Precise 3D Reservoir Prediction of EI Reservoir in Z8-18 Area by Model Discrimination Technology

Hongsheng Lv

No.5 Production Plant Of Daqing Oil Field Company, Daqing, 163513, China

lvhsh@petrochina.com.cn

Keywords: 3D Reservoir Prediction, Z8-18 area, Model Discrimination

Abstract. It is well known that research on reservoirs has always been a very important part in the exploration and development stage. The distribution characteristics and scale of reservoir sand bodies are the ultimate purpose of exploration. The lithology and thickness of reservoir sand bodies play an important role in guiding the development of wells. Therefore, the prediction of reservoir sand bodies has become the core of current reservoir research. In this paper, through well-earth model discrimination technology, the three-dimensional reservoir prediction of the EI oil layer in the Z8-18 area, Daqing is carried out. It is concluded that different geological composition features correspond to different seismic waveforms, and then the EI oil layer reservoir in the entire Z8-18 area the situation is predicted. This method can display the thickness of river sand bodies relatively thin and the sand bodies with relatively small scale of plane spreading are displayed in a fine and clear manner through three-dimensional effects, which greatly improves the success rate of wells in exploration and development.

Introduction

The depositional period of the EI oil layer in Changyuan, Daqing was mainly controlled by the northern, southern and western provenances [1]. A set of deltaic plains and delta front subfacies sand bodies were deposited on the background of shallow lakes [2]. The type of reservoir is mainly the distributary channel of the delta front and the plain subfacies [3]. It has features such as multiple layers of sandstone, thin monolayer thickness, and flat misalignment. The reservoir properties are poor, with an average porosity of 12.6% and an average permeability of 1.15mD, which is a low porosity and extra low permeability reservoir [4].

The Z8-18 area is part of Daqing Changyuan anticline. The Z8-18 area stratum has the Early Cretaceous Shahezi formation, the Shahezi upper formation, the Yingcheng formation, and the Denglouku reservoir formation in time series. The Quantou Formation and Late Cretaceous Qingshankou Formation, Yaojia Formation, Nenjiang Formation, Sifangtai Formation and Mingshui Formation also included the Yi'an Formation, Da'an Formation, Taikang Formation, and Quaternary strata [5]. The Quantou Formation is the focus of our research. The Quantou Formation can be divided into four sections: the Quan 1st Member, the Quan 2nd Member, the Quan 3rd Member and the Quan 4 Member. Also, the EI Oil Formation and the EI Oil Layer 2 belong to the Quan 4 Formation. The upper stratum of the third section of quantou is also the key section of our study. During the deposition period, the formation was affected by various environmental changes. Therefore, the thickness of the reservoir sand body in the EI oil layer group in the Z8-18 area of Daqing Changyuan was not very thick, and the scale was not very large. Because general reservoir prediction methods must have good sand body thickness and large scale, general reservoir prediction methods cannot be applied to the EI oil layer group in Z8-18 District of Daqing, and use model discrimination technology for storage. Layer prediction does not necessarily require good sandstone thickness and large scale to make subtle predictions for subsurface reservoirs. Therefore, the model discrimination method can be used to fine-tune the EI oil layer group in Z8-18 District, Daqing. Three-dimensional reservoir prediction [6].

  DOI: 10.25236/isaicn.2019.066

Seismic Model Discrimination Method and Principle of Reservoir Prediction

Seismic model discrimination reservoir prediction method is a set of effective reservoir prediction methods for low-permeability and low-permeability sandy-shale thin inter bed reservoir reservoirs. The principle is that under the condition that the difference in surface geological conditions is negligible, the surrounding rocks are similar in lithology, and the same field acquisition and the same processing flow, different underground geological combinations correspond to different seismic responses, and the corresponding underground geological combination corresponds to the seismic response. In turn, different seismic responses correspond to different subsurface geological combinations, and similar seismic responses correspond to corresponding subsurface geological combinations.

In well-drilled areas, seismic-geologic models can be established using the well-side seismic traces and drilling data (Fig 1). Using the established seismic-geological model to infer the geological combination of the target layer in the unknown area is not only a method for predicting reservoirs using a pattern discrimination technique of seismic waveforms.

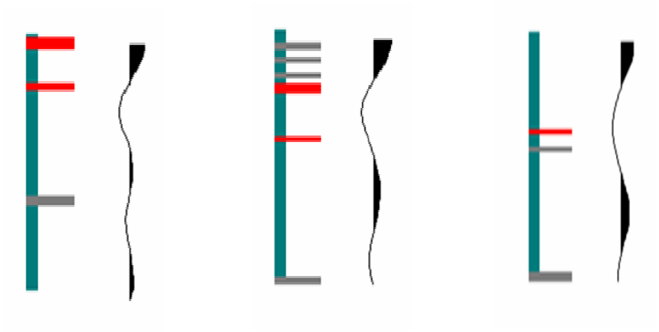

Fig 1 The pattern of one-to-one correspondence between geological composition and seismic response

Fine layering of reservoirs is based on the principle of this method. First, it is necessary to make a synthetic seismogram of the exploratory well in the work area. The reservoir unit is divided in the synthesis record. The establishment of the reservoir unit is based on the effective formation thickness that can be distinguished by the seismic wavelet, which is generally half the length of the wavelet. Then we use the three-stage sequence defined by each drilling data to correspond with the well-by-well seismic response, and build an earthquake-geologic model of the reservoir unit. Then, using the seismic data interpreted by the horizon, the model we have established is extended to the entire plane, that is, the seismic waveforms on the seismic section are transformed into the corresponding geological models through the established model. Then we will convert the model profile after conversion the isochronous subdivision layers in China are joined together to form a two-dimensional stratigraphic sequence element line by line, establishing a basic model for fine reservoir prediction (Fig 2).

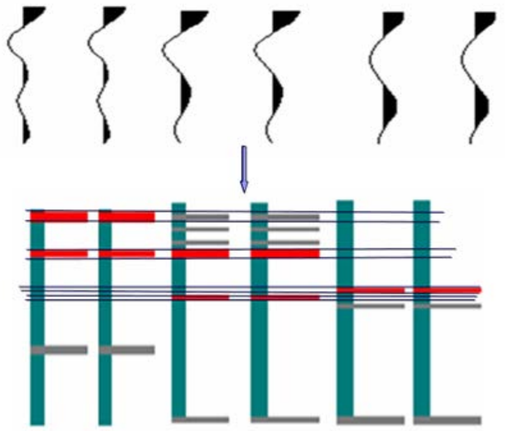

Fig 2 Discriminate the transformed model section with model discrimination

Using Well Seismic Model to Distinguish Fine Reservoir Prediction of EI Reservoir in Z8-18 Area

Establish Well Model and Well Shock Correspondence Mode. Before carrying out reservoir prediction for the EI oil layer in the Z8-18 area of Daqing Changyuan, it is first necessary to investigate whether the geological conditions of the Z8-18 area in Daqing and the collection, processing and interpretation of seismic data are the same source, only if all the conditions are satisfied. When the model discrimination technology mentioned above was used to perform reservoir prediction, it was possible to apply the model discrimination technique to predict reservoir formation in the EI oil layer in the Z8-18 area of Daqing. After investigation and research, it was discovered that the entire Daqing Changyuan Z8-18 area all of the conditions mentioned above are satisfied. Therefore, we can use the model discrimination technology reservoir prediction for the EI oil layer in the Z8-18 area.

The Z8-18 area of Daqing Changyuan has been in exploration for many years and is currently in the late stage of exploration. Therefore, the number of drillings in the works area is relatively large. We can use the detailed theory of the drilling to establish wells and seismic traces along the well. Earthquake-geological model. With the help of the established model, the reservoir prediction of the EI oil layer in the Z8-18 area of Changyuan, Daqing can be achieved, and the prediction of fine reservoirs in the EI oil layer can be achieved. The wellbore model of typical wells in the Z8-18 area can be achieved (Fig 3).

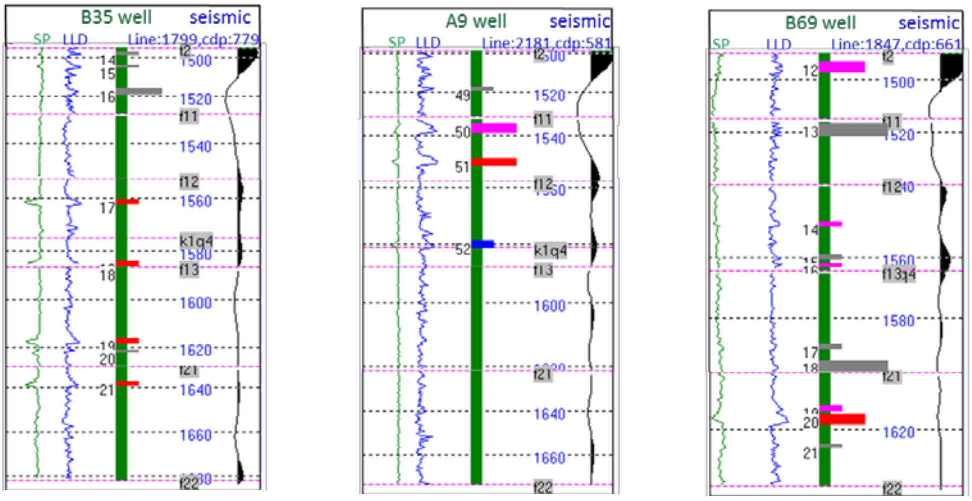

Fig 3 Diagram of the corresponding response of typical wells in EI oil layer

It can be seen from Fig 3 that different seismic responses correspond to different subsurface geological combinations, that is to say different seismic waveforms correspond to different subterranean formation combinations.

Predicted Result of Fine Reservoir in EI Oil Layer. ***Target Reservoir Prediction***. First, we need to make synthetic seismograms for each exploration well in the work area. Classify reservoir units in seismic synthesis records. The establishment of the reservoir unit is based on the effective formation thickness that can be distinguished by the seismic wavelet, which is generally half the length of the wavelet. Then we used the sequence division made by the drilling data of each exploratory well to correspond with the seismic response of synthetic seismic records of the well and established an earthquake-geologic model for each reservoir unit. Then, using the seismic data interpreted by the horizon, the model we have established extends to the entire plane, that is, the seismic waveforms on the seismic section are converted to the corresponding three-dimensional sandstone geological model through the model we have established. From the transformed three-dimensional sandstone geological model, the sandstone thickness is extracted according to the stratification result of the four-level sequence, and the fine reservoir prediction approaching the level of a single sand body is basically realized.

Analysis of Typical Forecasting Charts. In the following sandstone prediction charts, red and yellow indicate that the sandstone thickness is relatively large, while blue and green indicate that the sandstone thickness is not very large, that is, it is not very developed.

EI1 reservoir sandstone thickness prediction map (Fig 4), through analysis EI1 oil reservoir formation thickness between 18~27 meters, sandstone thickness between 1.6~15.1 meters, sand body thickness minimum 1.6m (B375),sand body thickness The maximum is 15.1m (C22),sandstones are mainly distributed in the central and southeast, and also developed in the north and southwest. The sandstone development area mainly corresponds to the distributary channel.

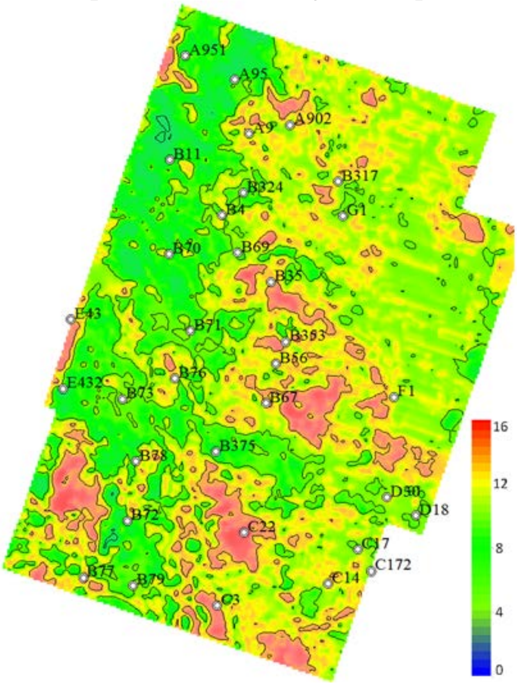

Fig 4 Prediction map of reservoir pattern of EI1 reservoir in the Z8-18 area

Prediction of the thickness of sandstone of EI2 reservoir (Fig 5). By analyzing the formation thickness of EI2 oil reservoir is between 21~29 meters, the thickness of sandstone is between 2.1~8.7 meters, the minimum thickness of sand body is 2.1m (B4),sand body thickness The maximum is 8.7m (A902).Sandstones are mainly distributed in the north and central regions, while some are developed in the north and southwest.

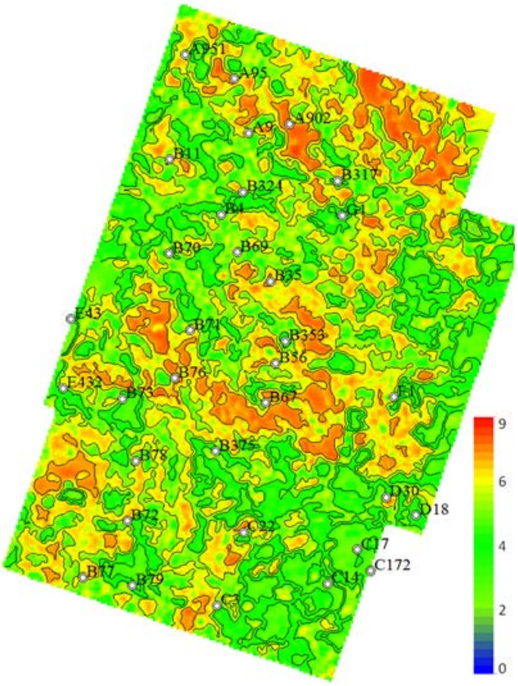

Fig 5 Prediction of reservoirs based on EI2 reservoir model in the Z8-18 area

The prediction map of the thickness of the sandstone of the EI3 reservoir (Fig 6) shows that the thickness of the reservoir of the EI3 oil reservoir is between 23 and 32 meters, the thickness of the sandstone is between 2.2 and 11.9 meters, and the minimum thickness of the sand body is 2.2 meters (C14).With a maximum of 11.9m (A95), sandstones are mainly distributed in the northwest, west, and central regions. Sandstone development areas mainly correspond to distributary channels.

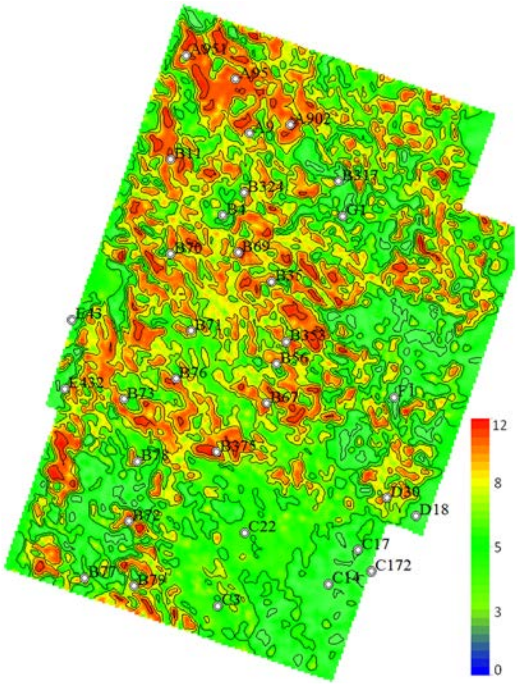

Fig 6 Prediction of the reservoir pattern of the EI3 reservoir in the Z8-18 area

According to the prediction and analysis of the sandstone in the EI oil layer by the model discrimination technique, there are three inflows of underwater distributary channels in the EI sandstone Formation. The most important rivers flow in from the northwest direction and flow southward from A95 well and from E432 well to B71 well. The sandstone is relatively developed. The thickness of the sandstone is generally more than 10m.It is the main oil zone in the area and it is in B76 well to B 67 well. The area is divided into three branches, of which the most important one flows southeast along B67 well to C14 well. The other two rivers flow in from the north east, one from the north via B317 well to B324 well and sink into the river flowing southeast, and the other from the northeast through F1 well to D18 well to the southwest.

Conclusion

The application of well-seismic model discrimination technology has completed a good three-dimensional reservoir prediction of the EI oil layer in the Z8-18 area of Changyang, Daqing. The thickness of the sand body in the EI oil layer of the entire Z8-18 area is relatively thin, and the scale of the plane distribution is relatively small. The relatively small sand bodies are predicted with fine and clear features, which improves the success rate of the wells in the exploration and development phase of the Z8-18 area. The method is applicable to all reservoir predictions with lateral changes in the reservoir with stable strong reflector shielding.

References

[1]Fu Guang, Fu Xiaofei. Main controlling factors and favorable area prediction of deep gas accumulation in Fuyang oil layer in northern Songliao Basin [J]. Natural Gas Geoscience, 2001, 12(3): 20-24.

[2]Liu Wenling. Application of Coordinated Kriging Method in Reservoir Horizontal Prediction [J]. Progress in Exploration Geophysics, 2004, 27(5):367-370.

[3]Ling Yun. Application of Basic Seismic Attributes in Interpretation of Sedimentary Environment [J]. Oil Geophysical Prospecting, 2003, 38(6):620-630.

[4]Lu Xiaoguang, Zhao Hanqing. A fine description of the planar continuity of fluvial reservoirs [J]. Acta Petrolei Sinica, 1997, 18(2):66-71.

[5]Yang Huiting, Jiang Tongwen, Yan Qibin. A preliminary approach to three-dimensional geological modeling of fractured carbonate reservoirs [J]. Petroleum Geology & Oilfield Development in Daqing, 2004, 23(4):11-12.

[6]Li Hong, Liu Yiqun. Stochastic modeling of sand-body of deltaic front in Huachi Oilfield [J]. Journal of Northwest University (Natural Science Edition), 2006, 36(6):957-960.