Variation regular and influencing factors of pore and permeability parameters of each oil layer of block A

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Abstract. The porosity and effective permeability values of an oil layer in different periods of the same block are quite different. It is proposed to take the actual production target interval and small block in block A as the unit, by analyzing the results of laboratory water flooding experiments and using the data of coring wells and exploration wells in the study area, as well as the data of static database, the variation rules of porosity and effective permeability in different development stages are summarized. After comprehensive study, it is found that the change of parameter interpretation model and water injection development are the main factors for the change of hole and permeability parameters of well completion logging interpretation in different periods in block A.

1. Introduction
The study of reservoir performance determines the development plan and effect, porosity and permeability are the key parameters to characterize the characteristics of fluid flow, its accuracy seriously affects the accuracy of reservoir 3D geological modeling and flow unit division, which makes numerical simulation difficult \(^1\). After the injected water enters the reservoir, the reservoir property parameters have changed greatly, at present, most of the researches are microscopic changes or comparing the interpretation of porosity and permeability with the data of coring wells in this area to judge its accuracy \(^2\). Through the study of porosity and permeability variation rules and influencing factors of each well pattern, the accuracy of porosity and permeability parameters will be comprehensively judged from the vertical and horizontal aspects in the same period.

2. Variation of pore and permeability parameters of experimental reservoir with water flooding development
Select the rock samples that have not been flooded in the sealed coring well or oil-based mud coring inspection well in block A, using a large amount of water to carry out water flooding indoors can simulate the changes of reservoir parameters in a short time under the condition of long-term water flooding, the experimental data of 22 core banks and 13 fresh cores were collected. The experimental procedures were as follows: Firstly, the porosity, permeability and other reservoir parameters of rock samples are measured, then, the rock sample is waterflooded with 1000 times of pore volume water, and the reservoir parameters of the rock sample are determined again after waterflooding. After washing, the clay mineral composition changes, the content of kaolinite decreases, the content of illite increases, and the content of chlorite remains unchanged. Medium water washing shows that the proportion of larger pore throat with radius of 10 \(\mu\)m increases after water washing, and the pore throat that contributes to permeability increases; Strong water washing can increase the proportion of pore throat with a radius of 16 \(\mu\)m after water washing. It can be seen that the main modification of strong
water washing is large pore throat, but the effect on small pore throat is small. After water flooding, the permeability of core bank and fresh core increased by 31.0% on average, Among them, the permeability of rock samples in the core library increased by 17.9% on average, The permeability of fresh rock sample increases by 44.1% on average, the reason for the difference is the permeability difference of reservoir rock samples, while the porosity increases slightly, with an average relative increase of 0.3-0.4%.

3. Variation of porosity and permeability parameters in different periods of core analysis
In order to comprehensively analyze and compare the data of coring wells and exploration wells in block A, based on the principle of adjacent well location, different drilling time and comparable horizon, it is optimized that the geological conditions in the east block of block A are favorable apricot a, apricot b, apricot c and the west block of block A apricot d, apricot e the coring data points of two groups of wells are analyzed. According to the existing data, it is found that the porosity and permeability of the primary infill well pattern and the basic well pattern of a reservoir in block A increase by 4.9% and 19.5%, respectively; The porosity and permeability of secondary infill pattern and basic pattern increase by 5.1% and 69.5%, respectively; Compared with the basic well pattern, the porosity and permeability increase by 5.2% and 187.9% respectively.

4. Variation law and influencing factors of pore and permeability parameters in well completion logging interpretation in different periods

4.1. Variation law of pore and permeability parameters interpreted by completion logging in different periods
Based on the static database of pure oil area from block x 8 to 13 in block A, 4144 wells in 6 small blocks were retrieved and extracted. Well logging porosity and permeability distribution maps of development wells in different blocks are drawn(as shown in Fig. 1 and 2). As can be seen from figures 1 and 2, the porosity distribution of the reservoir changes little during the primary and secondary infilling, but the porosity calculated by logging in the third infill period is lower than that in the first infill period and the second infill period, In particular, areas A 10, A 11 and A 12 are the most prominent. And from the mean value, the porosity interpreted by primary infill logging and secondary infill logging is similar to that of coring well, however, the porosity of logging interpretation of tertiary infill wells is much lower than that of coring wells. The difference of porosity interpretation system in different periods mainly focuses on the difference of interpretation model.

Figure1. Distribution of logging porosity in different development stages of an oil layer in block a 10
The effective permeability of primary infill logging and secondary infill logging interpretation is higher than that of basic well pattern logging interpretation; Especially, the effective permeability of secondary infill well logging interpretation is much higher than that of basic well pattern, the effective permeability of block A 8 and block A 9 is even several times of the basic well pattern; The effective permeability of three infill well logging interpretation is slightly higher than that of basic well pattern logging interpretation, but the effective permeability is much lower than that of secondary infill logging and primary infill logging.

4.2. Influencing factors of pore and permeability parameters in logging interpretation of completion well in different periods

For 50 years, the change of interpretation model of porosity and air permeability can be divided into three main stages: (1) Horizontal logging interpretation stage of basic well pattern \(^{[3]}\); (2) Logging interpretation stage of water flooded zone in adjustment well pattern \(^{[4]}\); (3) New series logging interpretation stage \(^{[5]}\). In order to study the factors that affect the variation of pore and permeability parameters in the interpretation of well completion logging in different periods, the applicability of porosity and effective permeability model in logging interpretation is analyzed, the distribution range and mean value of porosity and effective permeability of exploration wells, closed coring inspection wells and infill production wells are compared. The results show that: (1) There is little difference between the porosity of inspection wells and that of exploration wells in different infilling periods, that is to say, with the development of the oilfield, the change of porosity is not great, which is consistent with the previous water drive experimental results; (2) The porosity calculated by primary infill pattern and secondary infill pattern is similar to the average porosity of exploration wells and closed coring inspection wells in the same infill pattern period: The porosity calculated by three infill well patterns is much smaller than the average porosity of exploration wells and closed coring inspection wells in the same infill well pattern period, and the error is large. This shows that the porosity calculated by production wells during the period of primary infill pattern and secondary infill pattern can basically reflect the reservoir porosity at that time. The calculated porosity of production well is obviously lower than the actual situation in the period of three infill well pattern, the applicability of the logging interpretation model needs to be strengthened, which is one of the reasons for the large porosity error in the logging interpretation of three infill patterns; (3) The effective permeability of the closed coring inspection well in different infilling periods is higher than that of the exploration well, this phenomenon is caused by the increasing permeability with the development of water flooding in the oilfield, which is consistent with the previous experimental results of water flooding; (4)There is little difference between the effective permeability calculated by basic well pattern and that of exploration well: The effective permeability calculated by primary infill pattern and secondary infill pattern is higher than that of closed coring inspection well in the same infill pattern period: However, the effective permeability of three infill well pattern is smaller than that of closed coring inspection
well in the same infill well pattern period, and the effective permeability of three infill well pattern interpretation is much lower than that of one infill and two infill well pattern interpretation, this is in contradiction with the increasing permeability with the development of water injection. Therefore, the applicability of effective permeability model of primary infill, secondary infill and tertiary infill well pattern needs to be strengthened, this is one of the reasons for the large error of effective permeability in logging interpretation in different infill well pattern periods.

5. Conclusion
(1) In block A, the distribution of reservoir porosity has little change during the period of primary infilling and secondary infilling, but the porosity calculated by logging in the third infill period is lower than that in the first infill period and the second infill period.
(2) The effective permeability of primary infill logging and secondary infill logging interpretation in block A is higher than that of basic well pattern logging interpretation; The effective permeability of triple infill logging interpretation is slightly higher than that of basic well pattern logging interpretation, but much lower than that of secondary infill and primary infill logging interpretation.
(3) The change of parameter interpretation model and waterflooding development are the main factors for the change of hole and permeability parameters of well completion logging interpretation in different periods in block A.

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