

Research on Fine Engraving Technology of Abandoned Channel and Point Dam Sands Inside Curved Channel Sands in Underground Reservoirs of Large Sandstone Oilfields

Yanchang Su, Xiuling Pei, Jiantao Du, Zhichen Zhou

Oil Recovery Plant No.6, Daqing Oilfield Corp. Ltd., Daqing 163513, China.

Abstract: Aiming at the difficult problem of describing the abandoned river channel and point dam sand body under the condition of dense well network in the late stage of extra-high water content, applying the core, logging and dynamic production data, and adopting the method of “discussing the present and discussing the past, and predicting the model”, the modern deposition clarifies that there are 4 types of abandoned river channel: the neck-cutting type, the breach and diversion type, the scaled abandonment, and the gully abandonment. The method summarizes 3 types of small, medium and medium-large point dam sands, and realizes the fine depiction of abandoned channels and point dam sands by using modern deposition as a guide, and finely depicts that the abandoned channels in the study area are mainly of the scale and rerouting type, and the point dam sands are mainly of the medium type, and the method is able to accurately depict abandoned channels and point dam sands and the results of the depictions provide a precise description of underground meanders in the large sandstone oil fields. The results of the description provide a geological basis for the accurate dredging of the remaining oil in the sand body layer of large sandstone oil fields.

Keywords: Abandoned River Channel; Point Dam; Hydrodynamics; Sand Body Delineation

Introduction

The development of large sandstone old oilfield has entered the stage of extra high water content, the remaining oil within the underground reservoir is highly dispersed, and the residual oil dredging also has a shift from interlayer to intralayer^[1-3], and the fine description of the reservoir pays more attention to the characterization of the intralayer distribution. Because of poor sedimentary material, poor permeability and strong non-permeable shielding, the abandoned channel inside the Quliu River directly affects the connectivity between the sand bodies and the injection and extraction efficiency between the oil and water wells^[4-7], but because of the large thickness of the Quliu River sand body, large reserves, large residual reserves, etc., it is still the main object of dredging in the old oilfield^[8-10]. How to finely portray the abandoned river channel and point dam sand body on the plane has become the key factor of the remaining oil dredging in the underground curved river channel, although many scholars have done in-depth research on the related content, but due to the influence of limited data, it is impossible to realize the accurate portrayal of the abandoned river channel and point dam sand body^[11-14], this paper takes modern deposition as a guideline, and adopts the method of “discussing the present about the ancient, This paper, guided by modern sedimentation, adopts the method of “discussing the present with the past and predicting the model”, and realizes the fine portrayal of abandoned channels and point dams in the sand body of curved channels in the underground reservoirs of large sandstone oilfields, and achieves better results.

1. Characteristics of the development of point dam sand body in Quliu River

The main depositional characteristics of the curved river is that the river channel is curved, and the sand body of point dam is formed by side deposition, which is generally developed in the floodplain and delta plain. In the process of flow of curved river, the concave bank erosion, convex bank side accumulation, the formation of side accumulation point dam, the river channel in the side accumulation process, due to the role of the interception of bending and straightening, the formation of multi-phase abandoned river channel, abandoned river channel is mostly muddy sandstone or sandy mudstone deposition, permeability is poor, and the role of the remaining oil shielding is strong.

1.1 Hydrodynamic analysis of point dam

The formation of point dams in Quliu River occurs mostly in the flooding period, due to the rising of the river during the flooding

period, the hydrodynamic force is strengthened, the water flow in the river channel is affected by inertia, the main flow line is offset to the concave bank, the water flow produces a fluid component perpendicular to the concave bank, so that the water surface of the concave bank is elevated, and the water surface of the concave bank is strongly scoured and undercut the concave bank, and the sand content of the river water is increased.

Every flood event, the concave bank is strongly eroded, creating a new deep pool, the convex bank side deposits a new layer of sediment, forming a new lateral accumulation body, the curved river occurs a migration, a flood action before the end. In the dry season, the main stream line of the water body in the curved channel is close to the concave bank side, and along the diagonal direction diagonally through the shallow section of the river between the two neighboring bends, then the river has no hollowing out of the concave bank, and there is no lateral deposition in the convex bank. In plan form, the lateral accumulation layer of the point dam is convergent from upstream to downstream. The cause is that the upstream hydrodynamic force is strong and the erosion rate to the lateral direction is fast, and the downstream hydrodynamic force is weakened and the sedimentation effect is strengthened.

The last phase of the water flow waterway will be gradually weakened by the water flow, abandoned to form the abandoned channel, the abandoned channel style is diverse, which directly affects the effectiveness of the development of the oilfield water injection, how to accurately identify the current is a difficult point.

1.2 Different abandonment stages of curved river channels

The point dams of the curved river channel are divided into preliminary abandonment, moderate abandonment and high abandonment. Different types of abandoned river channels have different developmental characteristics, different combination patterns and different control of residual oil.

1.2.1 Preliminary abandonment

Preliminary abandonment refers to a tributary although still connected to the main river, but the water flow in the river channel has been very small, belongs to the preliminary abandonment stage, the modern deposition of this reality is more, for example: located in Ewenke Banner Bayintala Township, the Yimin River at the three-way Bay toll station, the first northern curved ring also belongs to the preliminary abandonment of the abandoned river channel is still a large amount of water, the point of the dam on the vegetation grows vigorously (Figure 1A).

1.2.2 Moderate abandonment

Medium degree abandonment is relatively early, there is a small amount of river water in the abandoned channel, but it is not connected with the main river, and there is no water flowing into it (Figure 1B). For example, the Yimin River located in Bayintala Township, Ewenke Banner, at the toll station of Sandawan, with the second meandering loop in the middle.

1.2.3 Highly abandoned

Highly abandoned river channel is generally nonsense channel internal water body has basically dried up, and filled with very thick mud, beach head and the corresponding concave bank height difference is generally about 1-2m, for example: located in the northern part of the Yimin River town Yimin River, observed that the abandoned channel width of 40-50m, through digging pits abandoned channel has been filled with 1.5m thick mudstone, and then filled with 1.5m basically filled with the level of the river channel and the river bank on the difference in vegetation growth. The difference in vegetation growth between the river channel and the river bank is obvious, the abandoned river channel is dominated by water-loving water plants, and the two sides of the river bank are dominated by low meadows that are not water-loving (Fig. 1C).

1.2.4 Completely abandoned

The abandoned channel of the Hailar River, located in the Haote Tahai in the western part of Hulunbeier City, was observed to be completely filled in, and the low-lying area was basically not visible (Fig. 1D).

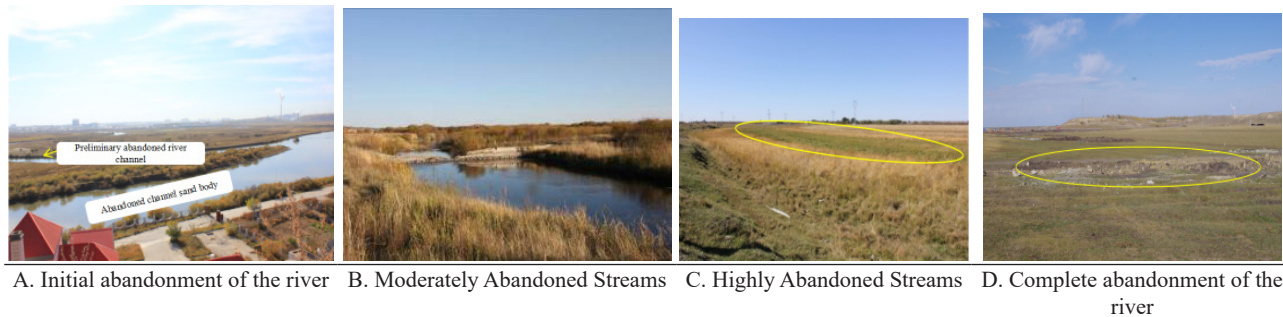


Figure 1 Yimin River in Hulunbuir City

1.3 Different abandonment methods for curved stream channels

1.3.1 Neck-cutting type

In the process of development of the curved river, the side of the waterway erosion, the river channel is more and more curved, in the convex bank of the neck of the curved river, due to the role of the bending force and lateral circulation and erosion gradually become narrower, and finally in a certain hydrodynamic conditions of the river naturally cut off the bends and take the straight, the original curved channel was abandoned, in the town of Yimin River in the north of the Yimin River Abandoned channel (Figure 2A) is this type.

1.3.2 Break diversion type

Due to excessive bending of the river and subsequent diversion, a number of continuously distributed meander rings were abandoned. There are three consecutively abandoned point dams of the meandering river in the Yimin River located at the Sandaowan toll station in Bay-intala Township, Ewenke Banner (Fig. 2B).

1.3.3 Scale-like abandonment

Due to the continuous occurrence of river abandonment, a lot of abandoned channel deposits are formed in the river valley, and part of the abandoned channels are continuously distributed to form a scale-like abandonment, which exists in the Root River near Argun city (Fig. 2C).

1.3.4 Abandonment of scouring ditches

Flood flooding in the point dam low-lying scouring the formation of small watercourses, with the scouring intensified, the string ditch water flow increased, when by the majority of the body of water development to all flow through the string ditch, the original channel gradually silt uplift and cut off, the formation of natural string ditch to take the straight. Located in Hulunbeier City, Chenbaerhu Banner of the Golden Horde Khan grassland tribes of the Molgrad River can be seen in the gully, the next flooding period gully may become a river channel, and the current river channel abandoned (Figure 2D).

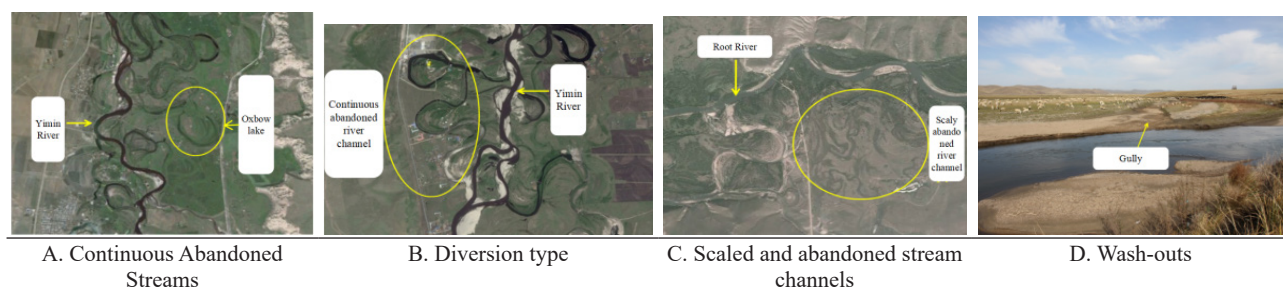


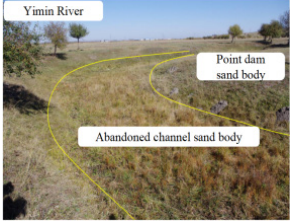
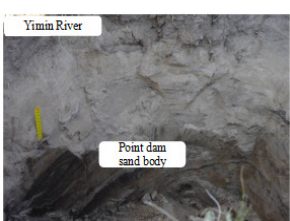
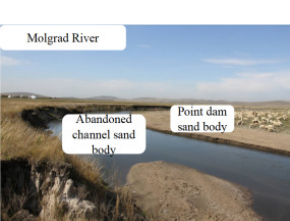
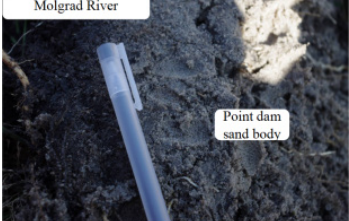
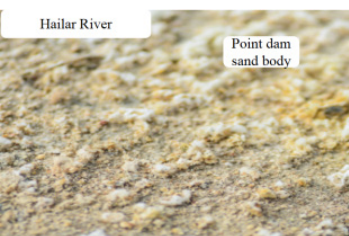
Figure 2 Abandoned Rivers of Yimin River and Gen River in Hulunbuir City

1.4 Different types of point dams

Different types of point dams occur as a result of river action (Table 1), with small and medium-sized point dams formed by single small channels; and larger composite point dams formed by wider rivers. Small point dams, small 20m wide point dams and 200m of river

sand formed by 5-10m small channels; medium-sized point dams, 300-500m point dams for river widths of around 50m; medium-large point dams, 300-500m point dams or composite point dams for rivers >50m.

Table 1 Different types of point dam sands

Typology	Plane Feature	Profile Characteristics		Characterization
small point dam				Small point dams 20m wide formed by 5-10m riffles, 200m of river sand
medium sized point dam				About 50m of channel width to form 300-500m point dams
Medium-large point dams				>50m of river forming 300-500m point dams or composite point dams

2. Characteristics of abandoned river channel and internal architecture of point dam sand body in LMD oilfield

The study area is located in the northernmost part of Daqing Changyuan, a short-axis backslope tertiary structure with two asymmetrical flanks, and is a backslope-controlled reservoir; the reservoirs in the study area are generally fluvial-deltaic-phase deposits. From the division of depositional environment, it can be identified as the floodplain-divergent plains phase deposition dominated by fluvial phase deposition, with severe cut-and-stack of curvilinear rivers, and is the internal abandoned river carving large, which has a greater impact on the development.

2.1 Characterization of abandoned river channel deposits

Mudstones formed during flooding as a result of channel abandonment are generally limited in width, occurring mostly between channel sands and are often subject to varying degrees of scour. Such muddy compartments, generally pure, contain little sand and develop horizontal laminations, indicating the relatively static diagenetic character of the water body in the abandoned channel. The contact relationship with the overlying and underlying sandstone is an erosional contact. The electrographic curve of the abandoned channel is bell-shaped or dentate bell-shaped, with a syncline contact at the top, dominated by muddy deposits. The lateral connectivity of the sand body is degraded due to both the entrapment formed by the lateral accretion of the curvilinear river and the abandoned channel acting as a local shield (Fig. 3).

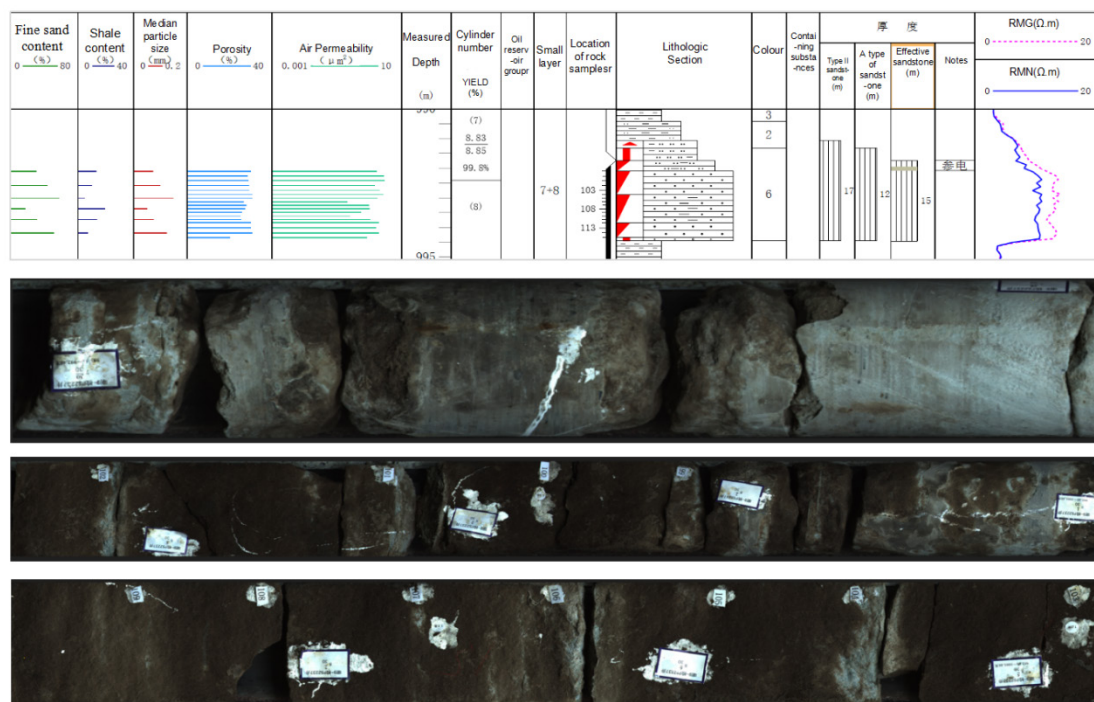


Fig. 3 Characteristics of sand body deposition in the abandoned channel

2.2 Abandoned river channel combination pattern

The method of “pattern guidance + inter-well prediction” is formed to depict the abandoned channels, solving the problem of complex distribution and difficult combination of different abandoned channels, enriching the deposition pattern of the abandoned channels, and finely depicting the distribution characteristics of the abandoned channels.

The sand body of point dam is in the shape of “sugar gourd” with different sizes on the plane, and the bottom of point dam body is the deepest and thickest, and it becomes shallow and thin in the direction of both sides and far away from the abandoned river channel, which is in the shape of eccentric lens, so we can accurately identify the sand body of point dam by searching for the location of thickness increase.

2.3 Fine engraving of abandoned channel inside the curved flow point dams

In layer A, the abandoned channel is mainly preliminary abandoned, and the sand body of the point dam is mainly small; the area between the channels is small, and the overflow sand is mainly used, and the main channel area is large, and the oil content of the reservoir is good (Fig. 4).

B layer sand body, the abandoned channel is mainly medium abandoned, the point dam sand body is mainly medium-sized; the area between channels is small, mainly with overflow bank sand, seldom develop mud between streams, the main channel area is large, and the reservoir is good in oil content (Fig. 5).

C layer sand body, the abandoned river channel is mainly dominated by scale-like abandonment, and the point dam sand body is dominated by medium-large sizes; the area between the river channels is small, mainly dominated by overflow bank sands, and the main river channel is large, with good oil content in the reservoir (Fig. 6).

In layer D sand body, the abandoned channel is mainly dominated by small scale-like abandonment, and the point dam sand body is dominated by medium-large scale; the area between channels is small, mainly dominated by overflow bank sand, the main channel is large, and the reservoir is good in oil content (Fig. 7).

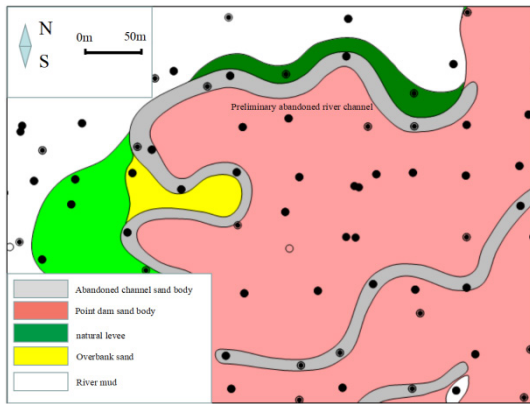


Fig. 4 Distribution of sand bodies in layer A

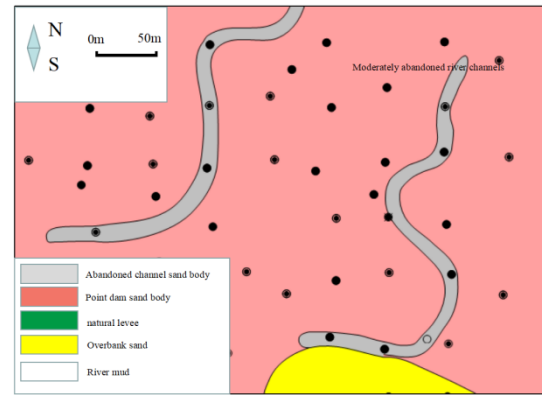


Fig. 5 Distribution of sand bodies in layer B

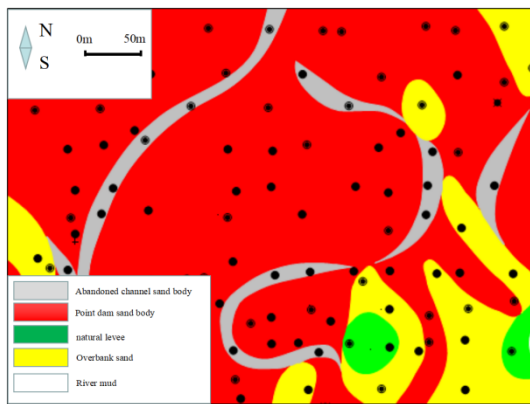


Fig. 6 Distribution of sand bodies in layer C



Fig. 7 Distribution of sand bodies in layer D

Through fine engraving, the reservoir sedimentary microphase in the study area is generally dominated by point-dam sand body and abandoned river channel deposition, the effective thickness of point-dam sand body is generally greater than 3.0m, and the abandoned river channel is generally 1m; due to the shading effect of the abandoned river channel, the later development focuses on dredging for the shading-type residual oil of the abandoned river channel.

3. Conclusion

(1) Abandoned river channel mainly develops neck-cut type, breach diversion type, scaly abandonment, and gully abandonment, totaling four types; point dam sand body mainly has small, medium, and medium-large point dams, totaling three types.

(2) Using modern sedimentation as a guide, it is clear that the abandoned channels in the study area are mainly of the scale-like and rerouting type, and the point dam sands are mainly medium-sized, which ultimately realizes the fine engraving of the curved channel sands, and provides a geological basis for the dredging of residual oil in the curved channel sands in the oilfield.

References

- [1] Zeng Xiangping. Application of Reservoir Configuration Research in Fine Oilfield Development. Petroleum Exploration and Development, 2010, 37 (4): 483-489.
- [2] Dou Songjiang, Sun Chaoyin, Zhang Yanjun, Kong Lingjiang, et al. Study on the internal configuration of channel sand bodies in reservoirs of Dagang Oilfield. Xinjiang Petroleum Geology, 2009, 30 (3): 284-286.
- [3] Zhou Yinbang, Wu Shenghe, Yue Dali, et al. Analysis and identification methods for controlling the dip angle of lateral accumulation layers inside point dams. Journal of China University of Petroleum (Natural Science Edition), 2009, 33 (2): 7-11.
- [4] Li Jun, Song Xinmin, Xue Peihua, Zhang Hailong, Sun Jingmin, et al. Subdivision and genesis of single sand body layers in the

Yangdachengzi Formation meandering river facies oil reservoir in Fuyu Oilfield. *Petroleum and Natural Gas Geology*, 2010, 31 (1): 119-125.

[5] Zhang Shulin, Guo Yajie, Wang Yu, et al. Research on the spatial configuration and effect analysis of thin interlayers inside river sand, *Petroleum Geology and Engineering*, 2009, 23 (3): 76-77.

[6] Wang Jian, Xu Shouyu, Zhong Weiping. Genesis and distribution characteristics of interlayer in fluvial reservoirs. *Geological Science and Technology Information*, 2010, 29 (4): 84-88.

[7] Qi Luning, Yang Shaochun, Lin Bo, et al. The influence of the configuration element combination of fluvial reservoirs on the distribution of remaining oil. *Xinjiang Geology*. 2010, 28 (1): 69-72.

[8] Zhou Weidong, Liu Zhenkun, Yue Dali, Zhou Yinbang, Zhong Xinxin, et al. Point Dam Configuration of the Neogene Guantao Formation in Zone 7 of Gudong Oilfield in Jiyang Depression, *Petroleum Geology and Development*, 2010, 31 (1): 126-134.

[9] He Wenxiang, Xu Ya, Liu Junfeng, Guo Wei, et al. Comprehensive geological study on the configuration of fluvial reservoirs in the northern third zone of Maling Oilfield. *Journal of Petroleum*. 2010, 31 (2): 274-279.

[10] Shi Shangming, Ma Yanping, Wang Lei, Wang Qi. Identification method for single channel in composite sand bodies of meandering rivers. *Science and Technology and Engineering*, 2011, 11 (3): 471-475.

[11] Bai Zhenqiang, Wang Qinghua, Du Qinglong, Hao Lanying, Zhang Shanyan, Zhu Wei, Yu Deshui, Wang Hejun. Three dimensional geological modeling and numerical simulation of meandering river sand bodies, *Journal of Petroleum*, 2009, 30 (6): 898-907.

[12] Lan Lifeng, Bai Zhenqiang, Yu Deshui, Huo Zhengwang, et al. Geological modeling and application of three-dimensional configuration of meandering river sand bodies. 2010, 32 (4): 20-25.

[13] Edited by Zhang Shaochen, Li Chen, Jia Peiyi, Xu Wei, et al. The architectural structure of meandering distributary channel sand bodies and residual oil exploration in the South Second District of Sanan Oilfield. *Journal of Daqing Petroleum Institute*, 2009, 8, 33 (4): 32-38.

[14] Wang Tao, Li Xiangfang, Yao Yuedong, Li Baozhen, et al. Research on the Technical Limits of Horizontal Well Development in Positive Rhythm Bottom Water Reservoirs. *Special Oil and Gas Reservoirs*, 2009, 16 (1): 58-60.

[15] Zhao Wenqi, Yi Jun, Wang Xiaodong, et al. Analysis and study of horizontal well productivity in river type gas reservoirs. *Oil and gas well testing*, 2010, 19 (2): 4-7.

Author introduction: Yanchang Su (1969-), male, Han nationality, Heilongjiang Daqing, Ph.D., senior engineer, research direction: oil and gas field development engineering.