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Influence of the Seismic Attenuation on the AVO Analysis in Miocene Strata from Carpathian Foredeep - SE Poland

K. Cichostępski* (AGH University of Science and Technology) & M. Kasperska (AGH University of Science and Technology)

SUMMARY

Amplitude versus offset (AVO) is one of direct hydrocarbon indications. One of the factors which can have negative influence on AVO effect is seismic wave attenuation. This paper presents how seismic attenuation distorts AVO analysis. To compensate this effect the inverse Q filter was used. Firstly, the evaluation of usefulness of the inverse Q filtering was verified on the model data. The promising results gave basis for the using the inverse Q filter on real data. Inverse Q application amplified intercept and gradient. After this procedure, analyzed AVO anomaly is less ambiguous.

Introduction

One of the measurable effects indicating the presence of hydrocarbons is amplitude variations with offset (AVO) of the seismic record (Ostrander, 1984). One of the factors that distort AVO analysis is the attenuation of seismic waves. It affects changes in amplitudes with offset. To compensate the attenuation influence on the seismic record, the inverse Q filter is needed.

This study is based on seismic data (Fig. 1) from the central part of the Carpathian Foredeep, which is located in south-east Poland. In this area gas deposits occur commonly in thin-layered rock formations, showing a class II AVO anomaly. The aim of this paper is to show how seismic attenuation distorts AVO analysis, as well as how to compensate this influence by using inverse Q filter. The methodology was firstly tested on model data.

Figure 1 Part of time seismic profile.

Method

Q factor values, used for model and real data, were estimated using VSP data from C-4 well. This was done by determining the trend of cumulative attenuation curve in the depth domain (Wang, 2007).

Figure 2 Comparison and AVO analysis of model data: A) Model without attenuation; B) Model with attenuation; C) Inverse Q filter on model with attenuation; D) AVO analysis of modelled data.

The second step was modeling of AVO effect in Hampson-Russell software (CGG, 2012). In order to verify the correctness of the assumed methodology, the modeling of the single CDP showing typical AVO class II anomaly (Fig. 2) was done. The Elastic Wave modelling algorithm was used with Q factor equal to 47. The synthetic 30 Hz Ricker wavelet was assumed. Two models were calculated, one involving influence of attenuation (Fig. 2a) and the other with none (Fig. 2b). Then, the model with attenuation was proceed using the inverse Q filter. The result of inverse Q filter on the model data is shown in Figure 2c. The AVO analysis of the models (Fig. 2d) shows that attenuation affects

significantly amplitudes. The analyzed AVO class II after Q compensation shows a higher amplitude at zero incident angle (intercept) and a higher relative amplitude change with incident angle (gradient).

Example

Synthetic CDP modeling confirmed that attenuation has an important impact on amplitude changes with offset/incident angle. It gave the basis for the use of the seismic inverse Q filtering to process real seismic data (Vista, 2012). The estimated Q factor values from VSP data was used once again. Figure 1 demonstrate bright spot in the study area. The bright spot shows AVO class II anomaly (Fig. 3a). Inverse Q application (Fig. 3b) strengthens both intercept and gradient within analyzed bright spot. This procedure made the AVO class II anomaly more evident. Moreover, inverse Q filtering enhanced the resolution of seismic data, which is important for thinly layered rocks.

Figure 3 A) Recorded CDP; B) Recorded CDP after inverse Q filter;
C) AVO analysis.

Conclusions

This paper presents successfully application of inverse Q filtering as a procedure which allow for proper AVO analysis. Inverse Q application amplified intercept and gradient. After this procedure, analyzed AVO class II anomaly is less ambiguous.

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