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Quantitative study of Shahejie Formation sandstone carrier connectivity of the Wen'an slope in Baxian Sag

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Abstract: The sandstone of Shahejie (Es2) Formation in Wen'an slope area of Baxian Sag is the research object, using the oil pressure data of the development well to compare the adjacent wells, to determine the connectivity built in sandstone transporting. According to the relationship between the ratio of the sand and sandstone carrier connectivity, establishes a mathematical model to determine the probability of sandstone carrier connectivity, and by using this model, the Shahejie of Wen'an slope sandstone transporting layer can be quantitative characterization. Research shows, when ratio of the sand less than 23%, between the sand body is not connected; when the ratio of the sand is greater than 23%, sandstone carrier connectivity probability with sandy increased with the increase of the ratio becomes larger, when more than 50%, sand body fully connected. This study can provide the basis of reservoir characteristics for the oil and gas reservoir in Wen'an slope area, and also is the foundation to carry out oil and gas migration path.

Keywords*: sandstone carrier, connectivity, quantitative characterization, Wen'an, Baxian Sag*

I. INTRODUCTION

Prior to 1990s, the study of the connectivity characteristics of sandstone reservoirs, generally stay in qualitative research. With the development of technology, in order to meet the requirements in the field of oil field development, domestic and foreign scholars carried out a lot of sandstone reservoir layer connectivity research work, trying to find a better method for the quantitative study of, and achieved many results and understanding. The results show that the connectivity of sand bodies is closely related to the ratio of sandstone in the formation, and it can be well predicted by using discrete stochastic model. Allen[1] proposed a theoretical model, the critical value of the ratio of the sand to determine the degree of sandstone carrier connectivity. Qiu[2] et al based on the actual situation of China's oil and gas bearing basin, the critical value of Allen was modified, and the channel sandstone density was more than 50%, the sandstone carrier connectivity was very good, and the sand body was in large area. King[3] makes use of percolation theory analysis of the superimposed sandstone carrier connectivity, He believes that the existence of a numerical as ratio of the sand threshold feature, when ratio of the sand is below this value, sand body between each other is connected, with the ratio of the sand is more and more high, between the sand bodies began stacked to form clusters of sandstone carrier connectivity; and when the ratio of the sand is higher than a limit value, the formation of large fully connected sandstone distributed. The specific value of the characteristic threshold value and the upper limit value of the sandstone connectivity, the difference of the values given by different scholars is larger, there is a certain dispute. In recent years, the characteristics of various migration channel transportation research has gradually become the oil and gas in the forming process of an indispensable research contents. Author use Wen'an slope area oil field development dynamic data to judge in the study area between adjacent wells of the sandstone carrier connectivity, and use Luo Xiaorong[4] proposed mathematical model on sandy ratio and sandstone carrier connectivity relation to determine the study area of sandstone carrier connectivity calculation mathematical model, to do a quantitative characterization about the transport layer of Es2 connectivity. This research can

provide reference and reference for the study of oil and gas reservoir dynamics in the area, and also can be used as the basis for the study of oil and gas accumulation in the area.

II. RESEARCH METHODS

In order to quantify analysis the connectivity of characteristics of the main connectivity of the transport layer in study area, the author chooses the 31 fault block area of the development well information as an example to analyze the relationship between the sand body and the sand body, According to statistics, the establishment of relationship between sandstone carrier connectivity and ratio of the sand. According to the probability model, the connectivity characteristics of quantitative characterization of sand sandstone transporting layer two. Specific methods are as follows:

(1) Because of the limited development data of the research area, the selected block wells should have the characteristics of close distance and full oil pressure data. We establish a connection between the adjacent wells in each block, so that it constitutes a connected mesh, which is convenient for data extraction (Fig.1).

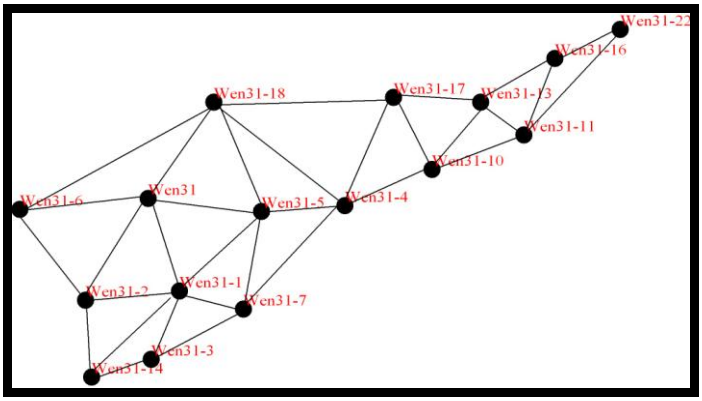

Fig.1：Es2 sand bodies connected to the grid in the 31 section of the fault block

(2) To make full use of the production data, select the effective method to judge the sandstone carrier connectivity between wells. If two well determination is communicated, read between the two wells about 1 / 2 the distance of sandy ratio, corresponding connectivity is connected; on the contrary, if the two wells of the transport layer is disconnected, read between the two wells about 1 / 2 the distance of sandy than, corresponding to the two pass down for not connected.

(3) Luo Xiaorong et al in the king et al of the sand body space distribution probability model(Fig.2), by using the Gaussian fitting to establish the following relationship to describe the connectivity between the transport layer in the sandstone:

$$P = \begin{cases} 0 & (h \le C_0) \\ 1 - e^{[-(h-C_0)^2 / b^2]} & (h > C_0) \end{cases} \quad (1)$$

Formula: P is the probability of sand body connectivity; h is the ratio of the sand; C_0 is percolation threshold; C is a fully connected coefficient. B is connectivity index. $b=(C-C_0)/\sqrt{3}$

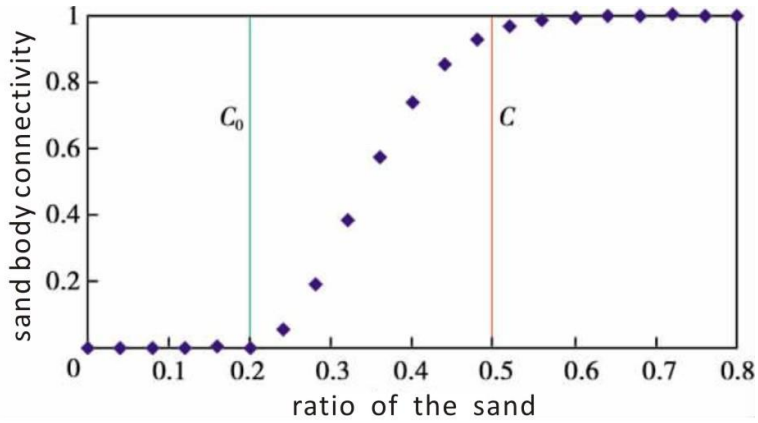

Fig.2：Graph of the relation between ration of the sand and sand body connected probability

(4) The model is applied in Wen'an slope area, the quantitative characterization of Es2 sandstone transporting layer connectivity.

III. COONECTIVITY FLUID BETWEEN WELLS IN THE WEN 31 FAULT BLOCK

The data of oil field development is the premise to directly reflect the characteristics of oil reservoir development. Commonly used methods of analysis are reservoir pressure analysis, fluid property change trend analysis, inter well productivity analysis, inter well chemical tracer monitoring etc[5-7]. According to the actual situation of oil field data, the oil pressure data of each well is used to compare the fluid pressure, so as to judge the fluid connectivity of sandstone. Due to the same reservoir sand body in the same hydrodynamic system, throughout their original formation pressure is balanced, the pressure of the same depth should be equal, original formation pressure and depth curves should approximate to a straight line. In the production process, the change trend of the well pressure with time should be roughly similar. According to this characteristic, the fluid pressure data of each well can be used to analyze the sandstone carrier connectivity between adjacent wells. For example, in the Wen 31 fault block of the text Wen31-16 well, the Wen31-13 section of the Es2 section of the from December 2006 to October 2009 oil pressure change with the time of the basic agreement (Fig.3), according to the preliminary view that the 2 diameter Es2 sand body is connected.

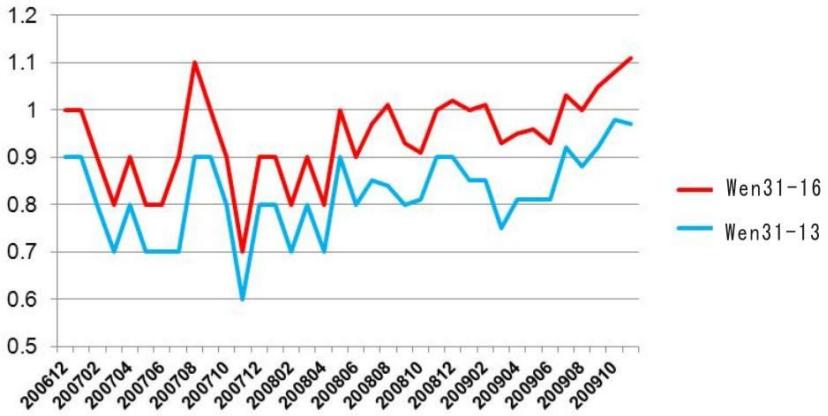

Fig.3：The time variation of single well oil pressure

Data based on the sample of the 116 wells a total of 228 data, using the above research method, analyzes the adjacent wells between sandstone transporting layer connectivity and sandy ratio between the relationship, determine the formula of sandy than the lower limit and the large area communicated with sandy than boundaries, and the sandstone transporting layer connected the quantitative evaluation.

IV. APPLICATION OF CONNECTED PROBABILITY MODEL IN ES2 OF WEN'AN SLOPE IN BAXIAN SAG

Use the established to judge sandstone carrier connectivity probability mathematical model, according to the study area of ES2 sandy ratio data, depicting the Baxian sag Wen'an slope of sandstone transporting layer probability plane diagram (Fig.4). The map can well analyze connectivity features two sections of sand sandstone transporting layer. In addition to the northeast region of the sandstone carrier connectivity is not good, the other regions of the connectivity are better. So we can see that the reservoir condition is not the main factor controlling the reservoir formation, but it can be used as the basic condition for the study of reservoir forming factors.

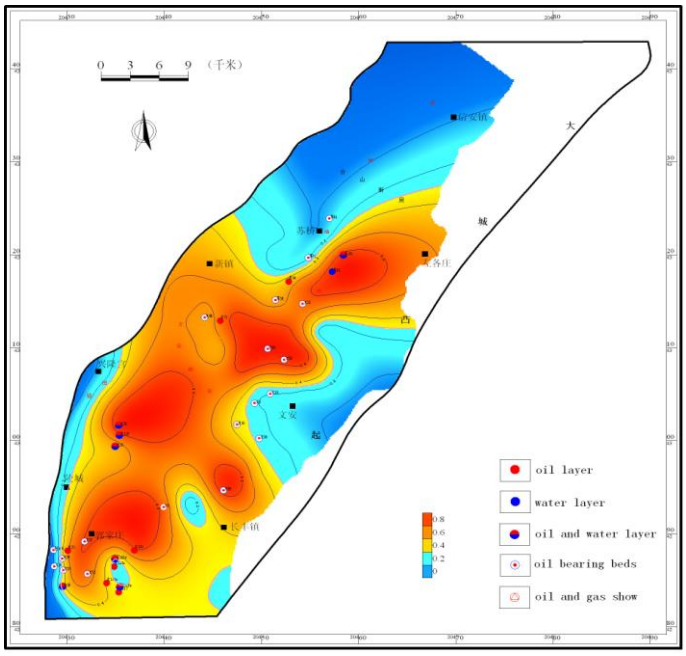

Fig.4：Wen'an slope Es2 sand body connected probability map

V. CONCLUSION

(1) In this paper, through the use of the oil pressure data between wells, to determine, the connectivity between adjacent wells. In the 31 block 8 block development wells on the basis of the data, established by using ratio of the sand to determine the mathematical model of sandstone carrier connectivity. When sandy ratio less than 23%, the sand body is connected; with the increase of the sandy than ideas, between the sand bodies began to overlay and sand body built connectivity probability becomes larger. W When the ratio of the sand is larger than 50%, the sand body is completely connected.

(2) The mathematical probability model of judging the connectivity of sand bodies is established, and it is used to study on the connectivity of Wen'an slope area Es2 transport layer. In addition to the poor connectivity of the northeast, most of the connectivity is good, which is the favorable conditions for oil and gas migration, is not the main control factors of oil and gas accumulation in the study area, but it is essential step in the study of oil and gas accumulation.

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