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Combining Geological Conditions and Geochemical Techniques to Analyze the Controlling Effect of Lateral Migration Paths of Sand Bodies on Reservoir Distribution

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Abstract: The lateral migration of oil and gas in the sandstone transport layer is continuously distributed, which is controlled by the distribution of the oil and gas potential energy field in the formation. The parameter ratio traces the migration path of oil and gas in the sandstone transport layer, and the results show that the lateral migration of oil and gas in the sand body is mainly concentrated in the vicinity of the paleostructural ridge and the dominant migration channel.

Keywords: Paleofluid potential; Sand body dominant path; Oil and gas migration path tracing.

1. Introduce

The dominant migration pathway for lateral migration of oil and gas in sand bodies generally refers to the path of convergence and migration from high potential energy areas to low potential energy areas along “high permeability zones” and “structural ridges” [1]. Using mud logging, logging interpretation and seismic data to obtain the burial depth of the top surface of the sandstone transport layer, calculate the fluid potential energy value of the sand body transport layer by formulas 1 and2, and draw the oil and gas potential energy contour map of the sand body layer. Determine the dominant path of oil and gas lateral migration, as shown in Figure 1.

$$\Phi = gZ + \frac{P}{\rho_o} \quad (1)$$

$$P = \rho_W gZ \quad (2)$$

Where: Φ is the fluid potential, kJ; Z is the burial depth of the sandstone layer, m; P is the fluid pressure, MPa; ρ0 is the oil and gas density, g/cm3; ρw is the formation water density, g/cm3; g is the acceleration of gravity, Take 9.8m/s2.

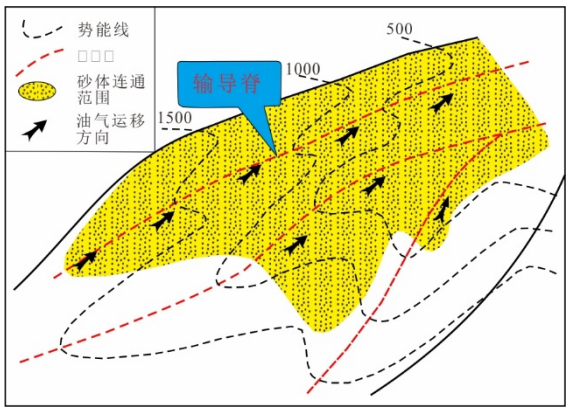

Figure 1. Relationship between structural ridges of sandstone transport layers and lateral hydrocarbon migration paths (according to Sun Tongwen, 2014)

The same type of crude oil and crude oil from the same hydrocarbon stove have differences in maturity and heterogeneity of crude oil physical and chemical properties during the oil and gas charging process. Therefore, some characteristic parameters are often selected to trace the oil charging direction and migration path. On the charging map, the farther away from the source rock, the smaller the ratio of the tracer parameter is [3]. In this paper, alkyl dibenzothiophene parameters are selected to trace the charging direction and migration path of crude oil in the Shahejie Formation in the study area, and they are mutually demonstrated with the dominant channels of lateral migration of sand bodies to analyze the lateral migration of crude oil in the Shahejie Formation on the Wen'an slope. Channels have a controlling effect on reservoir distribution.

2. Distribution of Lateral Migration Paths of Sand Bodies

The crude oil in the Shahejie Formation on the Wen'an slope belongs to freshwater-brackish lake type crude oil, and the relative density of crude oil is relatively large. 0.89 g/cm3; the density range of the third member of Shahejie is 0.80~0.92, and the average value is 0.87 g/cm3. The burial depths of the top structures of the Es1, Es2 and Es3 members were obtained by using 3D seismic data, and their oil and gas potential energy values were calculated by formulas 1.1 and 1.2 to obtain the oil and gas potential energy and paleostructural ridges (Figure 2).

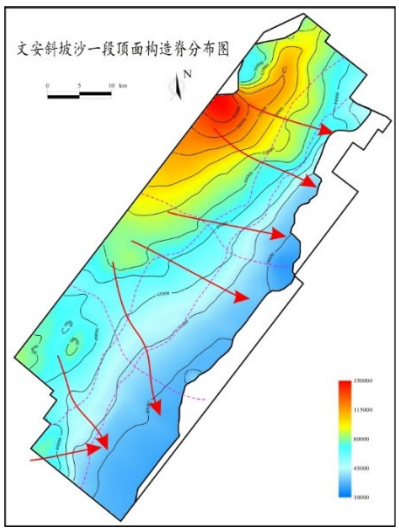

Figure 2a. Distribution map of paleo-hydrocarbon potential energy and paleo-structural ridges in the Es1 member of Wen'an Slope

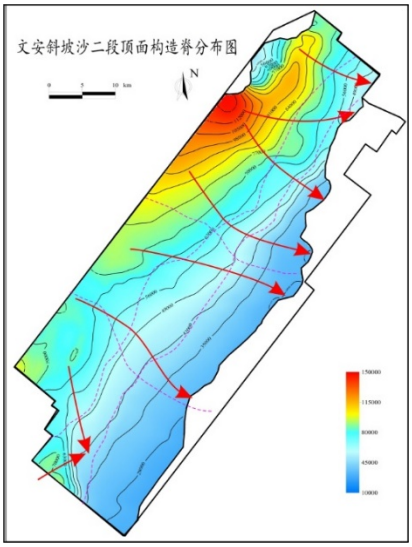

Figure 2b. Distribution map of paleo-hydrocarbon potential energy and paleo-structural ridges in the Es2 member of Wen'an Slope

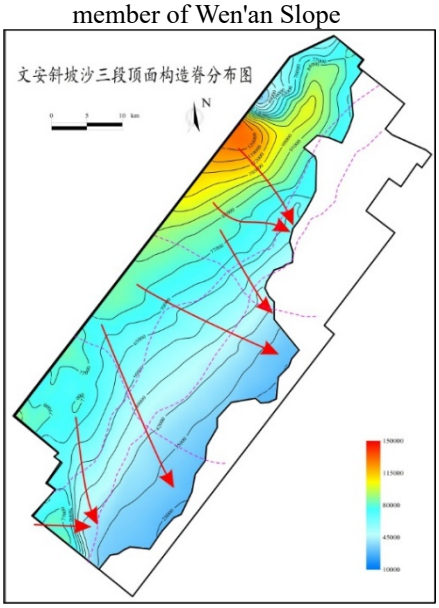

Figure 2c. Distribution map of paleo-hydrocarbon potential energy and paleo-structural ridges in the Es3 member of Wen'an Slope

It can be seen from Fig. 2 that the distribution characteristics of the paleo-hydrocarbon potential energy field in the Shahejie Formation on the Wen'an slope are as follows: (1) The high potential energy value is located in the inner slope of the surrounding depression and trough belt, and shows a gradually decreasing trend from west to east (in the inner slope and outer band); (2) The paleo-hydrocarbon potential energy is the highest in the northwest of the slope near the Baxian trough; (3) The paleo-hydrocarbon structural ridges are developed in the southern, middle and northern segments of the slope, and the Sha-1 and Sha-2 members are more developed than the Sha-3 paleo-hydrocarbon structural ridges.

The lateral migration of oil and gas in the sand body is not only affected by the paleo-structural action, but also related to the connectivity of the sand body[4]. Combining the distribution of paleo-structural ridges, the connectivity range of the sand body, and the distribution relationship of oil and gas, the migration of oil and gas in the sand body is described. The dominant path of the shift is shown in Figure 3.

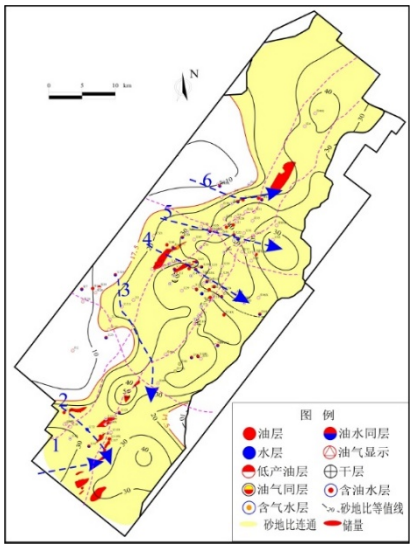

Figure 3a. The relationship between the lateral migration path of oil and gas and the distribution of oil and gas in the Es1 member of the Wen'an slope

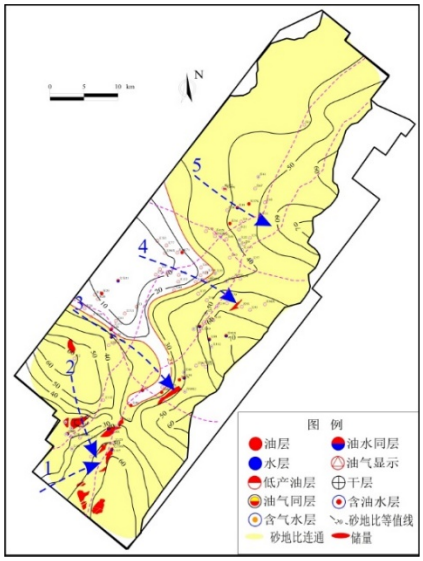

Figure 3b. The relationship between the lateral migration path of oil and gas and the distribution of oil and gas in the Es2 member of the Wen'an slope

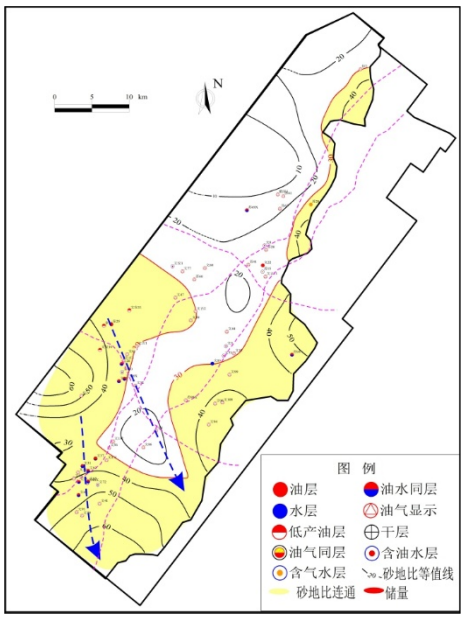

Figure 3c. The relationship between the lateral migration path of oil and gas and the distribution of oil and gas in the Es3member of the Wen'an slope

There are 6 lateral migration paths developed in the sand bodies of the first member of Shahejie Formation in the Wen'an slope, which are relatively developed as a whole. They are distributed from north to south on the four nose-shaped structural belts of Suqiaonan, Shigezhuang, Changfengzhen and Yilianpu (Fig. 3a). Among them, the No. 3 migration path and the oil source comparison results both prove that the Shahejie Formation oil in the southern part of the Wen'an slope is contributed by the source rock of the third member of the Shahejie member in the middle of the Wen'an slope; there are 5 lateral migrations in the sand body of the second member of the Wen'an slope. The path (Fig. 3b) is mainly concentrated in the southern part of the Wen'an slope. The two migration paths in the south converge, which is conducive to the accumulation of oil and gas; the third member of the Shahejie Formation shows less oil and gas, and a total of two sand bodies have dominant migration in the southern part of the slope. (Fig. 3c), and the two migration paths also confirm that the crude oil in the southern segment has the contribution of the Es3 source rock in the middle segment of the Wen'an slope.

3. Alkyldibenzothiophene Tracer Lateral Transport Pathway

Differences in thermal stability of different carbon atoms on alkyldibenzothiophenes and the formation mechanism of hydrogen bonds, parameters of alkyldibenzothiophenes 4-/1-methyldibenzothiophene (4-/1-MDBT), 2, 4-/1,4-dimethyldibenzothiophene (2,4-/1,4-DMDBT) and 4,6-/1,4-dimethyldibenzothiophene (4,6-/ 1, 4-DMDBT) and other parameters are often used to trace the filling direction and path of the reservoir. The 6-/1,4-DMDBT ratio gradually decreased [3 5].

The distribution map of the 4-/1-MDBT parameters of the polycyclic sulfur-containing aromatic compounds alkyldibenzothiophene in the Es1, Es2 and Es3 in the Wen'an slope shows that the 4-/1-MDBT parameter values of the crude oil in the slope are along the lateral direction of the sand body. The migration path gradually decreases from the inside to the outside, and the oil and gas generated from the source rocks in the Baxian trough and the Maxi trough migrate from west to east along the lateral migration path of the sand body from the inner slope near the trough to the outer belt. The crude oil of the first member of the slope Shahejie is mainly distributed in the Shigezhuang structural belt in the central part and the Yidianpu structural belt in the southern section. -4X1 Well, Wen 20-19 Well, Wen 20-20 Well, Su 55-12 Well, and Su 74 Well show a decreasing trend from west to east, indicating that the oil and gas charging direction of Shigezhuang structural belt is from west to west Eastward migration; the 4-/1-MDBT value of crude oil in the southern section gradually decreased along the NE direction from Well Xi6-23 to Well Wen119-20, indicating that the oil and gas in the southern section migrated along the NE direction from the Maxi trough in the charging direction of the crude oil. to the Argumentation Fort area. The crude oil in the second member of the Shahejie Formation is mainly concentrated in the southern section, and the 4-/1-MDBT value of crude oil in the NE direction gradually decreased from 1.34 to 1.14 from Well Wen 119-21, Well Wen 122, and Well Wen 31-35X, indicating that the crude oil in the southern section is more abundant. Note that the direction is the NE direction. Both the middle and southern sections of the third member of the Shahejie Formation are developed, and the 4-/1-MDBT values of Wells Wen 31-19 and Well Wen 118-10X in the south are gradually decreasing along the NW direction, which may indicate that the central part of the Wen'an slope contributes to the crude oil in the southern section; Among them, the variation trend of 4-/1-MDBT values

4. Conclusion

On the whole, the crude oil of the Wen'an slope migrated from the inner belt to the outer belt from west to east, but the crude oil in the southern section has two dominant migration paths, namely, the movement from the Masi Sag to the Lilianbao area and the middle section of the Wen'an slope to the south of the slope. The crude oil in the middle and northern sections migrated from the Baxian trough from west to east and from the inner slope to the outer belt mainly along the lateral dominant migration path of the sand body.

Comparing the distance between the oil-bearing well location and the lateral dominant migration path of oil and gas, the oil is mainly distributed along the dominant lateral migration path of the sand body in the main oil-bearing intervals of the whole Wen'an slope, such as the first member of the sand body and the second member of the second member of the sand body. As the distance to the dominant migration path increases, the degree of hydrocarbon enrichment gradually decreases.

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