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Low Permeability Sandstone Reservoir Prediction

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Abstract: The comprehensive interpretation of seismic geological technology plays an important role in reservoir evaluation. Its core is combined the geological model and seismic interpretation technology, and apply the advanced geophysical techniques to predict and evaluate the reservoir. Also, looking for favorable reservoirs in low porosity and low permeability reservoir is an important direction for hydrocarbon exploration. This paper uses the means of seismic interpretation and sedimentary facies analysis to predict the high quality reservoir and deploy the well location.
Keywords: seismic interpretation, sedimentary facies, reservoir prediction.

INTRODUCTION

This paper is based the on combination of geological, seismic, high resolution logging, and accurately described the distribution pattern, physical characteristics and the classification of Ultra-low permeability sandstone in Da'an oilfield. Specific research contents include:

1 The establishment of a high quality reservoir identification model

2 Planar distribution of reservoir prediction

3 describe the features of reservoir space distribution

D SEISMIC QUALITY RESERVIOR PREDICTION TECHNIQUE

Seismic data interpretation

1. The quality of seismic data analysis

The study area is about 70 km^2, Seismic work area line number is: 1-777, trace number is: 4-1275. Deal with the seismic data of the target stratum, the spectral analysis shows that the basic frequency target stratum is 35HZ or so. Transverse resolution is high and the vertical resolution is low, which can only reach 15~20m. But the thickness of single sand body in the study area is 2 ~ 6 m. Therefore, seismic data doesn't match the requirements of the resolution of thin interbed reservoir. And this requires dealing with the help of using attributes to improve the resolution that can be detected of thin layer.

2. Seismic synthetic seismogram and horizon calibration

In the synthetic records, mainly on the basis of the existing geological hierarchical data and acoustic logging data, to make the high quality of synthetic seismic records [1].

In Landmark, the steps of applying Syntool module to make high precision seismic synthetic record are Start the Syntool, Choose well curve, Generate and edit synthetic record, and store synthetic record [2].

This paper takes the method of combining well-log and seismic data to demarcate horizon, uses synthetic seismic records for horizon calibration and determine to take T_2 and two obvious reflection interfaces under T_2 as the standards. And find the location of the target stratum on seismic section.

3. Horizon interpretation

Through the production of synthetic seismic records, confirm the seismic reflection feature of the target stratum target stratum. The characteristics of each main reflection reservoir in Fuyu are as follows:

T_2: Strong reflection interface, correspond the maximum of wave crest

f_1: strong reflection, correspond the first maximum of wave crest under T_2

f_3: middle-weak reflection, correspond the location of the breaking point from the f_1 wave crest to the trough under f_1

f_6: strong reflection, correspond the maximum position between the two wave crest under T_2

f_{11}: weak reflection, correspond location of the breaking point between the second T_2 wave crest and the trough under T_2

Seismic attribute prediction results

Amplitude or energy attributes are the characteristic parameters of dynamic on record and maximum amplitude. It mainly reflects wave impedance in the target layer, thickness of strata, rock composition, formation pressure, the change of porosity and fluid composition. Which to identify the delta, river, or special lithologic body, and it can also be used to identify the lithology changes [3].

Comparative and analyze of extracted attributed graph and Sandstone contour map, we found that the root-mean-square amplitude attribute graph of f_2~f_4 is matched the sandstone contour map well, and the overall trend is identical with the sandstone thickness contour map. The amplitude attribute map showed the trend that sandstone is thicker in the middle than in the study area around. Contrast with the sandstone and the attributed graph of well point location, the tendency of H87, H87-7, H87-2 and D41 are highly degree of agreement with the sandstone contour map. (Fig.1)

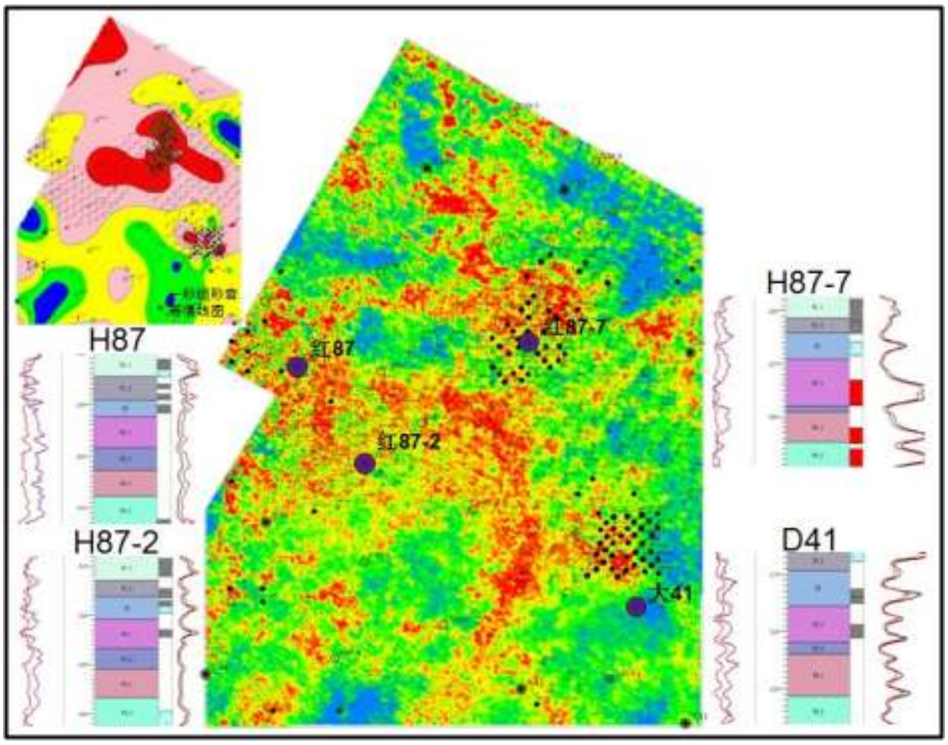

Fig.1: RMS Attribute diagram of f_2-f_4

DEVELOPMENT EVALUATION OF SMALL LAYER SANDSTONE EFFECTIVE THICKNESS

On the basis of the analysis of sedimentary facies, establish the classification of ultra-low permeability reservoir evaluation standard for analysis and evaluation is in the first place. (Table 1)

Table 1: Ultra-low permeability reservoir classification evaluation standard

reservoir types	Extra low permeable layer	Ultra-low permeable layer		compact layer		
subclass	I	II a	II b	IIIa	IIIb	IIIc
Permeability, mD	＞1.0	1.0-0.3	0.3-0.1	0.1-0.04	0.04-0.025	＜0.025
Porosity, %	＞13.0	13.0-11.0	11.0-7.0	7.0-5.0	5.0-2.1	＜2.1
oil-bearing grade	oil immersed /oiliness	oil immersed /oiliness	oil immersed / Rich oil / oil patch	oil patch / oil immersed	oil patch / fluoresce nce	Not oily

On the basis of the effective thickness of the log interpretation data in the study area, drew 12 average effective thickness of sandstone histogram of small layers vertical in fuyu reservoir (Between 1.5 ~ 5 m). And counted well numbers (Fig.2).

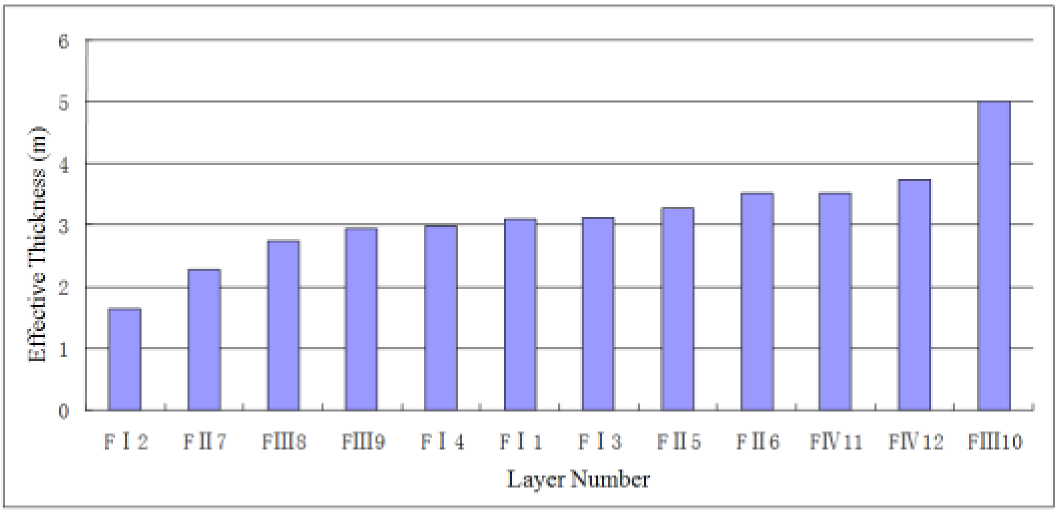

Fig. 2: Each small layer of fuyu reservoir effective thickness on average

HIGH QUALITY RESERVOIR PREDICTION AND DRILLING OPTIMIZATION

In view of the characteristics and the complex pore structure of the tight sandstone reservoir. It took permeability, effective thickness, the pore radius distribution range, diagenesis types and the main oil-bearing strata as the reservoir classification evaluation index. Refer to ultra-low permeability reservoir classification evaluation criteria and classification of Da'an oilfield high quality reservoir control factors (table 2). Consider on two key control factors which are permeability and effective thickness first, and second on the pore radius distribution range, the main diagenesis types and the main horizon. Divide the well area of highly quality reservoir into four types: A class of reservoir is high permeability reservoir, big effective thickness, uniform pore structure, good pore connectivity, strong seepage capability, good physical property. The pore radius distribution range of 0.092 ~ 0.56μm, and the main type of diagenesis is secondary pore dissolution; the second class reservoir is high permeability reservoir, big effective thickness, relative uniform pore structure, strong seepage capability. The pore radius distribution range of 0.062 ~ 0.56μm, and the main type of diagenesis is strong corrosion secondary porosity or the weak cement mixed pore; The third class reservoir is high permeability reservoir, big effective thickness, poor pore structure, narrow throat, poor connectivity, strong seepage resistance. The pore radius distribution range of 0.034 ~ 0.24μm and the main type of diagenesis is the weak cement mixed pore; The forth class reservoir is low permeability reservoir, small effective thickness, poor pore structure, narrow throat, poor connectivity, strong seepage resistance. The pore radius distribution range of 0.019 ~ 0.24μm and the main type of diagenesis is strong compaction-medium cement intergranular pore. In the first kind of well area, refer to avoid the development area and the vicinity which developed many barrelers, advice 6 wells finally, they are w1，w2，w3，w4，w5，w6. The well area which the chosen 6 wells located is high permeability, big effective thickness, uniform pore structure, good connectivity. And the main type of diagenesis is strong corrosion secondary porosity.

Table 2: The table of high quality reservoir control factors of comprehensive classification of Da'an oilfield

Type Governing Factor	First class	Second class	Third class	Forth class
permeability，mD	1.0-0.3	0.3-0.1	0.1-0.03	<0.03
effective thickness，m	20-6	6-4	4-2	2-0
pore radius distribute range，μm	0.092-0.56	0.062-0.37	0.034-0.24	0.019-0.065
The main type of diagenesis	Strong corrosion secondary porosity	weak cement mixed pore	weak cement mixed pore	strong compaction- medium cement intergranular pore
Main horizon	FⅢ$_{10}$、FⅣ$_{11}$、FⅣ$_{12}$	FⅡ$_{5}$、FⅡ$_{6}$	FⅠ$_{1}$、FⅠ$_{3}$、FⅠ$_{4}$	FⅠ$_{2}$、FⅠ$_{7}$、FⅢ$_{8}$、FⅢ$_{9}$

CONCLUSION

1 The research shows that pore throat radius control permeability obviously, and pore size has good relativity with permeability.

2 Oil-bearing sandstone effective thicknesses of $FIII_{10}$, FIV_{11}, FIV_{12} and FII_6 is bigger, and they are key research horizons of Fuyu reservoir in Da'an oilfield.

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