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Correction of Thin-bedded Horizon Structural Model with Integration of Spectral Decomposition of Seismic Data and Logging Results - Case Study in West Siberia

A. Masoud* (Gubkin Russian State University of Oil & Gas)

SUMMARY

The problem that resulted this study was nonconcurrence of seismic reflection data by logging results about true position of productive layer in a reservoir inside west Siberian basin. Different scenarios have been studied to explain the reason of unadjustment between these two set of data. By decomposing the frequency of seismic and integrating them with logging results, we found out that in this special part of reservoir, because of low thickness of reflector and amplitude tuning that happened between a set of thin layers, usual full band frequency seismic reflectors even show deceptive continuity of targeted layer and has made it impossible to track truly. The results provided by this study, clarified the source of error in structural model of the reservoir and determined true position of the productive horizon near the problematic well area.

Introduction

Over the past half century, Seismic surveying has been one of the main methods to visualize geological structures and positioning the horizons underground. Amplitude of recorded waves has being the main attribute to achieve these goals. Like any other method, seismic surveying has limitations. Some factors such as interference of seismic waves with different frequency, the noise interfere and low pass filtering property of the earth in deep surveying preclude this method to provide high resolution images of deep subsurface . As a special example, interference of wide range of frequencies in recorded data hide low frequency reflections and on the other side, because of low energy level in reflections with higher frequencies and their contamination with regional noise, these reflections are suppressed in seismograms.

On the other hand, data provided from wells usually have much higher resolution. A usual set of Logging data can locate the true position of horizons have thicknesses even less than one foot with acceptable reliability. However, the inhabited problem with logging data is that they are one directional, i.e. there is no guarantee about lateral continuity of properties measured inside the wells.

Understanding the Christmas and drawback of each method directs us toward integration of high frequency seismic surveying with well loggings data in order to modify structural model of reservoir. While in the areas close to the wells, these two data have overlap and can be used to modify models with high level of accuracy . The problem that resulted this study was nonconcurrence of seismic reflection data by logging results about true position of productive layer. The region of interest was part of one reservoir in west Siberian basin. The producing horizon is located at the depth of 950-1000 milliseconds , just over fundament and partially covered by complex structure resulted by salt intrusion into upper layers. This situation cause significant lateral variation of velocity which increase uncertainty of velocity models used for time-depth conversion. Errors in velocity model can produce some artifacts in the form of anticline or syncline after time depth conversion. However, existence of a well in these areas can modify the velocity model by positioning the true depth of each horizon. In the area, near well No.37 of this reservoir was the same situation, except the fact that even after velocity model optimizing, there was still a considerable difference between positions of interested horizon in well logging data and seismic based structural model. This position of thin producing layer was important to define overall dip of layer. Depending on dip of the layer ,we could expect different type of hydrocarbon (oil or gas) further from the well No.37.

Methodology

Different scenarios have been studied to explain the reason of unadjustment between these two set of data. Trueness of logging data and probability of errors related to fluctuation of wireline length during process of logging investigated. Finally by decomposing the frequency content of seismic and integrating the results with logging results, became clear that because of low thickness of reflector and amplitude tuning happened between a set of thin layers in this special part of reservoir, usual full band frequency seismic reflectors even show deceptive continuity of targeted layer and has made it impossible to track truly. Based on thickness of the horizon in problematic area, three frequency of 60Hz, 80Hz and 100 Hz have been chosen to produce three different spectrally decomposed cubes (figure 1). Each of these produced cubes showed distinct reflection continuity with different depth in time interval of 950-1000 milliseconds. At the end, the image produces by empowering frequency of 80 Hz gave the best continuation of reflectors in the area, which matched with well logging information about the position of the horizon.

Application

The results provided by this study, clarified the source of error in structural model of the reservoir and determined true position of the productive horizon near the problematic well area. The modified model can be readily used to predict geometry of producing layer beneath the area with structural complexity.

Conclusion

The problem that resulted this study was nonconcurrence of seismic reflection data by logging results about true position of the productive layer. Different scenarios have been studied to explain the reason of unadjustment between these two set of data and finally have been showed that, interference of wide range of frequencies in recorded data hide low frequency reflections and low energy level in reflections with higher frequencies caused false geometrical interpretation of producing horizon in the problematic area. By using spectral decomposition of seismic data and also well logging result, true position of the productive horizon near the problematic well area determined and overall structural model modified.

Figure 1 Three sections resulted by spectral decomposition of 3D seismic data of region (60Hz(B),80Hz(C),100Hz(D)).Pointer in figure (C) shows the true position of producing layer detected by using 80 Hz frequency section.

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