An application of sedimentation simulation in Tahe oilfield

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Abstract: The braided river delta develops in Triassic low oil formation in the block 9 of Tahe oilfield, but its sedimentation evolution process is unclear. By using sedimentation simulation technology, sedimentation process and distribution of braided river delta are studied based on the geological parameters including sequence stratigraphic division, initial sedimentation environment, relative lake level change and accommodation change, source supply and sedimentary transport pattern. The simulation result shows that the error rate between strata thickness of simulation and actual strata thickness is small, and the single well analysis result of simulation is highly consistent with the actual analysis, which can prove that the model is reliable. The study area belongs to braided river delta retrogradation evolution process, which provides favorable basis for fine reservoir description and prediction.

1. Introduction

The block 9 of Tahe Oilfield is located in the northeastern of the Tahe Oilfield (Figure 1). The tectonic position is in the south of the Shaya uplift of the Tarim Basin. It is a tectonic-controlled anticline reservoir with an area of 10km^2. Triassic low oil formation is a braided river delta sedimentary system, and the oil-bearing interval is about 20 meters in the upper part of the low oil formation, and it is a braided river delta plain and braided river delta front deposition system with the source from the north east. Due to the lack of drilling data and coring data, coupled with the smaller thickness of the study interval, it is difficult to analyze the sedimentary evolution with seismic data, and the precision of the study can not meet the requirements of the late reservoir. Numerical simulation is a comprehensive study of geological system and geological deposition process by logical or mathematical description method. The quantitative mechanism is used to verify the deposition mechanism and analyze the spatial evolution of the deposition system. Therefore, this paper explores the formation process and sedimentary evolution of braided river delta in the study area by sedimentary simulation method.

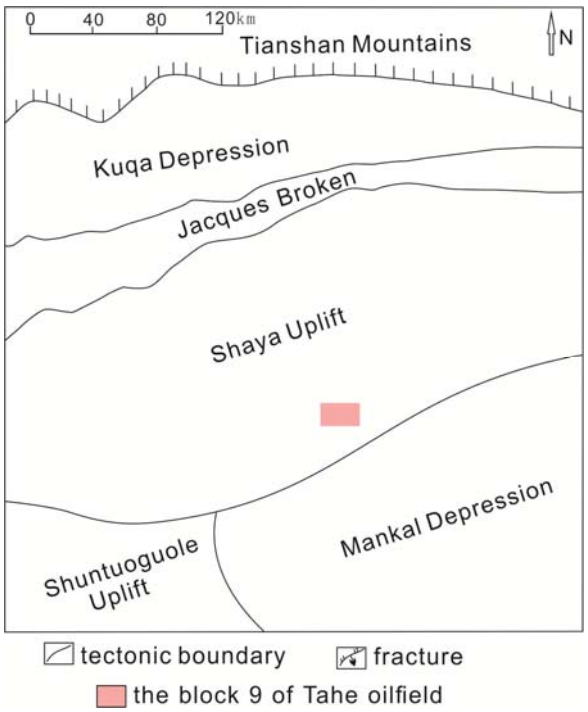

Figure 1. Location sketch map of block 9 in Tahe oilfield.

2. Research ideas

In view of the complexity of the stratigraphic deposition process, predecessors believe that stratigraphic numerical deposition simulations are impossible to achieve, Burton et al. (1987) argue that stratigraphic numerical deposition simulations are theoretically impossible. However, based on the different understanding of formation and deposition processes and their interrelationships, Cross (2000) argues that there is sufficient information in the formation and that the reconstruction of basin sedimentary history by quantitative methods is both theoretical and practically feasible. At present, the Dionisos software is more mature to apply in stratigraphic numerical deposition simulation. Based on the principle of sequence stratigraphy, the complex interaction between the accommodating space (including sedimentation and lake level change), source supply and sediment transport is simulated by quantitative analysis, and the evolution process of reservoir deposition under various depositional environments is simulated, and the isochronous sequence stratigraphic framework and sand body distribution model are established, which provide quantitative sedimentation model for sedimentary facies study, sand body development and distribution. Aiming at the research status of the target layer of the Triassic low oil formation in the block 9 of the Tahe Oilfield, the technical route of the numerical sedimentation simulation method is proposed (Figure 2).

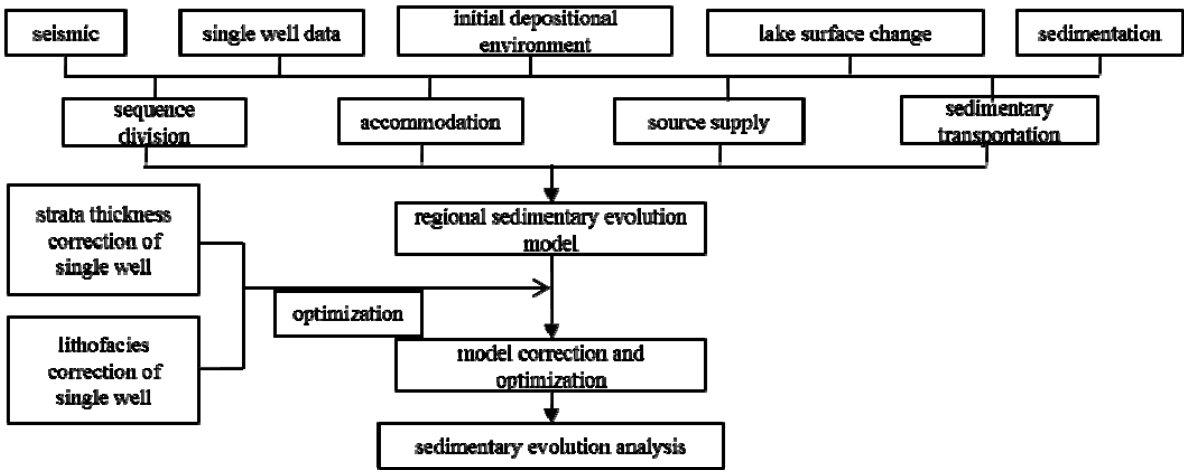

Figure 2. Technology route of sedimentary simulation method.

3. Simulation parameter extraction

The key of the application of the deposition simulation method is mainly in the input parameter selection, simulation results analysis and application. In the simulation, it is necessary to define the model in the study area, determine the initial depositional environment and the sequence division, and make the relative lake level curve, and obtain the relevant parameters such as accommodation, source supply and sediment transportation.

3.1. Model definition

Due to the size of the study area is small, the simulation area is 5.5km × 3.5km, and the grid size is 0.1km, and the simulation time is 235~234Ma and the time step is 0.05Ma. The main lithology includes coarse sandstone, fine sandstone (Medium sandstone) and silt mudstone.

3.2. Sequence division

According to the base - level cycle theory proposed by Cross, the sequence is divided according to the core and logging data. From the logging curve and the core analysis, it is found that there is a stable and thick mudstone deposit at the top and bottom of the target layer. The thickness of the sandstone gradually reduces and the mudstone increases from bottom to top, and the whole is a positive rotation.

3.3. Initial base water depth

The initial base water depth refers to the depth or shape of the initial time basin. Based on the underlying tectonic map, lithology, stratigraphic thickness variation and regional sedimentary characteristics, the paleo-topography and paleo-water depth were deduced, and the initial water depth was obtained.

3.4. Accommodation changes

According to the lithology and logging data of the coring well and the sedimentary environment represented by it, the relative lake level curve is estimated. During the depositional period of the study area, the change of the lake is relatively simple, which is the rising process of the lake water.

3.5. Source supply and sedimentary transportation

The total amount of source supply is estimated from the thickness of the formation, and then the supply rate and lithology ratio of the different sedimentary period are calculated according to the sedimentary facies distribution and the lithological cycle of typical well. Finally, the change of the supply rate of the source with time is defined. Because the delta is mostly hydrodynamic

transportation, the particle transportation method in the delta sedimentary environment is dominated by long-term low energy transport by the grain size analysis data. According to the particle size analysis data, hydrodynamic, sedimentary area slope and sediment transport mode, the software automatically estimates the transport factors of various lithology.

4. Simulation results analysis

The results show that the simulated thickness has a high degree of coincidence with the well point, and the error rate does not exceed 10%, and most of less than 5% (Table 1), which indicates that the model is highly reliable.

Table 1. Error analysis of formation thickness and simulated thickness.

Well	Actual thickness(m)	Simulation thickness(m)	Error rate (%)
TK9-J1	17.67	17.26	-2.38
T912	18.03	18.08	0.28
TK910Hd	18.67	18.54	-0.7
TK907Hd	21.56	20.33	-6.05
S100	15.02	16.59	9.46
S95	15.88	17.54	9.5

In addition, the comparison of the single well analysis of the real drilling is compared with that of the simulation. From the figure 3, we can see that the coarse sandstone decreases from the bottom upwards with the rise of the lake level. And the sedimentary facies evolved from the braided river delta plain to the braided river delta front. The simulated single well facies distribution is consistent with the real drilling, and the reliability of the model is proved from several aspects.

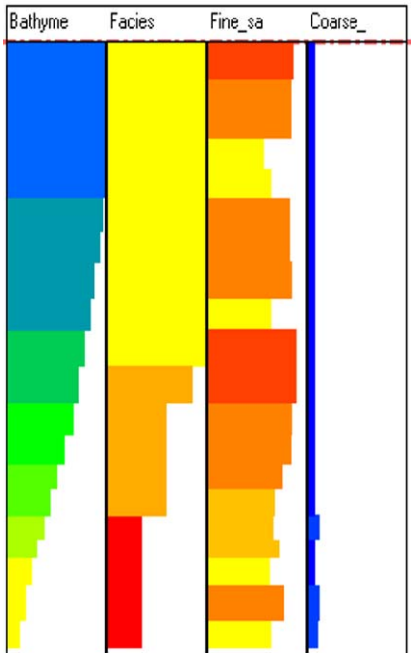

Figure 3. Comparison of the single well analysis.

According to the preferred regional sedimentary evolution model, the sedimentary evolution of the study area is analyzed and summarized. From the simulation sedimentary process of the study area (Figure 4), it can be seen that during the period of 235.85Ma, the study area is braided river delta plain deposition area as a whole. During the period of 234.65Ma, with the rise of lake water, the depositional area of braided river delta plain continued to descend to the northeast direction of the source, and the area of the braided river delta front was gradually expanded. During the period of 234.4Ma, the sedimentary area of braided river delta plain continued to migrate to the source, and the depositional extent in the study area was further reduced, while the braided river delta front area

covered most of the area. During the period of 234Ma, with the further deepening of the lake water, the braided river delta plain deposits exit the study area, and extensively developed braided river delta front sediments. The simulation results are in good agreement with the results of the conventional analysis. The study area is a retrogradation sedimentary evolution process with the rising of the base level and the lake water (Figure 5).

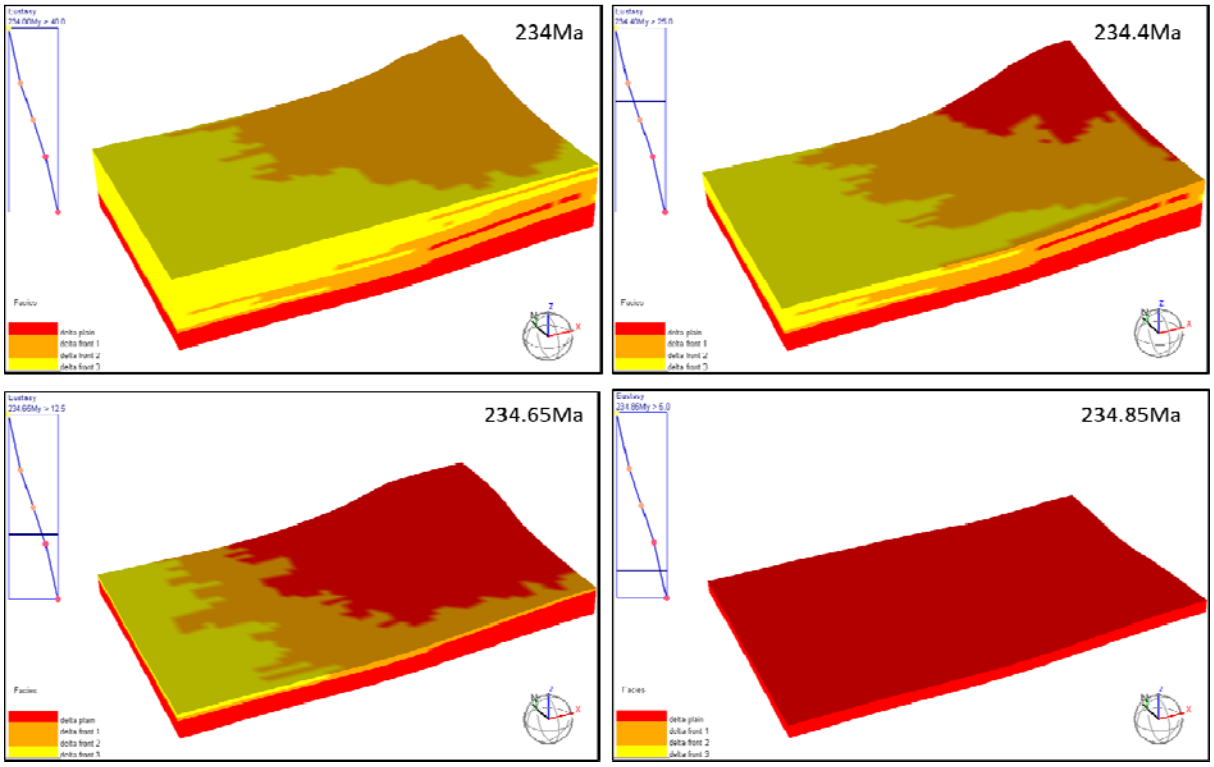

Figure 4. Sedimentary simulation evolution process of the study area.

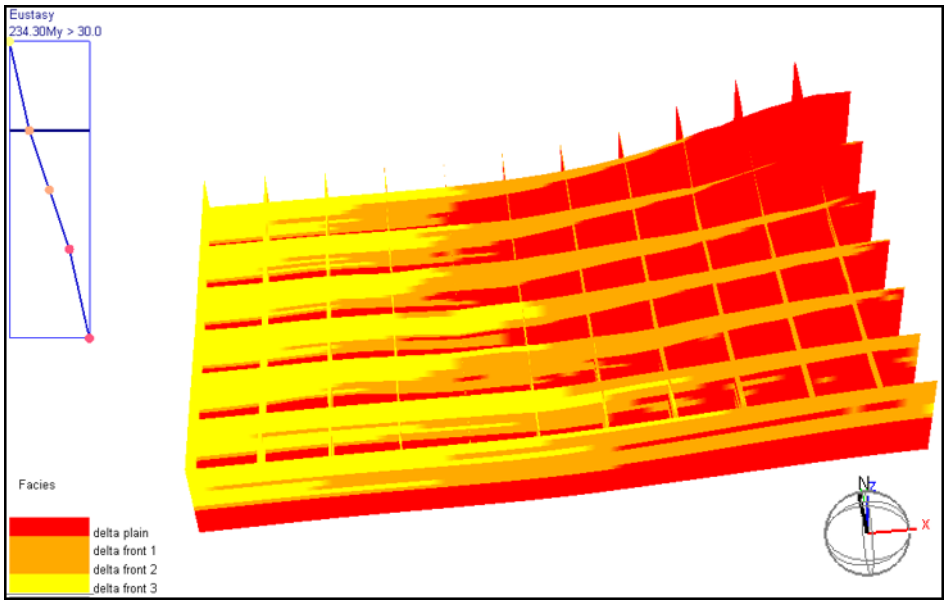

Figure 5. Sedimentary fence diagram of the study area.

5. Conclusion

The Dionisos software is used to study the sedimentary simulation of the Triassic low oil formation in the block 9 of Tahe Oilfield. The reliability of the model is verified from the aspects of single well strata thickness and single well lithofacies analysis, and the simulation result is in good agreement with the conventional analysis. The study area belongs to the braided river delta retrogradation sedimentary evolution process with the base level rising and lake level increasing.

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