# Discussion on reservoir description method of well vibration combined with tight well pattern area

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**Abstract.** In the process of rapid social and economic development, the demand for the oil of related industries is more and more large. The continuous increase of oil exploitation is causing some oil fields to gradually enter the period of special high water cut development and increasing the difficulty of oil exploitation. Therefore, how to improve oil recovery is the key question that relevant personnel think and solve. Based on this, this paper mainly describes the channel sand body description technology combined with well shock, and analyzes the reservoir description method combined with well shock combined with the general situation of an oilfield working area, aiming at improving the prediction accuracy of sand body in dense well pattern area and effectively guiding the development and adjustment of potential excavation work.

**Key words:** Tight well pattern area; Well shock combination; Reservoir description method.

## 1. Introduction

The application of the well vibration combination technology in the dense well pattern area can more accurately describe the inter-well sand body, accurately combine the channel sand body, effectively improve the reliability and effectiveness of various work, and provide strong support and guarantee for the later oilfield development and production. In addition, the method of combining well seismic with reservoir description in dense well pattern can recombine abandoned channel, correct various types such as variable sand body in channel, main channel shape and swing, and describe channel sand body more accurately, effectively avoiding the uncertainty of reservoir description by only using well data.

## 2. Analysis of channel sand body description technique combined with well shock in dense well pattern area

### 2.1 Section extraction and selection

The equal-scale subdivision method based on the top and bottom of the reflection marker layer applied in the time domain can effectively characterize the relative equal-size of the interface of the small layer. Meanwhile, in the actual operation, the method of correcting well curve, extracting frequency conversion and variable wavelet can be used in the dense well pattern area to form a synthetic record, and the more precise calibration and final zone calibration can be applied in the combination of well vibration and marker layer. In addition, the staff realized equal proportion subdivision according to the marker layer to analyze the sedimentary characteristics of the target layer in detail. Local adjustment of stratigraphic level is targeted, and fine isochronous stratigraphic framework close to sedimentary unit level is created at the same time to ensure the extraction accuracy of the target layer as slice [1].

With the help of a variety of dense well pattern area information, the specific thickness of sandstones drilled at well points and the amplitude energy of stratum sections are analyzed in detail. Generally, about 74% of the range of medium-strong amplitude area is distributed in the well points of a class of sandstones, the thickness of which is no less than 2 meters, so as to determine that the well shock matching relationship is good. Ensure that the optimized strata sections have good applicability in channel sand body characterization.

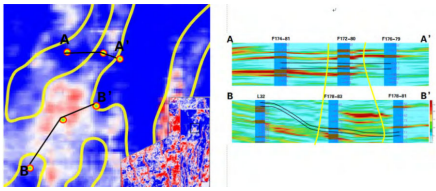
### 2.2 Channel sand body characterization

The seismic data show a higher plane resolution, and the boundary and strike of the channel sand body can be identified more accurately. Based on the level of seismic identification and current technology, Continuous research and practice have formed a variety of fine description methods of well seismic combination reservoir, such as well point microfacies control, collaborative analysis of seismic sedimentology plane prediction, fine tracking and characterization of key target sand bodies, and separate treatment of different kinds of sand bodies, which promote the identification of river

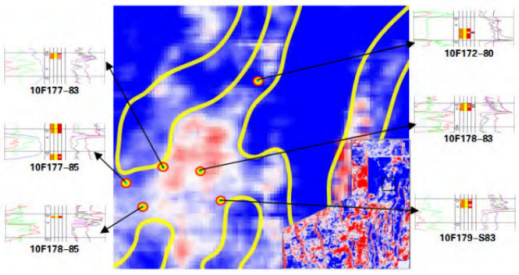
channel sand bodies and realize the semi-quantitative description of "seismic trend guidance".

(1) Composite river channel. Combined with the sedimentary study of the new period, it is clearly found that for the composite channel, there is not only one abandoned pattern of meandering ring, but also the abandoned pattern formed by multiple abandoned meandering ring in the area of high curved composite channel. It is generally difficult to identify the point dam body of the channel in the same period on the plane. In addition, based on the analysis of diagenetic conditions, it is difficult to accurately determine whether the multi-stage channel plane is cross-cutting and overlapping, or a single channel has undergone multiple channel changes [2]. However, based on the analysis of slice attributes, it is difficult to define the key regularity of the composite channel sand body morphology under the influence of high value surrounding rock and multi-point dam plane convergence, etc., and it is relatively easy to define the boundary of point dam and the contour of variable sand body. (1) A comprehensive analysis of the seismic trend information, to determine the size of the point dam, the specific spread of abandoned river in the meansional zone. (2) Reasonable application of optimal seismic attribute slices can more accurately define the abandoned channel strike and spreading point in relevant areas, and accurately depict the channel trend within the range of large high-value sandstone. (3) Guide the plane combination of internal point dam and abandoned channel in the composite channel, and then show a good response to the abandoned channel in the sand in the seismic inversion profile, further define the boundary points between Wells, constantly optimize the understanding of plane combination, and then effectively complete the fine characterization of well seismic combination reservoir.

⑵ Narrow river channels. The application of seismic attribute slicing and inter-well inversion profile can effectively improve the certainty of the boundary of the channel sand body. At the same time, the application of frequency division attribute slicing can effectively guide the characterization of the channel sand body, fully implement the narrow and small channel, realize the effective combination of points and lines, draw the boundary line more precisely, and define the spreading point of the narrow and small channel. For example, analyze the actual situation of one of the small layers (as shown in FIG. 1), clarify the specific strike and spread point of the narrow and small channel in "looking for sand in the mud", clarify the boundary line of the channel between Wells with sudden change of seismic attribute value (as shown in FIG. 1A), and effectively correct the amplitude slice by combining with the actual well point curve. The boundary and strike of narrow and small river channels are more accurately reflected (as shown in Figure 1B). In addition, in profile, combined with the actual situation of inter-well sand body connectivity in seismic inversion profile, the boundary points between narrow and small river channels were further defined (as shown in FIG. 1C).



（A）Looking for sand in the mud （B）The inversion profile confirms the connectivity of sand bodies between Wells




（C）Well point verification

Figure 1: Combination of well and seismic characterization of narrow and small channel sand bodies

## 3. The significance of fine characterization of reservoir combined with well vibration

On the one hand, well seismic combined with reservoir fine characterization to achieve effective integration of seismic data and geological information, and constantly improve and perfect the previous model mapping method. The traditional mapping method is mainly based on the microfacies of modern deposition and outcrop, and the planar combination of well points. However, the combination of well seismic and reservoir description method can organically combine seismic and well information, give full play to the application value of seismic information, provide more complete and reliable model information for fine characterization of channel sand bodies, and obtain the result of fine characterization of channel that is most similar to the underground reality [3].

On the other hand, the method of reservoir characterization based on well vibration has changed greatly, which further realizes the fine characterization of channel sand body. In practical application, this method is mainly combined with 3D seismic data to correctly interpret the specific strike and distribution characteristics of the channel sand body in space. At the same time, combined with the specific analysis of well information, it can be effectively transformed into the channel distribution characteristics of different sedimentary units, so as to more accurately identify the channel boundary on the plane and more accurately define the channel boundary points on the profile. Therefore, on this basis, effective combination of well point microfacies plane and section is carried out to create a 3D geological model

meeting the actual conditions of the well, which effectively solves the problems of unclear boundary and multiple solution of plane combination in the characterization of well channel sand body by traditional model mapping method, and comprehensively improves the prediction accuracy of inter-well channel sand body.

## 4. Overview of tight well pattern area

The east-west fast fault of the first block North of an oilfield is mainly located in the middle of the Short-sleeve anticline structure in the north of the oilfield, and the oil-bearing area is about 17.2km2. This study area is mainly located in the frequent Baidong area along the shoreline of the lake, where there are various types of oil deposits. Meanwhile, channel sandbodies, estuary bar sandbodies and thin bedded sandbodies interlace with each other, showing serious heterogeneity, and channel sandbodies are key reservoirs. Reservoir porosity is between 23% and 25%, permeability is about （300-1500）$\times 10^{-3}\mu m^2$, present in the hole, the permeability characteristics of composite moisture content is above 90%, belong to determining phase.

## 5. Application of reservoir description method in combination with well shock

### 5.1 Conditions of Use

Compared with the logging method, the seismic method has a significant advantage in the coverage density on the plane. However, the current seismic identification ability and technical conditions in the practical application process tend to cause the seismic longitudinal resolution is relatively low, about 10 meters. The well shock coincidence rate of different types of channel sandbodies in the study area was analyzed, mainly the well points with sandstone thickness of no less than 2 meters, which were located within the range of medium-strong amplitude attribute. It was obviously found that the well shock coincidence rate was not less than 50% and the ratio of layers was not less than 65% in meander river, delta distributary plain and channel sandbodies. However, the well seismic coincidence rate of the delta far bank and outer front facies sandbodies is relatively low, which fully indicates that the seismic data have good applicability in the prediction of meandering river, delta distributary plain and inner front facies channel sandbodies.

Channel microfacies distribution direction, width, fork Angle, width-thickness ratio and other parameters in different development zones are different to some extent, so it is necessary for staff to conduct statistical analysis and create reservoir parameter database, as shown in Table 1.

Table 1: River channel parameters of a and b dense well pattern development zones

| block | Mean channel width (m) | Mean channel thickness (m) | Channel width to thickness ratio | Angle of bifurcation （°） | Extension azimuth （°） |
|---|---|---|---|---|---|
| a | 56.1 | 1.4 | 37.34 | 39.1 | 31-38 |
| b | 90.3 | 2.1 | 40.90 | 38.2 | 32-44 |
| On average | 82.4 | 1.7 | 39.20 | 36.6 | 32-39 |

### 5.2 Improve the prediction accuracy of inter-well sand body

The application of well vibration combined with reservoir description method can more accurately depict different types of channel sand bodies, fully reflect the sedimentary features of sand bodies in various sedimentary environments, so that people can more correctly understand the distribution characteristics of sand bodies and effectively approach the actual underground conditions. In addition, the staff confirmed through well inspection that the combination of well shock and well sand body prediction, clear boundary and well data study results are more reliable, mainly in the following aspects:

(1) Channel sand body boundary position transformation. Combined with the depositional facies zone diagram of the well, it is clear that the channel boundary is mainly in the central part between the two Wells, and the channel width is predicted to be about 110 meters. However, combined with the analysis of seismic attribute slices, the location about 30 meters south of the well is the attribute mutation position, and then it is determined that the width of the river channel presents a rapid change rate, while the width of the vertical channel strike is about 50 meters. The detailed analysis of the logging characteristics of the reserved posterior well shows that the spontaneous potential presents a straight curve. However, the microelectrode curve mainly presents slight fluctuation without significant difference, thus determining that the well is a pinch-out microphase, which fully indicates that the application of the well shock combined with the sedimentary facies zone diagram can effectively enhance the identification accuracy of the boundary position of the channel sand body between Wells [4].

(2) Newly added channel sand body. Combined with the depositional facies zone diagram of the well, it is determined that two Wells in the study area are not channel microfacies, so it is determined that there are corresponding channel microfacies between the Wells. However, the analysis with the help of seismic attribute section shows that there is a certain low value range of seismic attributes between the two Wells, and then the well seismic combined depositional facies zone diagram is used to effectively identify the channel microfacies about 40 meters wide between the two Wells. A detailed analysis of the detailed logging characteristics of the reserved post-test well shows that the spontaneous potential presents a bell-shaped curve, and the curve amplitude difference at the bottom of the microelectrode is relatively high. The comprehensive determination that the well belongs to the channel microfacies fully indicates

that the application of the combination of well shock and sedimentary facies zone diagram can effectively improve the effective identification accuracy of narrow and small channel sand bodies between Wells [5].

（2）Added microphase inside and outside the surface and pinch-out. According to the sedimentary zone facies diagram of the Wells, it is mainly determined that two Wells in the study area are the same channel, and there is no surface or inside-out microfacies between the Wells, showing good connectivity. With the help of seismic attribute slices, it can be clearly found that there are attribute mutation areas behind the two Wells, and then according to the combination of well seismic sedimentary facies map, the existence of about 50 meters wide pinch-off microfacies between the two Wells can be effectively identified. In addition, by analyzing the logging characteristics of the reserved post-test well, it is obviously found that the spontaneous potential mainly presents a flat curve, while the microelectrode does not have a curve amplitude difference. Therefore, it is determined that the well belongs to the pinch-out microfacies, which fully indicates that the application of the well shock combined with the sedimentary facies map can comprehensively improve the identification accuracy of the newly added inner and outer channel sand bodies and pinch-out microfacies between Wells.

## 6. Conclusion

In the practical application of the method of combining well seismic with reservoir description, it can effectively give full play to the maximum application value of the dense well pattern data and seismic data in the development block, reduce the subjectivity in the study of sedimentary facies with the help of well data, reduce the multi-solution of the prediction of inter-well channel sand body with seismic data, and effectively improve the accuracy of the sedimentary microfacies map.

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