. This side for oil and gas migration can get the maximum space, of without under the envelope in the oil and gas reservoir.

By high resolution sequence stratigraphy and sedimentary facies study to realize, spring head group, four sedimentary period of overall a lake leaching process, pooling of basin developed on the margins of the braided river to the inside of the basin, in turn evolved into a meandering river, shallow water delta, shore shallow lake and shallow lake, longitudinally with sedimentary datum rise sand body gradually thinning, sand body types from braided river, meandering river to braided river and shallow water delta evolution, the overall level is zonal and vertical positive cycle characteristics. Accumulation condition analysis showed that green a high mature hydrocarbon source rock is in Fuyang oil layer into the premise of the reservoir, sandstone type, diagenesis and secondary pore formation is the Fuyang reservoir, the important factors controlling the reservoir and single well productivity, T₂ fault is the Fu Yang oil layer of the oil and gas migration into a key factor in pool and lower sandy ratio determines the Fuyang reservoir to

lithologic reservoirs. The development of Fuyang reservoir zonation with, that is with the edge of the basin structural reservoir types, slope structure - lithologic reservoir types of belt, central depression belt of lithologic reservoir types, central depression belt type of lithologic reservoirs are the most favorable reservoir belt. At present, the oil and gas resources of the Fu Yang oil layer is only 25.49%, and the remaining resources are 20.49×10^8 t, and there is still a great exploration potential. Oil and gas exploration is a process of continuous exploration, Daqing oilfield exploration history review, every time the geological theory of innovation and geological knowledge deepening brought breakthrough and exploration of oil and gas reserves increased by a large margin, with the further understanding of the geological exploration and, Fuyang oil layer will have a good exploration prospect.

VIII. CONCLUSION

Qing 1 member mudstone is not only the source rock of the source rock, but also the cover layer. Fuyang oil source fault and sand control, intrusion type accumulation model. Closer to the source rocks as a whole green, oil and gas obviously. At the end of Mingshui formation Qingshankou source rocks reached the peak of oil. The period of Qingshankou formation deposition is the period of most intense fault activity in Quantou and Qingshankou formation, with a relatively large amount of stretch, is good oil and gas migration channel.

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