A certain block of oil and gas accumulation understanding

Yanfeng Bao

No.5 Production Plant, Daqing Oil Field, China

Abstract: The block is located in the southern part of an oil field. A grooved area held by three structures. The blank area is 41.6 square kilometers. It accounts for about 20% of the blank area. The faults in this area are more developed, mainly in the NNW direction, Permeability 0.7~1542mD, The average is 275.1mD, the porosity is 11.1~27.8%, the average is 23.2%, the average effective thickness is 2.2m, and the river channel width is 100-300m. The three-dimensional seismic data were collected in 2004, the accuracy of the survey network was 20m×40m, the number of coverage times was 66 times, the main frequency was 39-42Hz, the surface element was 10m×10m, and the data was finely processed and explained in 2008.

Keywords: Oil and gas accumulation; Sedimentary facies; Trapping.

1. Analysis of accumulation conditions

Oil and gas accumulation is inseparable from two factors, one is static geological factors, including source rocks, reservoirs, caps and overlying strata; The second is dynamic geological action which includes trap formation and hydrocarbon formation, transport and aggregation. These geological elements and processes must have an appropriate spatial and temporal configuration to convert the organic matter in the source rock into oil and gas, and then form oil and gas reservoirs. These concepts are very consistent with the research idea of "raw storage cap transport circle protection" oil and gas bearing system proposed by petroleum geologists in China. In the following analysis, the accumulation control factors of this block are analyzed from two aspects: static geological elements and dynamic geological effects.

1.1 Raw oil conditions

Sufficient oil source is the basis of reservoir formation, Qingshankou Formation is mainly lacustrine sedimentary oil layer, Qingshankou Formation sedimentary large section of mudstone is not only regional cap, but also good source rock. The overlying grape flower oil layer is the result of upward accumulation of oil from the green section after a large amount of oil is discharged from the source rock, under the joint matching of fluid potential and fault, and continues to move laterally after entering the grape flower oil layer. The dark mudstone of the green section of this block develops, and the predicted thickness is between 50~80m, and the average thickness is 70m. The source rocks of this block are developed, providing sufficient oil and gas for the grape flower oil layer.

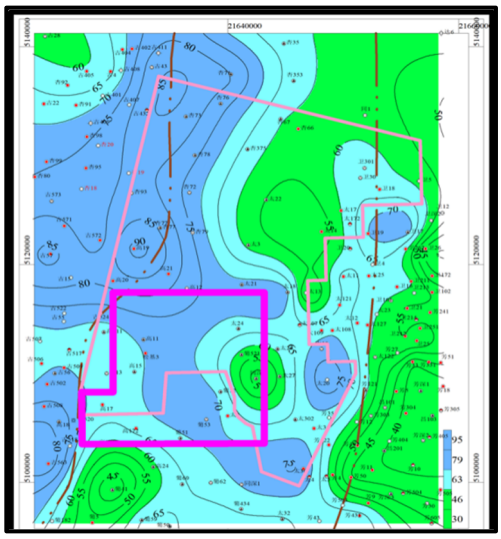

Fig. 1 Cyan dark mudstone thickness prediction map

1.2 Reservoir Conditions

The grape flower oil layer is located in the sedimentary environment of the delta front, and it can be seen from the prediction results of sedimentary facies that the entire grape flower oil layer is a set of reservoirs deposited in a large water retreat process, mainly developing underwater diversion channels, mat-like sand, side beaches and inter-stream bay sedimentary microfacies, the sand body is thicker and the sand quality is purer, the physical properties and connectivity are better, and the sand body is mainly flaky or nearly north-south strips.

In addition, the grape flower oil layer is the product of the short lake retreat in the depression stage of the lake basin, and the source of material mainly comes from the north and northwest of the block, and the main reservoir is the sediment of river channel sand and side beach. The thickness of the oil layer is about 50~70m, the scale of the sand body contained is large, the number of development layers is small, the thickness of single sandstone is generally less than 3m, the lateral connectivity of the sand body is good, and it is lens-like and short axial distribution. From the perspective of the physical characteristics of the reservoir, the porosity distribution range of the samples of the grape flower oil layer was 4~26%, and the average was 15.0%, which did not change much overall, and it belonged to the medium pore reservoir. The permeability distribution range of grape flower oil layer samples is generally about 0.1~300mD, which is a low permeability reservoir, so the grape flower oil layer is a mesoporous and low permeability reservoir.

1.3 Trap conditions

There are various types of traps in this area, including tectonic traps, lithological traps and composite traps, and the formation time, type of trap, and distance from the oil source all determine the effectiveness of the trap. In terms of formation time, the end of Nenjiang-Mingshui is the formation and shaping period of various types of traps in this block, and it is also the maturity and expulsion period of source rocks of the Qingshankou Formation, and the two match in time and are effective traps.

1.4 Migration Conditions

In terms of oil-generating environment, the Qingyi Formation is the source rock layer in this area, and according to the previous research, it is known that the block is accompanied by three fold movements at the end of the Nenjiang Formation, the end of the Mingshui Formation and the end of the Old Tertiary period, and at the same time, the arrival of the peak period of the Qingyi Oil-producing Rock, the peak period of production and oil discharge, under the action of the regional stress field, a large number of early and middle faults are revived and opened during the migration period, which has become the most favorable channel for migration. Through the plane and sectional comparison, a total of 83 oil source faults were developed in this block, and the whole area was developed, which could effectively communicate the lower source rocks and sufficient oil sources.

The grape oil layer needs a medium-term fault to play a communication role, supplemented by the disintegration surface between the Qingshankou Formation and the bottom layer of the Yaojia Formation, so that the oil generated by the Qingshan Pass Formation crosses the mudstone sedimentary strata of the Qingyi Section II and III, and under the guidance of local structure, a longitudinal and horizontal net blanket-like channeling mode is formed to reach the Grape Flower Oil Layer, and the relatively good physical conditions in the oil layer also create conditions for lateral transport. The lateral conduction channel is a fault-sand composite channel. In the eastern tectonic belt, north-north-west migration is the mainstay, and the north-north-west fault and sand body form a reverse trending fault-sand body transmission system. In the western part of the block, the lateral migration direction is mainly in the near east-west direction and the north-north-west direction, and the forward fault-sand body form is transmitted.

2. Oil-water distribution characteristics

On the plane, according to the analysis of the existing data, there are 24 exploration and evaluation wells in the blank area, a total of 12 oil tests, 5 industrial oil flow wells, 4 low-yield oil wells, 3 water wells, and the highest daily oil production well, with a daily oil output of 11.664t. Five of the obtained industrial flow wells are located in the northeast slope of the blank depression area, which is inside the tectonic trap. The oil test wells located in the structural depression are mainly based on water layers.

In the longitudinal direction, from the analysis of the drilling situation of 22 wells that have been drilled, each single well is drilled with sandstone, and the interpretation results are oil layer, same layer, water layer and a small amount of dry layer. The average sandstone thickness is 16.2m, but only 9 wells have been drilled effectively, averaging 1.58m. The relationship between oil and water is complex, and the oil-water layer is interlayered, and the inverted relationship between the oil and the water appears under the oil.

Tab 1 Statistics table of the number of oil test layers

Layer number	Total number of layers (pcs)	Number of oil outlet layers (pcs)	Proportion (%)
PI1.1	5	1	20.0
PI1	3	0	0.0
PI2	1	0	0.0
PI3	5	1	20.0
PI4	2	1	50.0
PI5	2	0	0.0
PI6	4	2	50.0
PI7	3	2	66.7
PI82	3	1	33.3
PI9	2	1	50.0
PI10	1	0	0.0
PI11	1	1	100.0
total	27	9	33.3

Tab 2 Test oil thickness statistics table

Layer number	Total thickness (m	Oil thickness (m)	Proportion (%)
PI1.1	12.2	3	24.6
PI1	4.4	0	0.0
PI2	1	0	0.0
PI3	6.3	1.5	23.8
PI4	4	3	75.0
PI5	2.6	0	0.0
PI6	12.4	4.2	33.9
PI7	10.6	4	37.7
PI82	9.2	3.2	34.8
PI9	5.2	1.6	30.8
PI10	2.4	0	0.0
PI11	1.2	1.2	100.0
total	71.5	21.7	30.3

3. Conclusion

Through the analysis of the main controlling factors of reservoir formation in this block, the oil and gas plane migration direction is moved from the high potential energy area to the low potential energy area, that is, the middle low-lying area is transported to the surrounding high parts, and the reservoir is formed by effective trapping and occlusion in the migration direction. The faults on the west and southeast sides of the lower part are consistent with the oil and gas migration direction, the fault occlusion effect is not good, and the angle between the northeast fault trend and the oil and gas migration direction is large, which is easy to form lithology-fault reservoirs.

(1) Oil and gas are transported from low-lying areas to high parts, and after encountering structural traps on the migration path, structural reservoirs are easy to form;

(2) There are faults blocking the oil and gas migration channel, and the sand body and fault are well matched, which is easy to form fault-lithological reservoirs;

(3) Oil and gas are transported from low-lying areas to high parts without obstruction, and oil and gas are transported until they are blocked.

Therefore, accurate understanding of the structure and sand body and their matching relationship is the key to drilling high-yield evaluation wells.

References

1. Cui Baowen, et al. Progress and recommendations of oil exploration in the northern part of the Songliao Basin [J]. Daqing petroleum geology and development, 2018.
2. Xu Jianjun, Huang Lida, Yan Limei, Yi Na. Insulator Self-Explosion Defect Detection Based on Hierarchical Multi-Task Deep Learning[J]. Transactions of China Electrotechnical Society, 2021, 36(07): 1407-1415.
3. Limei, LIU Yongqiang, XU Jianjun, et al.Broken string diagnosis of composite insulator based on Grabcut segmentation and filler area discrimination[J].Power System Protection and Control, 2021, 49(22):114-119
4. Yi, Q. Wang, L. Yan, et al., A multi-stage game model for the false data injection attack from attacker's perspective. Sustainable Energy Grids & Networks 28 (2021).
5. Na Yi, Jianjun Xu, Limei Yan, Lin Huang. Task Optimization and Scheduling of Distributed Cyber-physical System Based on Improved Ant Colony Algorithm. Future Generation Computer Systems, 109(Aug. 2020), 134-148.
6. Yang Zhao, Jianjun Xu, Jingchun Wu. A New Method for Bad Data Identification of Oilfield Power System Based on Enhanced Gravitational Search-Fuzzy C-Means Algorithm. IEEE Transactions on Industrial Informatics. VOL. 15, NO. 11, NOVEMBER 2019 5963-5970

7. Jing Han, Xi Wang, LiMei Yan, Aida Dahlak, et al. Modelling the performance of an SOEC by optimization of neural network with MPSO algorithm. International Journal of Hydrogen Energy, Volume 44, Issue 51, 22 October 2019, Pages 27947-27957. https://doi.org/10.1016/j.ijhydene.2019.09.055
8. HU Jianyi. Frontiers of petroleum geology. Beijing: Petroleum Industry Press, 2002.
9. FU Xiaofei et al. Tectonic characteristics of slope in western Songliao Basin and control of hydrocarbon accumulation[J].Chinese Journal of Geology, 2007, 42(2): 209-222.