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Condition analysis of oil gas lateral diversion and its dominant migration pathway—In Jizhong depression Liuchu area as an example

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Abstract: Oil and gas lateral diversion is the study of Jizhong depression left key problems of oil and natural gas accumulation in Liuhu area, according to the study area, 84 well data and 3D seismic data to study the control factors of lateral shunt in the Liuchu area. The following results were obtained: 1) cap rock development is a prerequisite for fault reservoir lateral diversion; 2) reverse oil source faults "convex ridge" near upper reservoir is lateral injection point 3) in the lateral injection point's reservoir physical properties determine the lateral distributary stratigraphic position, and the dominant migration pathway is drawn, This conclusion can guide the exploration in the area of Liuchu area, which can provide reference for other exploration.

Keywords: *lateral diversion, dominant migration pathway, shale stratum ratio, Liuchu area, injection point.*

I. INTRODUCTION

Liuchu structure is located in south central Raoyang sag of Bohai Bay Basin, area of about 515km2 ,east Yuanchanglou - Yangwuzhai tectonic belt, west connected Liucun low uplift, south to the Yuke tectonic belt, north and Liuxi-Dawangzhuang tectonic belt is connected. The main body of the Liuchu area is influenced by the Two-way extrusion of Liuchu-Huangpucun and north Dawangzhuang, and asymmetric collapse in late collapse formation. Liuchu area is a collapse anticline that formed due to the main body is subjected to east Liuchu-Huangpucun fault and west Dawangzhuang east fault double extrusion and the collapse of the latter, occurrence of regional extension, differential displacement in the course of the fall of the two relative fault, fault occurrence and formation of rolling, Is a typical complex fault block oil structure. The development of the area is Es1x and Es3s two sets of hydrocarbon source rocks, and the reservoir is well developed in this area. Shahejie formation and Dongying formation can act as reservoirs, by comparing the previous understanding of oil source, the oil and gas in Dongying formation and Es1s reservoir are mainly derived from the source rocks of Es1x, is a combination of a shallow reservoir. Is characterized by source rocks in the lower part and reservoirs in the upper part According to the distribution area of Shahejie hydrocarbon generation threshold of 3100 meters can be defined in the area of mature source rock, the reservoir around the source center is zonal distribution, and the collapse in the core of anticline oil and gas shows the best. In the vertical direction, the Dongying formation's three layers are found oil and gas. Performance is the characteristics of a source rock supply multiple reservoirs. It also proves that the main migration direction of oil and gas is first by the oil source fault to the upward migration, and then to the reservoir lateral diversion. In this paper, the study on the factors of the lateral distribution of oil and gas, the oil and gas migration path in the Liuchu area is described.

II. CAP ROCK DEVELOPMENT IS A PREREQUISITE FOR FAULT RESERVOIR LATERAL DIVERSION

The vertical migration of oil and gas to flow toward the reservoir side, first controlled by the regional seal, the migration path is controlled by the macro closed bottom layer or transport layer the 3D geometry of the top surface, Liuchu area in Es1s ~ Ed longitudinal mainly developed 3 sets of cover layer, growth layer and

concentration. The cover has obvious diachroneity. Through the observation of the rich mudstone section, the thickness of Ed1+2 cap rock is the largest. The thickness of the cover layer is the most developed in the two wings of the structure, and the core of the middle part is gradually reduced. The relationship between the thickness of the cap rock layer and the sealing oil and gas is not good, and the relationship between the cover and the oil and gas is closely related. Cover the mud cover ratio reflects the purity, its value is high cover layer heterogeneity is stronger, more is not easy to damage the sealing ability. The statistical results of the 62 reservoirs in the Dongying formation and the sand in the Liuchu area show that the oil sealing probability is more than 90% when the mud is greater than 0.8(Fig.1，Fig 2). Therefore, high cover layer of mud than area can be effectively broken-reservoir lateral diversion.

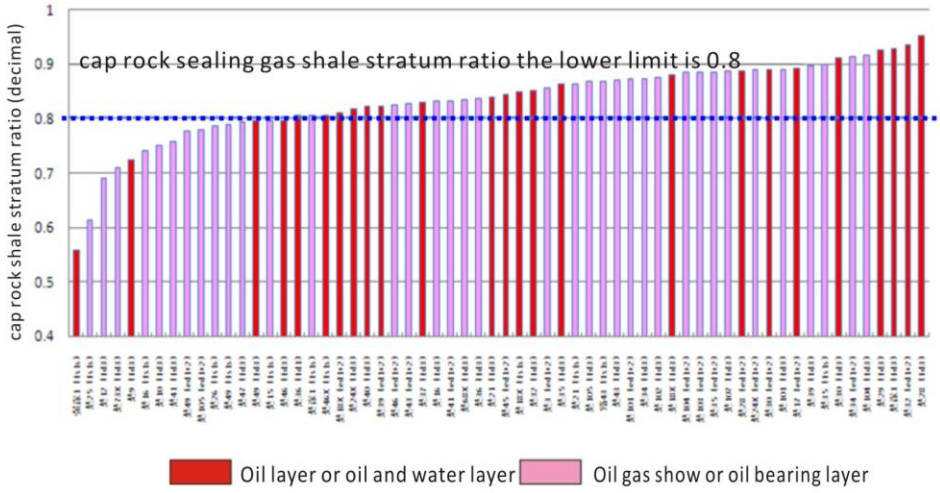

Fig.1：LIuchu area shale stratum ratio and oil gas display relationship

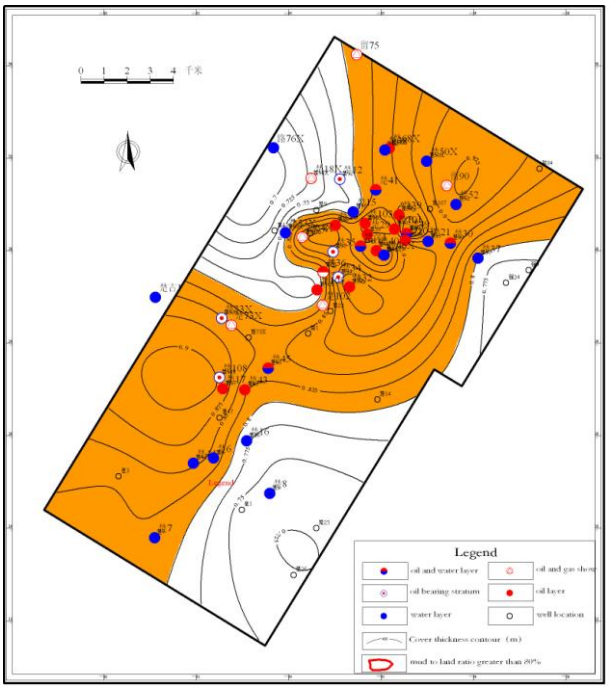

Fig.2：Liuchu area's Ed1 and Ed2 cap rock and mud to ground ratio contour map

III. REVERSE OIL SOURCE FAULTS "CONVEX RIDGE" NEAR UPPER RESERVOIR IS LATERAL INJECTION POINT

Different fault and sand body combination type, the advantageous position of the lateral diversion of oil and gas is different. There are 4 main types of normal faults and sand bodies in the section of the combination types, namely reverse normal faults, the consequent fault, "roof" is the "roof" reverse fault and normal fault[1], reverse fault refers to the fault of two disc sand bodies tend to agree with the fault, the opposite tendency, and the horizontal regulation on the corner, and under the horizontal angle is negative, the consequent normal fault is just the opposite; "roof" is refers to the hanging wall fault sand body and faults tend to agree and footwall sands and faults toward the opposite direction; "roof" is "roof" fault and normal fault opposite. In 4 types of normal faults and sand bodies in the "roof" is on the fault footwall are strong, filling, faults and sand is the most favorable configuration; "roof" is on the fault footwall are weak, filling, faults and sand is the most unfavorable configuration; reverse normal faults on the more favorable, more favorable to the normal fault along the footwall. The main area of the Liuchu area is reverse normal fault, and oil and gas mainly to the upper wall's reservoir filling.

When the transporting faults the upward migration of oil and gas in regional cap rock, in regional cap closed began to flow toward the lateral reservoir, contact is not part of fault and reservoir of oil and gas can be used as lateral diversion sites, but at fault in a very limited area to transport. For fracture, the fracture zone with complex internal structure and fault plane is often uneven, oil and gas in the fault zone in a limited space along the channel migration, follow along the maximum flow direction and reduce the potential migration concentration of migration, in the path of least resistance. Therefore, oil and gas is not along the entire oil source faults, also there is a dominant migration pathway. The advantage of oil and gas migration path is mainly affected by the cross-section shape and fluid potential effect, can be divided into the following three situations: (1) plane fault does not change the migration path of oil and gas began to remain unchanged since the entrance point of the path, the dominant migration pathway is not obvious; (2) to make a concave fault streamline is divergent, no the dominant migration pathway; (3) convex fault streamline accumulated dominant migration pathway, to form a vertical convex ridge fault obviously, not only for the low potential area, and can converge to the oil and gas, oil and gas along the fault plane transporting channel advantage, oil and gas to the first layer off the convex ridges together, along the vertical ridge transport.

By means of the combination of the buried depth contour[2] and the three dimensional geological modeling method, the dominant channel of the cross section of the oil source fault is identified, and the dominant position of the lateral distribution of oil and gas is the dominant position of the reservoir. In general, Liuchu area near the ridge section of the hanging wall of the fault is the reverse lateral filling part of oil and gas. The corresponding fault and convex ridge, there are 3 types of 60 lateral injection points. Take the Dongying formation as an example (Fig.3), oil and gas migrate to the upper layer of the overlying layer, and migrate to the reservoir at the injection point.

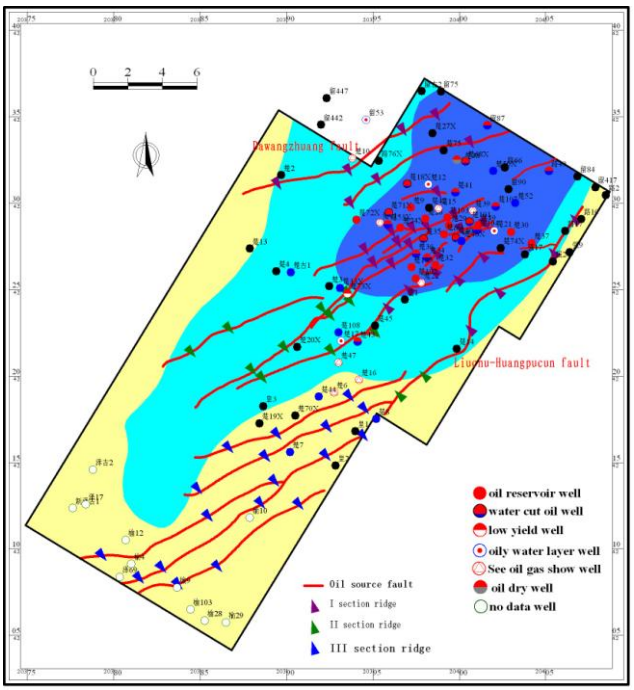

Fig.3：Dongying group bottom in Liuchu area oil source fault lateral injection points location of the map

IV. IN THE LATERAL INJECTION POINT'S RESERVOIR PHYSICAL PROPERTIES DETERMINE

V. THE LATERAL DISTRIBUTARY STRATIGRAPHIC POSITION

The reservoir physical property is difficult to decide the lateral migration of oil and gas of key factors, manifested in 2 aspects: 1) the greater the porosity, capillary resistance is small; 2) higher permeability, sand body connectivity is better, pore fluid flow more easily. However, in the practical application, porosity and permeability data is often very limited (typical wells core test), cannot be used to reflect the change of physical properties of a reservoir, the more realistic approach is use of ratio of the sand to evaluate reservoir sand body of reservior physical property[3].

Zheng Jianhui(2002) physical simulation experiments show that on the top of the cover in case of oil filling preferred good permeability layer (either in the top or bottom); sand ratio refers to the ratio of reservoir sandstone thickness and stratum thickness. Literature[4] is using percolation theory to study stacked sand body connectivity between the problem after thinks that there is a characteristic of sand than the threshold, below the threshold between sand body connectivity with sand ratio increased, sand body between the stacked conductor connected to form. In addition, sand ratio also reflects the change trend of sandstone thickness and stratum thickness, is more important in the research of oil and gas migration in the reservoir sand body parameters. Liuchu area of each layer of sand than that of oil well and the average number of statistics, the ratio of sand and industry (the same layer) wells number was positively correlated. It shows that the sand ratio as the reservoir quality evaluation is feasible. The Ed2, Ed3 a total of 6 layers of 124 reservoir and oil-bearing sand than comparative analysis indicates that the reservoir (industrial oil flow or oil-water layer) were distributed in the basic sand ratio is greater than 0.15, showed that the Liuchu area when the reservoir sand ratio is greater than 0.15 (Fig.4) when good physical properties, relative displacement pressure low, easily broken reservoir lateral diversion. Therefore, the oil and gas distribution along the vertical migration of the oil source is preferentially selected by Ed2, Ed3 and Es1. Because the study area objective reservoir is fluvial, so consider the objective layer of sand than offline premise, but also reference sedimentary sandstone body shape and range.

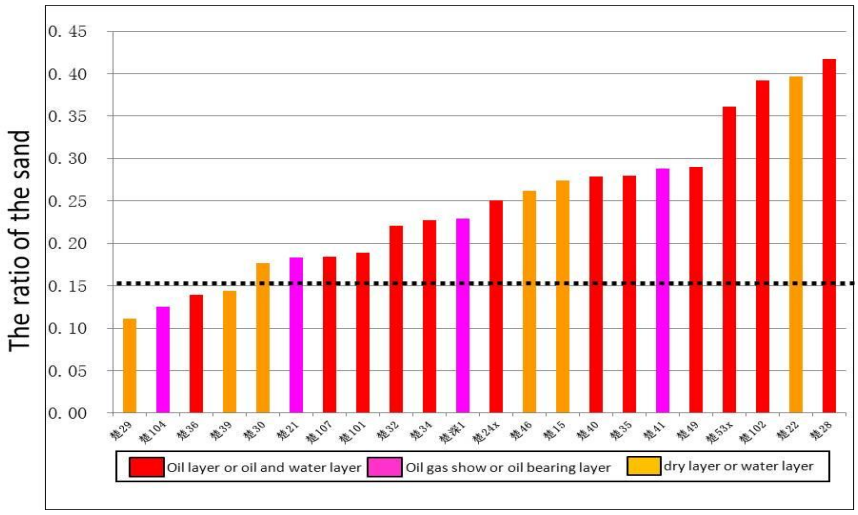

Fig.4：Liuchu area Ed3s the ration of the sand histogram

VI. OIL GAS LATERAL MIGRATION PATHWAY AND ROUTE

Wang Jianwei[5] were simulated under different conditions by Basin Mod basin modeling software, under the effect of buoyancy, the heterogeneous transport layer of oil and gas to give priority to the "high permeability" positive structural ridge department together, and along the tectonic "ridge" advantages of lateral migration, and when the change of transport layer the structure, relatively low as "high permeability" and "structural ridge" for the relatively low porosity and permeability, the oil and gas along the priority to the "structural ridge" together. The hydrodynamic effect in addition to "structural ridge" control, transport layer permeability also has influence on the migration of heterogeneity. It can be seen that the positive "structural ridge" is a key factor to control the sandstone transporting layer of oil and gas migration channel, and the high porosity and permeability "positive" structural ridge "is the transport layer of oil and gas migration" highway". In order to describe the dominant pathway, Li Sitian[6] put forward the concept of carrier ridge, conducting channel formed by matching by structural ridge with high permeability rocks. Under the effect of buoyancy, oil and gas first to the top layer of sand body migration and migration, convergence to the carrier ridge, eventually along the carrier ridge lateral long distance migration, migration of oil and gas migration is a key ridge accumulation process, no oil and gas migration stage, it is impossible to form with the economic value of oil gas reservoir.

Therefore, oil and gas into the reservoir after the lateral migration path is structural ridge with high permeability sand body composed of "carrier ridge" is oil and gas into the reservoir to the posterior migration path advantage (structural ridge + channel), and Liuchu area due to a number of oil source fault is nearly parallel to the distribution of single oil source fracture of oil and gas in the plane migration distance is generally not more than a fault interval, a plurality of oil source faults of oil and gas is the "relay" movement in the plane.

Considering the oil source fault lateral filling, different tectonic ridges and channel sand body distribution of 3 factors of Liuchu structure of each layer "carrier ridge" for a detailed characterization, its distribution has the following characteristics: 1): Western oil and gas along the vertical fracture direction, from the northwest to the Southeast "relay" lateral adjustment; 2): Eastern migration path is relatively small, from the east to the West also has the characteristics of adjusting; overall, the lateral oil and gas from the East and west sides to converge, to reflect the characteristics of two-way hydrocarbon supply. Comprehensive use of “injection point” and “carrier ridge”, and it can determine the level of oil and gas from the oil source fault into the reservoir after the lateral migration path (Fig.5).

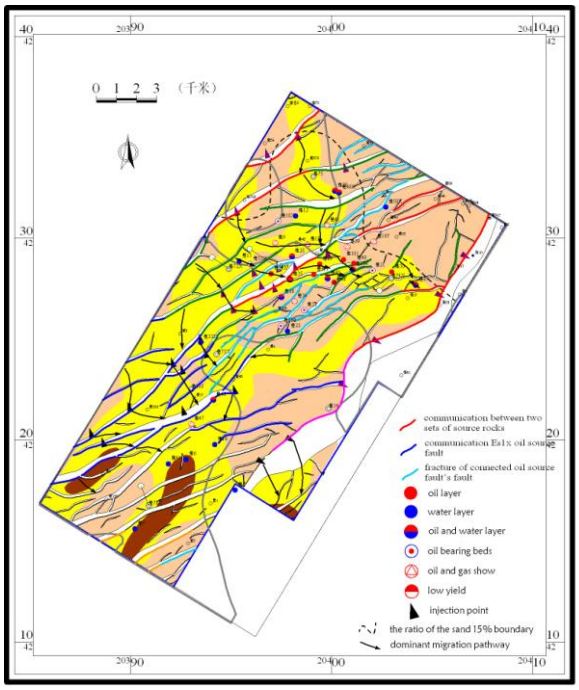

Fig.5：Liuchu area Ed3z oil and gas migration pathway map

VII. CONCLUSION

1) In shallow oil and gas migration process Liuchu area as a sand source rocks generated oil and gas in the shallow layer to the first vertical migration pathway through the oil source fault, because the regional cap rock barrier so that oil and gas to the lower part of the cover in different layers of sandstone reservoirs in lateral diversion conduit, side cover to separate the premise.

2) Is not the migration of oil and gas in the oil source fault is found, but the upward migration of oil source faults along the "convex ridge", when the regional seal, will enter the reservoir from the junction of the convex ridges and reservoir, and the formation of oil and gas reservoirs, namely charging point of intersection position. Liuchu area to reverse normal faults, so the reverse oil source faults "convex ridge" near the reservoir at the upper lateral injection point.

3) Than sand can characterize the reservoir properties and sand body connectivity, shallow sand ratio is greater than 15% sand Liuchu area communicated with greater probability, at the same time, the greater the reservoir sand ratio shows that sandstone is more conducive to the development of the oil source fault migration of oil and gas to both sides of sandstone layer the lateral migration of shunt.

4) Because of the main reservoir of the reservoir in the Liuchu area, sand bodies developed well, and the scope of the sand body was limited to oil and gas migration pathway. Therefore, the structural ridge with high permeability sand body composed of "carrier ridge" has become the oil and gas into the reservoir to the posterior migration path advantage. Taking into account the oil source fault lateral charge points, the distribution of the ridge and the channel sand bodies in different regions can be described by 3 factors.

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