Fine dissection of meandering river sand bodies under dense well nets

Ye Liu, Hong Lu, Yun Hu

College of Earth Sciences, Northeast Petroleum University, Daqing, China

Abstract: The main oil layer of Grape Flower in X Oilfield has entered the late stage of high-extra-high water cut, and the remaining oil distribution is uneven, so as to ensure the development effect of the purpose block. Based on the theory of fine sedimentology, the sedimentation characteristics of $PI1_1$ and $PI2_1^2$ deposition time units were studied. Combined with the sedimentary and logging data of the meandering river delta, the logging facies model was classified in detail and established. Eleven microfacies of 2 subfacies in the delta and the delta shunt plain were identified. $PI1_1$ and $PI2_1^2$ deposition microphase layout maps were drawn. According to the sedimentary microfacies and conventional flooded logging interpretation data, four flooding distribution histograms were plotted to obtain the residual oil distribution law. The research results provide theoretical support for the later development adjustment.

Keyword: Deposition time unit; logging phase model; sedimentary microfacies; flooding characteristics; Residual oil distribution.

1. Introduction

Since the early stage of development,XB Development Zone has been explored and developed for more than 60 years, and has experienced the layout of the basic well network, the first encryption adjustment, the second encryption adjustment, the third encryption adjustment, and the polymer flooding [1-6]. The main oil layer of the grape flower has entered the late stage of high-high water cut, with low recovery and very little production, and after long-term water injection, most of the remaining oil is stored in the sand body at different scales. XB Development Zone is a new type of anti-salt polyflooding promotion block, and the degree of sand body cutting and stacking is different, and the internal connection degree is different, resulting in large differences in the residual oil in different sand bodies.

he main reservoir PI1 and PI2 oil layer sand bodies in Q area are mainly dominated by the delta front margin and the delta diverted plain[7], and under the guidance of the principle of sequence stratigraphy, the PI oil formation in the northern part of the Changyuan X oilfield in Daqing was finely divided and compared with the sedimentary time units, and the isochronous stratigraphic lattice of the target layer was established[8]. The logging facies model was established by identifying the logging data under the guidance of the sedimentary model [9]. The flooding characteristics of different sedimentary microfacies were used to further illustrate the important influence of physical properties on the remaining oil.

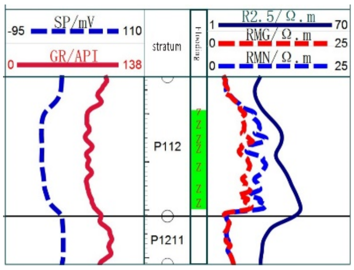
2. Overview of the study area

The central test area of Q area is located in the northern part of Daqing Changyuan X oilfield in the Songliao Basin [10]. Three rows from Q6 District to the north, and one row to Q8 District to the south. The study area is an anticline structure, which has the characteristics of a gentle structure and basically symmetrical wings. The target layer is the oil layer of grape flower in the first section of the Yaojia Formation. The PI1 reservoir is a delta intra-delta leading edge deposit, and the PI2 reservoir is a delta shunt plain sediment. The PI1 reservoir group and PI2 reservoir group in the test area were divided into $PI1_1$, $PI1_2$, $PI2_1$ and PI22 deposition units, and the $PI2_1$ deposition units were subdivided into $PI2_1^1$ and $PI2_1^2$ deposition units. Take $PI1_2$ and $PI2_1^2$ deposition time units as examples.

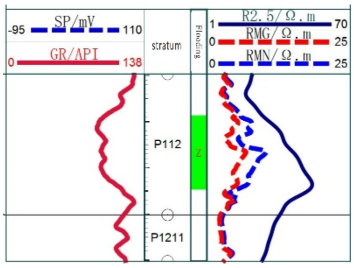
3. Sedimentary facies features

3.1 Well logging phase establishment

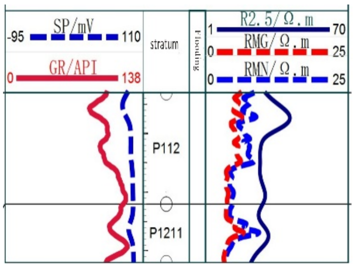
According to the differences in sedimentary environments in the study area, logging curves such as GR, SP, RMG/RMN were selected for comprehensive analysis and judgment, and 10 logging facies models of the leading edge subfacies in the delta and 11 subfacies modes of the delta shunt plain were established in the study area according to the different energy units (Figure 1).



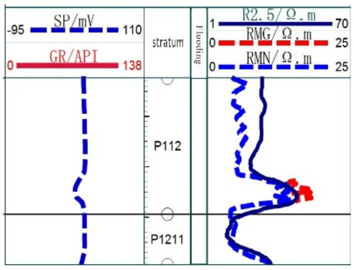
a.Underwater main river channel Q-Q-933 ($PI1_2$)



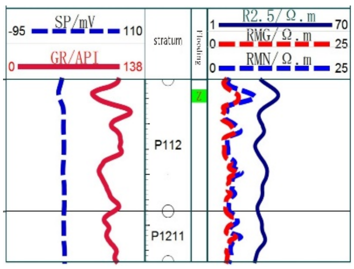
b.Underwater first-class river channel Q-Q-626($PI1_2$)



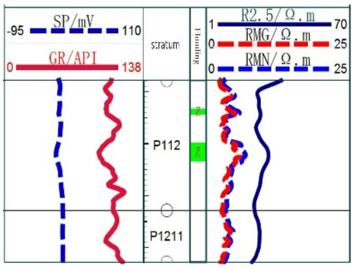
c.Underwater secondary river channel Q-Q-624($PI1_2$)



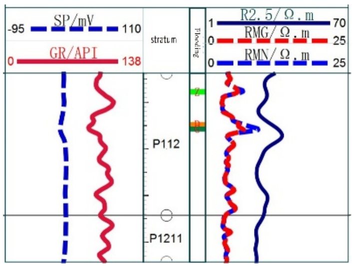
d.Underwater three-level river channel Q-Q-26($PI1_2$)



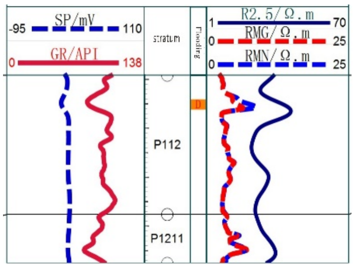
e.Underwater natural dike Q-Q-932($PI1_2$)



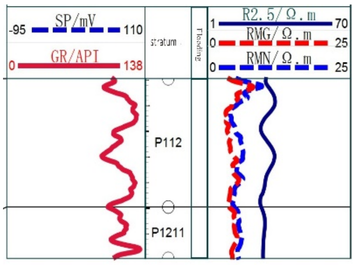
f.Underwater breaking fan Q-Q-930 ($PI1_2$)



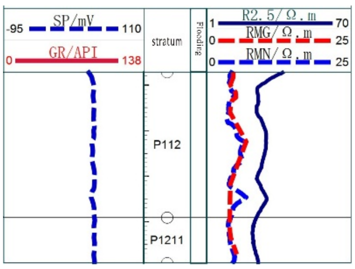
g.Thin layer sand body Q-Q-728($PI1_2$)



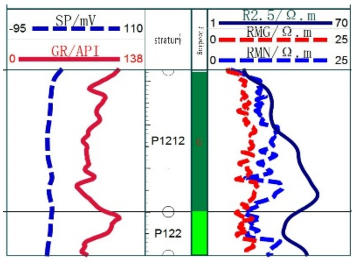
h.Thin layer sand constant Q-Q-729($PI1_2$)



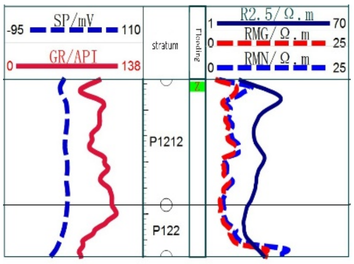
i.Thin layer sand edge Q-Q626($PI1_2$)



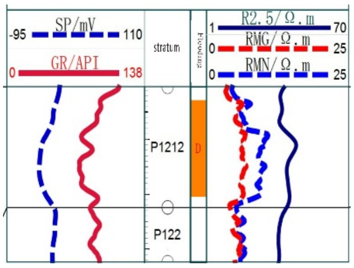
j.Underwater diversion bay Q-Q-123($PI1_2$)



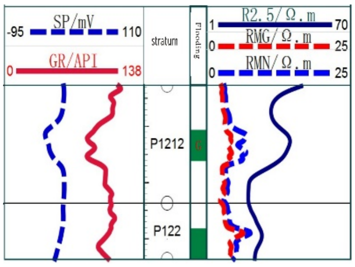
k.Main river channel Q-Q-Q740(PI2_1^2)



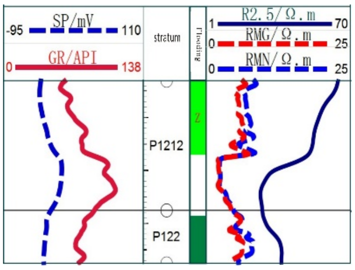
p.Natural dike Q-Q-Q635(PI2_1^2)



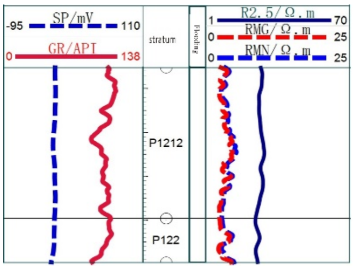
l.I-type river channel Q-Q-Q945(PI2_1^2)



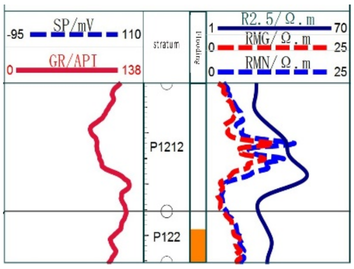
q.Break the fan Q-Q-Q943(PI2_1^2)



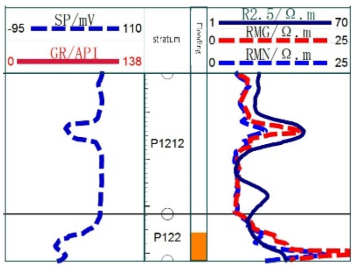
m.П-type river channel Q-Q-Q946(PI2_1^2)



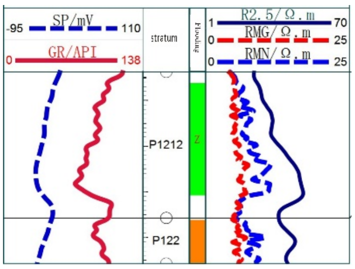
r.Overflow sand body Q-Q-951(PI2_1^2)



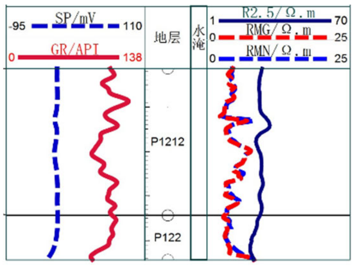
n.Ш-type river channel Q-Q-635(PI2_1^2)



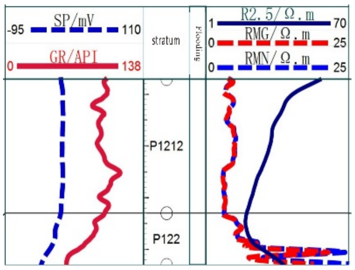
s.Overflow sand constant Q-Q-136(PI2_1^2)



o.Abandoned river channel Q-Q-739(PI2_1^2)



t.Overflow sand edge Q-Q-745(PI2_1^2)



u.Shunt mud Q-Q-Q745(PI2$_1^2$)

Fig .1 Sedimentary microfacies logging model

3.2 Intra-delta leading microfacies

(1)Underwater diversion channel: it is mainly divided into main river channel, type I channel, П type channel and Ш type river channel. The main river channel as a whole is high-extremely high amplitude and amplitude difference. The logging curves such as GR, SP, RMG/RMN are thick box type. The overall channel of type I is high to medium amplitude, and the logging curves such as GR, SP, RMG/RMN are thick box type. The overall channel of П type is high to medium amplitude, the GR and SP logging curves are bell-shaped, and the RMG/RMN logging curve is box-shaped. The Ш-type river channel is high to medium amplitude as a whole, and the whole bell shape.

(2)Underwater natural dike: the underwater extension of onshore natural dike, GR, RMN/RMG and other logging curves are seriously toothed, and the lithology is fine sand and silt.

(3)Underwater Breaking Fan: Located on the side of an underwater diversion channel, it has characteristics similar to that of an underwater natural dike, with a coarser grain size than an underwater natural dike.

(4)Mat-shaped sand: It is not limited by river channels and develops in a large area, and the degree of development is greater than that of overflow sand.

(5)Underwater diversion bay: A relatively concave bay area between underwater diversion channels. GR, RMN/RMG and other logging curves are seriously dentified, and the lithology is mainly mud.

3.3 Delta shunt plain microfacies

(1)Diversion river: GR, SP, RMG/RMN and other logging curves are selected for analysis, and according to the shape and thickness of the logging curve, the diversion river channel is divided into main river, primary river, secondary river channel and tertiary river. In general, the main river channel has a high-very high amplitude and amplitude difference; The logging curves such as GR, SP, RMG/RMN are thick box type. The overall first-class river course is high-medium amplitude. The secondary rivers were generally high to medium amplitude, the GR and SP logging curves were bell-shaped, and the RMG/RMN logging curves were box-shaped. The overall height of the tertiary channel is high-medium amplitude, and the logging curve is bell-shaped.

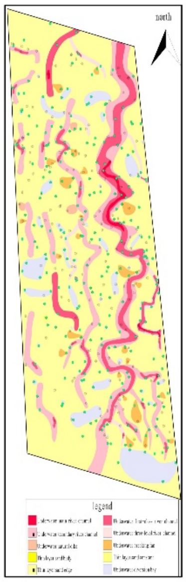
(2)Abandoned river channel: SP and GR show a bell-shaped positive rhythm, the thickness is thin, the upper part is dominated by sand and mud interlayer, and the bottom is generally high.

(3)Onshore natural embankment: the amplitude of the logging curves such as GR, RMN/RMG is low, the peak of the GR and SP logging curves is visible locally, and the sand and mud interlayer on the logging curve. The lithology is dominated by silt and silty clay.

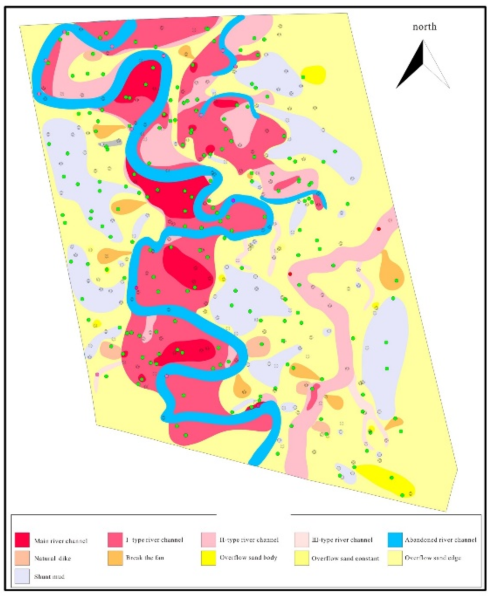
(4)Breaking fan: The logging curves such as GR, SP, RMG/RMN are funnel-shaped, and the thickness of the breaking fan is thinner than that of other sand bodies. The grain size is slightly thicker than that of natural, and the lithology is mainly fine sandstone and siltstone.

(5)Sludge between splits: GR, SP and other logging curves are approximate to mudstone baselines. The main lithology is mud with small amounts of silt and fine sand.

(6)Overflow sand: the logging curve is finger-shaped, and the vertical thickness is thin.



a.PI1$_2$ unit deposition microfacies



b.PI2$_1^2$ unit deposition microfacies

Fig.2 Layout of the microfacies plane of each small layer sedimentation

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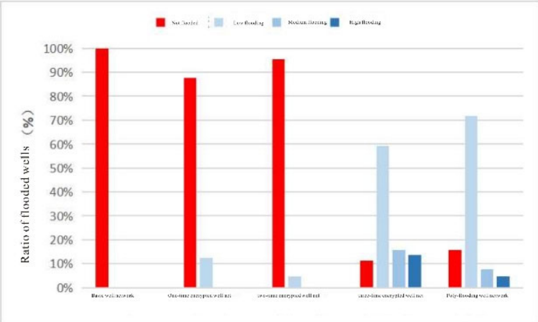
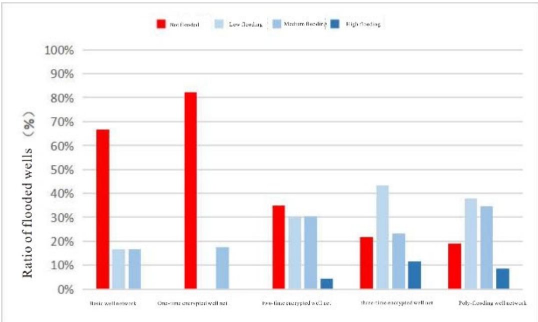
4. Residual oil distribution characteristics

4.1 Effect of different sand bodies on the remaining oil



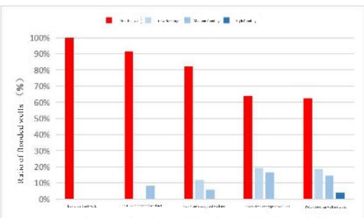
a.Histogram of the distribution of flooded wells in different batches of thin-bed sand network



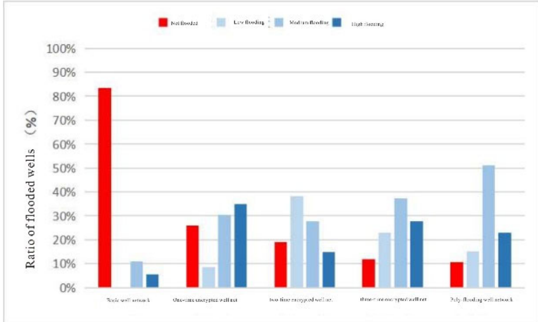
b.Histogram of the distribution of the ratio of flooded wells in different batches of well networks in underwater diversion channels

Fig.3 Histogram of flooding distribution of different microfacies of $PI1_2$

In summary, from the basic well network to the poly-flooded well network, the number of flooded wells in the underwater diversion channel increased, the proportion of unflooded wells in thin-bed sand gradually decreased, the proportion of low flooded wells gradually increased, and the ratio of medium and high flooded wells showed a decreasing trend. As a result, the residual oil stored in thin layer sand is higher and the residual oil stored in the underwater diversion channel is low.



a.Histogram of the distribution of flooded wells in different batches of overflow sand



b.Histogram of the distribution of the ratio of flooded wells in different batches of well networks in the diversion channels

Fig.4 Histogram of flooding distribution of different microfacies of $PI2_1^2$

The different types of energy phases, flooded wells and flooded well ratios at different stages in $PI2_1^2$ deposition time unit in the target area were studied. The results show that in the basic dense well network, the ratio of unflooded wells in the diversion channel is the highest, and in other batches of well networks, the ratio of unflooded wells gradually decreases, and finally drops to 10.79%. The ratio of the number of wells in medium water is high, and the ratio of the number of wells can reach 11.11%, and the ratio of high flooding is 5.56%. In the diversion channel, the ratio of well number from the basic well network to the low flood in the secondary well network increased to 38.30%, and the low flood ratio from the tertiary well network to the poly flood well network decreased, and the well number ratio decreased to 15.11%. For the ratio of the number of wells flooded in medium water, the ratio of well number can reach 30.43% from the basic well network to the primary infill well network, and then decreases to 27.66% by the secondary infill well network, and the maximum ratio increases to 51.08% from the tertiary infill well network to the poly flood well network. In the basic well network, primary infill well network, secondary infill well network, tertiary well network and poly flood well network, high flooding phenomenon appeared, and showed a trend of first increasing and then decreasing and then rising and decreasing [10].

5. Conclusion

(1)The sedimentation of Q area of X oilfield is the leading edge subfacies in the delta and the delta divergence plain subfacies, and 11 microfacies are mainly developed, namely underwater diversion channel, underwater natural dike, underwater break fan, mat-shaped sand, and underwater diversion bay. Diversion of river channels, abandoned river channels, onshore natural embankments, breaking fans, diversion of mud, overflow sand.
(2)On the plane, the size and geometry of the sand body have a close influence on the distribution of residual oil, and the reservoir has good physical properties, which is prone to flooding and low residual oil content. The reservoir has poor physical properties and is not easy to

flood, or the flooding condition is not good, and the residual oil content is high.

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