Research on Modeling Approach of Interlayer in T5 Oilfield

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Abstract. The interlayer plays an important role in the distribution law of remaining oil in the process of oilfield development, and it is of great significance to the later study of remaining oil distribution and the adjustment of oilfield development plans. Synthesize logging data, seismic data, and layering data of T5 oilfield, adopt the interlayer as the structural unit to build 3D model of the interlayer, which effectively reveals the distribution law of the interlayer. On the basis of this model, the facies-controlled modeling technology is used to build the attribute model, and lays a solid foundation for subsequent reservoir research work.

Keywords: facies-controlled modeling, stochastic modeling, interlayer, composite-facies-controlled.

1. Introduction
The oilfield enters into the later development stage of high water cut, remaining oil becomes more fragmented and complex, and multidisciplinary reservoir research has become the main means for quantifying remaining oil research. The interlayer distribution has an important influence on the remaining oil distribution, which has become the key point of geological research at present. T5 oilfield has entered into high water cut stage at present, and it is urgent to study the development law of interlayer in reservoir. In allusion to thick oil reservoir in T5 oilfield, synthesize logging data and layering data to identify and distinguish the internal interlayer, adopt the interlayer as the modeling approach of structural unit to build 3D model of the interlayer, effectively reveal the distribution law of interlayer, and provide important basis for the adjustment of the development plan of the research area and the research on the distribution law of deep residual oil.

2. Geological Survey of T5 Oilfield
T5 oilfield is a semi-anticline structure controlled by faults, it distributes north-east, the top of the structure is gentle and wing is steep. The secondary faults in the oilfield are not well developed, the fault distance is small, except for the H4 fault, it is parallel to the large fault in the south, which extends longer, has a controlling effect on the oil-water relationship, and the structure of the oilfield remains relatively intact. T5 oilfield belongs to large-scale river delta sedimentary complex, the direction of the water flow is perpendicular to the direction of the western Liaoning slope, the river carries sand into the lake to form the short-axis delta. The early delta developed in the northern part of the oilfield, and later it swings to the south to form: each stage of the delta sand body is superimposed and contiguous in the
oil field area; therefore, the reservoir stratum is very well developed. The reservoir has a large porosity and a wide range value, is between 13-45%, mainly distributed between 25-35%, sandstone has a medium permeability value, mainly distributed between 10-100mD, and 100-1000mD interval value is the most developed.

3. 3D Geological Model of T5 Oil Field

3.1. Modeling strategy and process
Fine reservoir modeling is to further finely describe the distribution and development characteristics of lithology, porosity, permeability, and saturation within reservoir in the fine-structured model framework, and finely characterizes the reservoir and heterogeneity in the 3D space of internal attributes.

![Fig.1 Roadmap of 3D geological modeling technology](image)

Fig.1 Roadmap of 3D geological modeling technology

The model types and modeling approach it contains mainly include the following aspects.
Modeling approach of Sedimentary microfacies: on the basis of the fine geological research results (sedimentary microfacies distribution map), use sedimentary microfacies digital software, use assignment approach to directly load into the 3D structure model of the sedimentary unit (single-layer sand) level, realize the building of 3D deterministic sedimentary microfacies model at the sedimentary unit (single sand layer) level.

The interlayer modeling approach mainly includes the following two aspects: first, the deterministic modeling approach is adopted to build the traceable and continuously distributed interlayer model among units. The second is to use stochastic modeling approach to build interlayer model that is scattered in small layers and cannot be traced among wells.

Porosity, permeability, saturation and other attribute modeling approach: the composite facies-controlled lithology model is used as the constraint condition, and the stochastic modeling algorithm is used to build distribution model distributed in 3D space, the reservoir parameters porosity, permeability and other attributes within the characterized sedimentary unit.
3.2. **Interlayer identification**

Synthesize and apply logging explanation interlayer data and single-well microfacies discrimination results to determine the continuity of the interlayer, and determine the interlayer distribution based on the separated layer results. From the single well: the small-layer composite sand body is actually composed of three sets of reverse rhythm sand bodies, combine the analysis of sedimentary cause, the top surface of the lower reverse rhythm sand body should be the sedimentary interface of the three sets of sand bodies, two sets of single sand body can be divided into based on this sedimentary interface. From the multiple wells, more than 80% of the well points have multi-stage deposits; the distribution area interlayers among single sand bodies is large, the interlayers among single sand bodies are mostly lithological or physical interlayers, which can be tracked continuously.

![Fig.2 Interlayer crosswell section](image)

![Fig.3 Distribution statistics graph of interlayer with different thickness](image)

3.3. **Interlayer modeling**

According to the identification results of interlayer, it was decided that the study area adopted the adjustment of the layering position, namely, the bottom interfaces of sandstone top as the new layering position, finely describe the distribution characteristics of interlayer. The facies-controlled method combining assignment and stochastic simulation [1–4] is used to build 3D geological model including the distribution of interlayers.

1. **Modeling of space interlayer of the sedimentary unit**

   The space interlayer of sedimentary unit has the geological characteristics of relatively thick interlayer and stable distribution and strong continuity, the interlayer is incorporated into the layer framework model, and consider as a layer, and the sand-soil interlayer model is built. Facies modeling adopts value assignment approach to build interlayer facies model. The vertical grid is set to 1 grid. 13 interlayer and 20 interlayer models were built in the Suizhong research block.
(2) Interlayer model of interlayer modeling of sedimentary unit (well control range)

Taking geostatistics as the theoretical basis, make full use of stochastic simulation algorithm of professional modeling software, use the geological knowledge and sedimentary microfacies model obtained from the fine anatomy of thick oil layers, in the framework of the structure model, the trend constrains the 3D spatial distribution of the interlayer, and build 3D facies-controlled reservoir lithology model that finely describes the internal heterogeneity of thick oil layers.

(3) Attribute model

From the reservoir sedimentology, the reservoir heterogeneity within the sedimentary microfacies is first manifested in lithology, the lithological distribution characteristics of different sedimentary microfacies have obvious differences, in order to further describe the internal plane and vertical heterogeneity of sedimentary microfacies, synthesize and use the fine description results of oil-water distribution map of the reservoir to build lithology model. Then, the rock-controlling porosity, permeability, and saturation attribute models are built to realize the scientific constraints, and the accurate and high-precision 3D geological model is built[5–6].
Fig. 6 Porosity model

Fig. 7 Permeability model

Fig. 8 Saturation model
(4) Model embedding

Embed the built interlayer model into the built reservoir model, so that the complete 3D geological model containing unit interlayer and interlayer information under the constraints of the structure model is built [7–8].

3.4. Application effect

The fine geological model built by the above approach greatly improves the conformity degree with the actual situation, moreover, the interlayer information is retained when the model is coarsened, it avoids the artificial adjustment of reservoir parameters during the numerical simulation process, and ensures the accuracy and efficiency of the numerical simulation[9]. Block F in the research area carries out numerical simulation on 265.23×10^4 nodes, the relative error between the fitted geological reserves and the actual geological reserves is 1.7%, and the absolute error between the historical fitting comprehensive water cut and the actual comprehensive water cut is 0.3%, the absolute error between the fitting verified recovery degree and the actual verified recovery degree is 0.5%.

4. Conclusion

(1) The 3D display of the development law of the reservoir interlayer model has important guiding significance for guiding the remaining oil research and development plan adjustment.

(2) The coarsening model retains the interlayer information and can more truly reflect the underground reservoir information, laying a solid foundation for subsequent numerical simulations.

(3) The composite facies control approach not only embodies the distribution characteristics of sedimentary microfacies, but also embodies the oil-water distribution mode constrained by structures and faults, making the simulation results closer to reality.

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