IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 05, Issue 10 (October. 2015), ||V1|| PP 34-39

The research of the water-flood law and the geological characteristic of the low permeable oil fields water flooded layer in the east of Daqing placanticline

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Abstract: In view of high water cut and low interpretation coincidence rate on the low permeability water-flooded zone in the east of Daqing placanticline, research for flooding mechanism, identification methods, well logging series and logging interpretation of water-flooded zone. Based on analyzing logging and geological data in this region, in view of geological characteristics, the water-flooded regularity has been studied, distinguish standard of the low permeability water-flooded zone has been built creatively, synthetical logging interpretation method has been proposed. therefore, water-flooded zone interpretation precision has been raised in the east of Daqing placanticline.

The results have been widely applied in the low permeability water-flooded zone in the east of Daqing placanticline, compared to production data, it shows that the results have higher value in actual application and have instructive function for low permeability oilfield.

Keywords：*water-flooded zone;; interpretation method;; low permeability oilfield;; distinguish standard*。

I. INTRODUCTION

The main oil layer of the Chao Yang Gou fieldwide waterflood is Fuyu layers, the verticality a nd horizontal of s permeable and low-porosity oil deposit. The lithology of the reservoir is dense, calic hes distribute many, the sandstone is a long strip distribution, the plane connectivity is poor; the layer developed faults.

The main oil layer of the Tou Tai fieldwide waterflood is Fuyu layers, the lithology of the reservoir is dense, the thin sand-shale interbed developed, the verticality and horizontal of sandstone changed a lot , the sandstone is a long strip distribution, the plane connectivity is poor.

The main oil layer of the Sheng Ping fieldweide waterflood is Putao Hua layers,the layer si medium-porosity and medium permeable oil deposit. The main lithology of the oil layer is celadon-lightgray siltstone and mudstone, the wettability of the stone is hydrophilic; shale content is about 10.4%. The average oil saturation is 57%, the effective porosity between 22.7% and 23.7%.

In the above mentioned blocks oil layer, the porosity is low, the permeable is poor, oil saturation is low, the bound water saturation is high ,made the oil layer resistivity low, the decline of resistivity is not obvious after oil layer being water flooding; the reservoir is dense, caliche developed, raised the oil layer resistivity, the difficulty of identifying watered-out layer increased; infill well after per formation, easy to mistake the high water flooded layer perforated, the well present the phenomenon of the high water cut. Therefore it is necessary to develop a set of suitable for the oilfield water flooded layer sedimentary rhythm and logging curve to meet the needs of oilfield development and production.

II. RESEARCH ON THE LAWS OF THE DIFFERENT SEDIMENTARY RHYTHM FORMATION WATER FLOODED

Reservoir heterogeneity of the east of Daqing placanticline is serious, sedimentary rhythm is various types, the variational law of stratigraphic lithology and physical property is different, the water-flood law is also different after water flooded layer. Different rhythm law of formation water is as follows:

1. The water flooding law of uniform formation

The lithology and physical property of the formation changed little, relatively homogeneous , stationary Reflect the stationary hydrodynamic condition at that time, present a box or a bell in the resistivity logs、 gamma ray curve and self-potential curve on the log .(Fig 1)

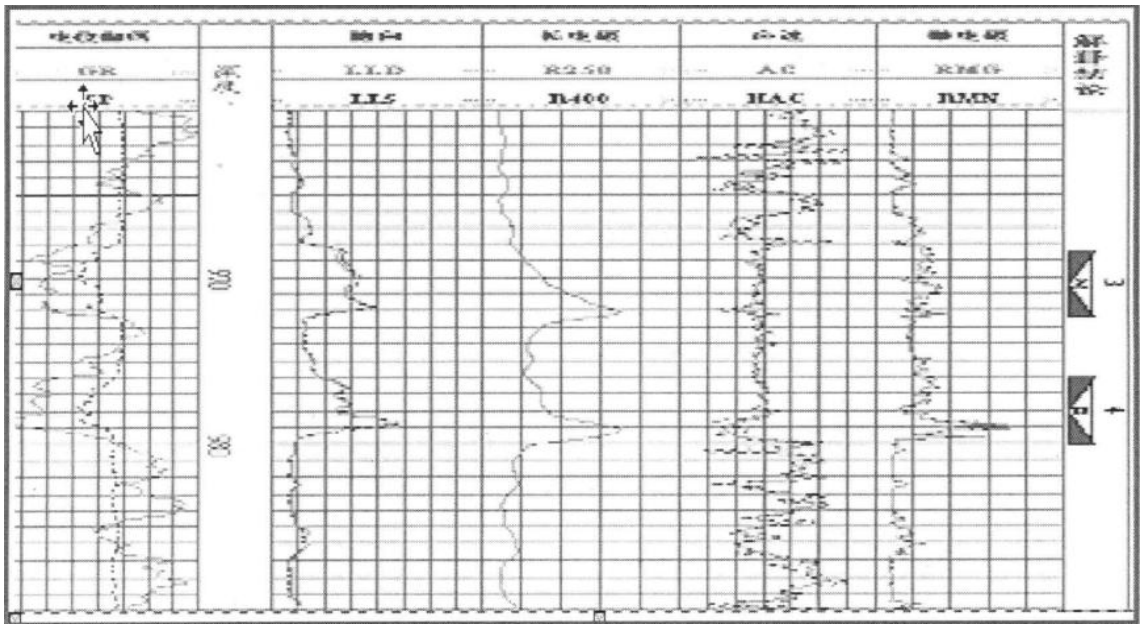

Fig 1 Illustrations of homogeneous formation water flooded

2. The water flooding law of positive rhythm formation

From the bottom of the reservoir to the top, sandstone particles change from coarse to fine, porous condition change from good to bad, reflects the water back - water into sedimentary environment at that time and the changing process which hydrodynamic condition change form strong to weak. Reflects on the log the apparent resistivity curve values change from big to small and the trend of the gamma curve values change from low to high. (Fig 2)

The reservoir presents the obvious characteristics of bottom water flooded, on the log mainly p resents the apparent resistivity curve values descend obviously, the round, the SP raised unusually, micr oelectrode curve value reduced, sound value bigger. The condition of these formations is the serious bo ttom water flooded and light top water flooded, the main cause of this condition is that the injected w ater often permeate along the best formation permeability, the top lithology permeability of the positi ve rhythm formation is bad while the bottom is the best, the injected water firstly turn into the botto m, the stress of the east of Daqing placanticline Is generally very low, there is no enough energy to make the injected water go into the top formation which the porosity-permeability condition is bad, the injected water make the water channel at the bottom formation after repeated erosion, the formation wa ter content rising quickly, result in the formation highly flooded.

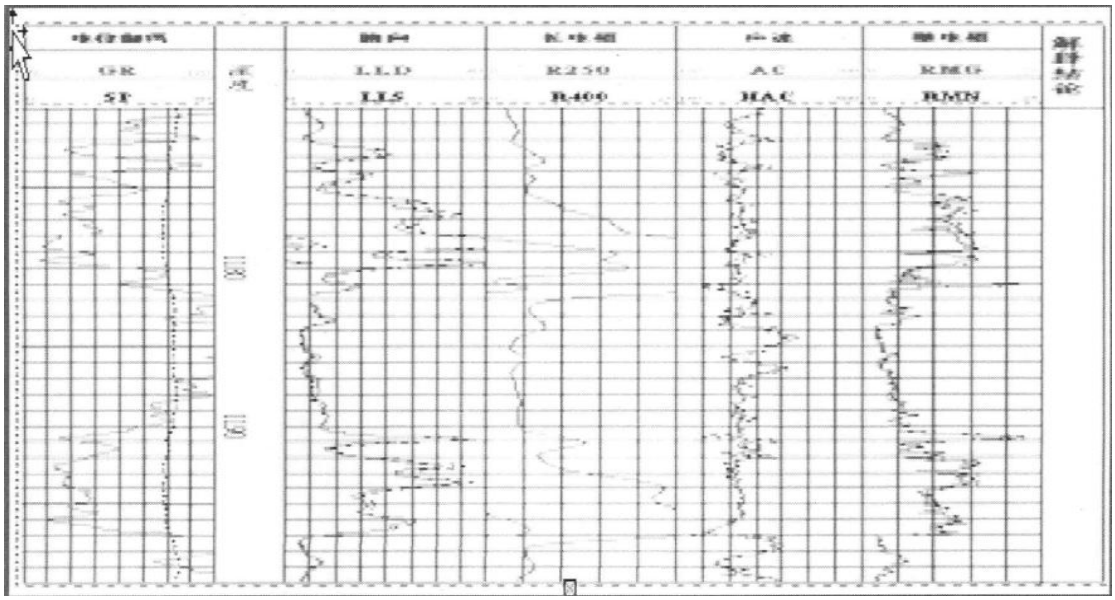

Fig 2 Illustrations of positive rhythm formation water flooded

3. The water flooding law of compound rhythm formation

Due to many deposition and superposed reservoir , thickness is quite big , the layer can subd ivide several positive and reverse rhythm formation, the lithology and physical property changed a lot, r eflects the water back - water into sedimentary environment at that time. The condition of the permeabi lity and porosity of the middle and lower part of the formation is best, on the log can see the superpo sition of many rhythm sandstone. Formation presents diversity after water flooded.

The log reflects in the water flooded layer, apparent resistivity curve decreases obviously, sp amplitude value anomalies, microelectrode curve value reduced, sound wave curve value bigger. (Fig 3)

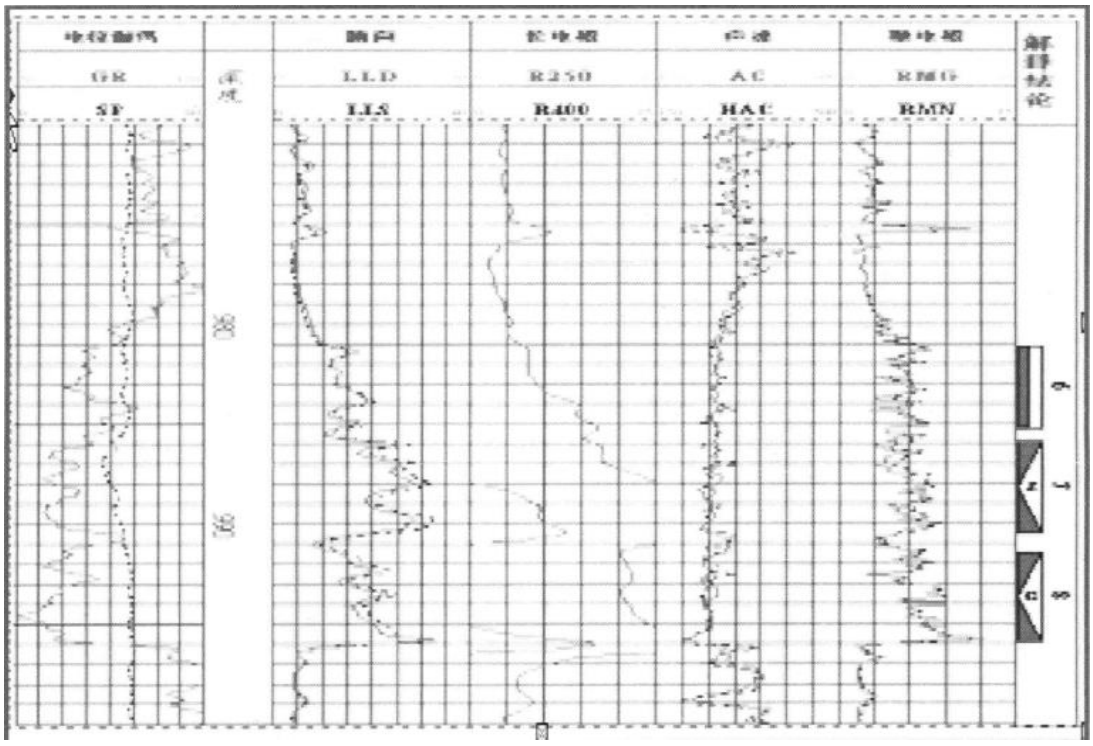

Fig 3 Illustrations of compound rhythm formation water flooded

4. The water flooding law of reverse rhythm formation

There is not many reverse rhythm formation in the east of Daqing placanticline, often compose with other positive rhythm formation into compound rhythm formation, from the top of the reservoir to the bottom, sandstone particles change from coarse to fine, the rock physical property from good to bad , reflects the changing process which the hydrodynamic environment changed from weak to strong.

The injected water firstly go into the formation which the physical property is good, by the water flooded degree increasing, the formation stress higher, due to the gravity, the middle and lower part of the formation slowly water flooded, on the log it reflects apparent resistivity curve value descended and the amplitude value of all layer is homogeneous, sp amplitude increased.

III. RESEARCH OF THE WATER FLOODED LAYER LOGGING CURVE CHARACTERISTICS

Low permeability reservoir after water flooded, rock affected by injection water washed repeatedly, big changes have taken place in the pore structure of the rock, fundamental changes in the formation fluid properties. Permeability and porosity condition of low permeability formation itself is very poor, in the east of Daqing placanticline, the stress of formation is low and the different reservoir water salinity, on the log curve formed different characteristics after oil layer being water flooding.

1. watered-out characteristics of logging curve

(1) the apparent resistivity curve values descend, smooth curve shape

Fluid properties of the formation changed after water flooded. Within the pores of the rock water displace the oil, resistivity amplitude obviously descend ,the curve shape changed from sharp to smooth, when the serious water flooded at the bottom of the R25m curve the maximum elevation.

(2) the microelectrode curve value reduced and appears positive variance

Formation fluid properties in the original is given priority to with oil into the oil-water coexistence or is given priority to with water, result in microelectrode curve values obviously lower, due to the porosity of formation bigger, the penetrating power increased, the permeability obviously bigger, easy to form mud cake , make the microelectrode curve and micro gradient curve appear the big positive variance.(Fig 4)

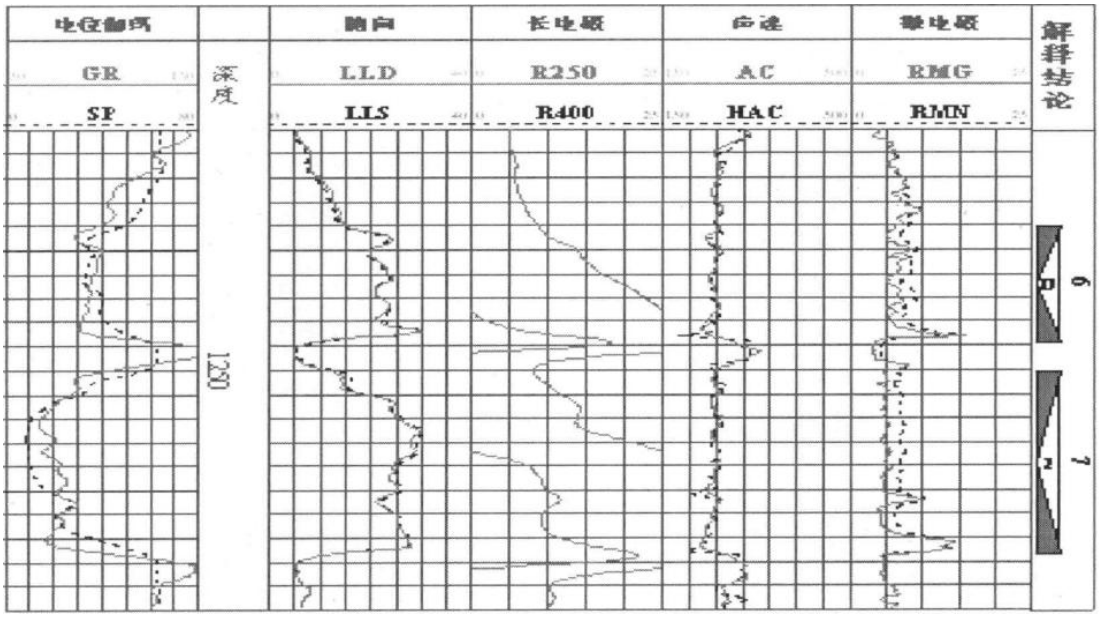

Fig 4 watered-out characteristic of resistivity curve

(3) self-potential curve appears unusually

The difference of the water flooded characteristic of the Sp curve of the different geological conditions regions is big, sp amplitude is positive anomaly or negative anomaly or without difference. In some formation present a spontaneous potential baseline shift. (Fig 5)

Sp presents different watered-out characteristics due to the large range of formation water salinity changes and the original formation pressure is low.

Sp curve shows the following several kinds of anomalies:

A: Spontaneous potential baseline shift (Fig 5)

B: SP negative anomaly amplitude increased, mainly due to the water content increased , Ion diffusion ability enhancement, the adsorption potential increased;

C: Sp amplitude decreases; in the middle and later periods of the fresh water flooded, the mixture concentration of the formation decreased, smaller diffusion potential, result in sp amplitude decreases even appears positive anomaly.

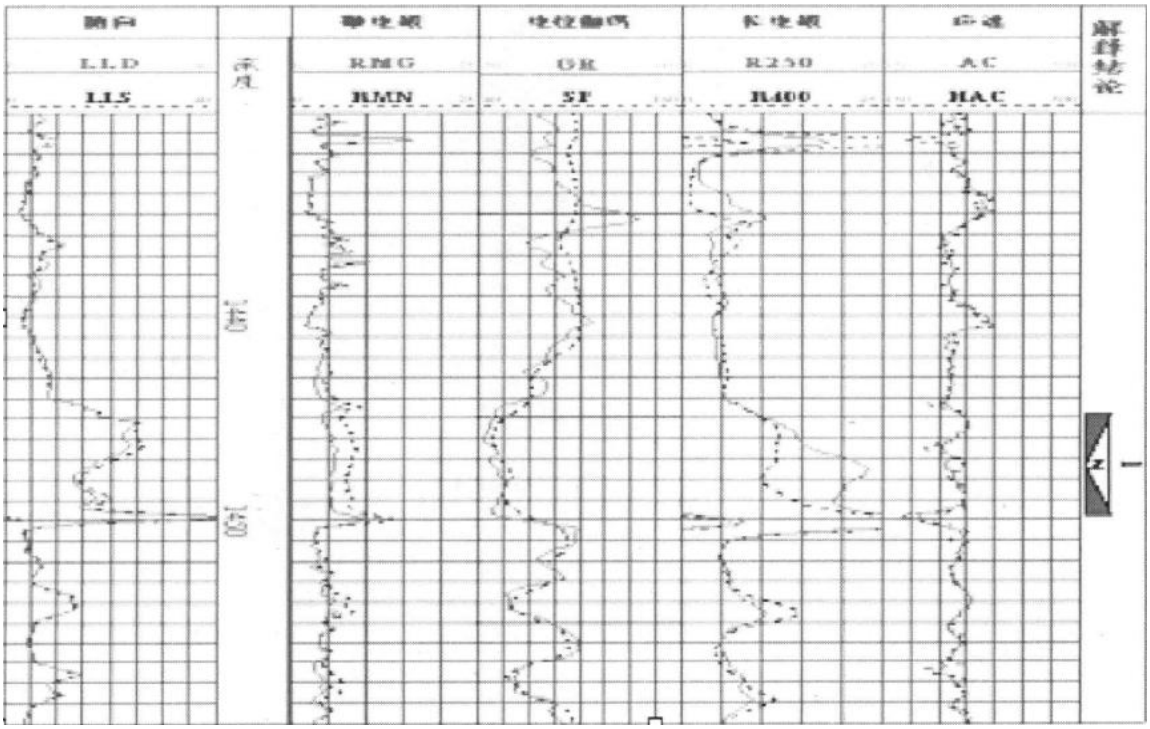

Fig 5 Watered-out characteristics of sp

(4) compensated sonic values increased

The injected water replace the oil , the formation washed repeatedly by water, take the argillaceous and part of cement of the hole, make the change within the rock pore structure, pore throat radius increased, sound value higher. The other reason is the porosity of formation itself is big, the part of formation which the condition of porosity-permeability is good often be water flooded.

IV. CONCLUSION

By means of the research of the geological characteristics and the study of sedimentary rhythm about the low permeable oil fields water flooded layer in the east of Daqing placanticline, summarizes a set of water flooded reservoir rule and qualitative water flooded layer interpretation method. Studied the positive rhythm, reverse rhythm, uniform rhythm, compound rhythm formation. Studied the water flooded layer logging curve:

the apparent resistivity curve, microelectrode curve, sp, compensated sonic value curve characteristics. For low permeability oilfield water flooded layer research has been widely used, through the comparison analysis and actual production data show, the results of the study has high practical application value, for other low permeability oil field water flooded layer interpretation has a certain guiding role.

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