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P301

Seismic Data Conditioning of Partial Stacks for AVO - Using Well Offset Amplitude Balancing

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SUMMARY

AVO analysis is increasingly becoming part of the everyday workflow, however it is often found that existing data sets require further conditioning in order to extract accurate reservoir properties within the zones of interest. We present a systematic workflow which incorporates the understanding taken from the well based AVO analysis to align the seismic data to the true AVO signal of the earth.
Compensation for NMO stretch and amplitude are key to this. The well based AVO Seismic Data Conditioning approach adopted here corrects for the relative amplitude loss between near and far offsets, often referred to as offset balancing. Each step progressively improved the final results of creating an Intercept and Gradient reflectivity, additionally the final partial stacks honour the AVO of the log based synthetics. The wells and the seismic now share the same dynamic range of AVO characteristics as those seen at the wells. Whereas previously we had a noisy gradient reflectivity at the top of the reservoir the improved data now showed characteristics which were more indicative of geological features. Seismic Data conditioning of the partial stacks is considered a cost effective alternative to seismic data conditioning of the prestack gathers.

Introduction

AVO analysis is increasingly becoming part of the everyday workflow, however it is often found that existing data sets require further conditioning in order to extract accurate reservoir properties within the zones of interest. We present a systematic workflow which incorporates the understanding taken from the well based AVO analysis to align the seismic data to the true AVO signal of the earth.
Rock Physics analysis of well data from 4 wells intersecting the same geological formation has concluded that the best lithology and fluid discriminators are Intercept and Gradient reflectivities along with their associated Acoustic and Gradient impedances. The theoretical AVO response derived from well data over the field area was consistent enough to provide high confidence. This AVO modelling suggested that at the top reservoir level we should observe a strong positive gradient. The gradient reflectivity derived from P-wave partial stacks did not match with the theoretical AVO response (Figure 4a).
Routine seismic processing does not prepare the data for input in a quantitative AVO analysis as noted by Ross and Beale (1994) and Martinez (1993). Noise in the P-wave seismic data mainly in the form of wavelet variations with offset and residual NMO corrections will significantly bias shear information (Cambois, 2000). In order to get more comparable seismic data with the theoretical AVO response a seismic data conditioning workflow on P-wave partial stacks was applied. In this paper I will outline the main steps of this workflow. (Fig(1))

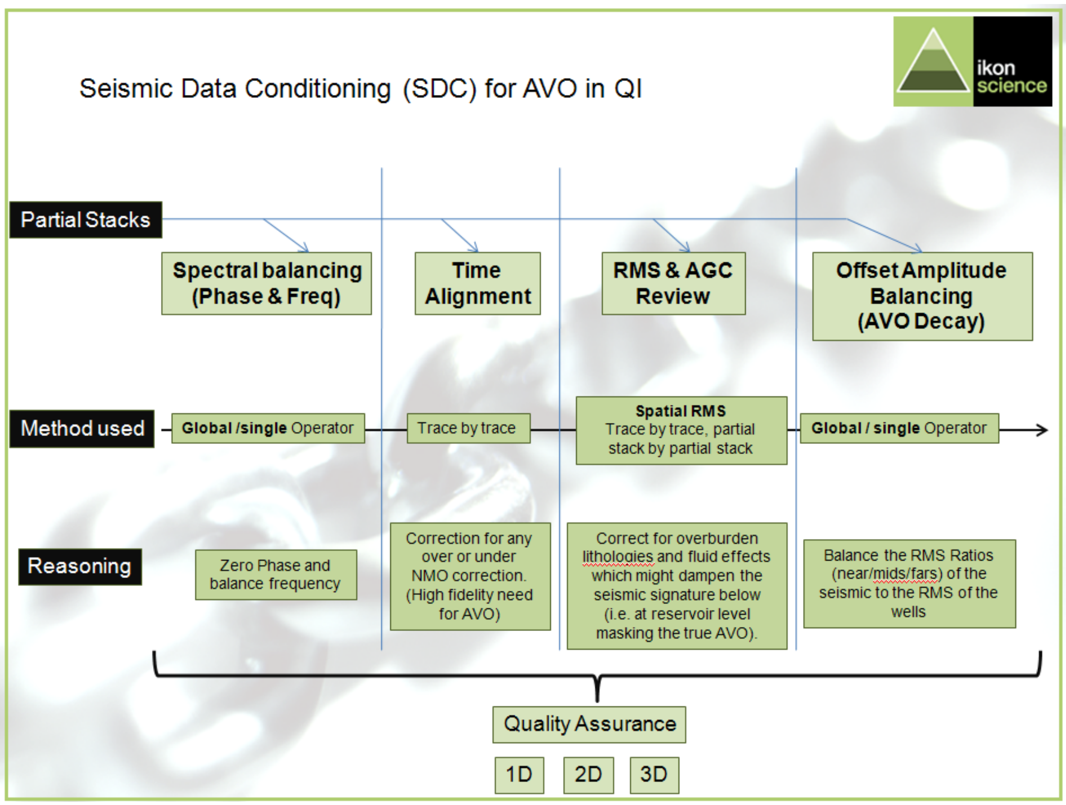


Figure 1 Ikon Science Q.I. - Seismic Data Conditioning workflow.

Seismic Data Conditioning is more commonly known as an exercise performed on prestack gathers, however it is also applicable to partial stacks. Seismic data conditioning of the partial stacks is considered as a cost effective, progressive, alternative to seismic data conditioning of the prestack gathers.

Seismic data conditioning workflow

All seismic partial stacks need to obtain the same phase and polarity in order to undergo spectral balancing. Well based analysis undertaken previously highlighted that the partial stacks were slightly out from zero phase. Subtle corrections would align the phase character of the wavelet with offset.

The following steps were key to the analysis:

1. Zero Phasing - The character of the wavelet discovered during the well analysis was used to correct the Near stack to zero phase.
2. Spectral Balancing - Spectral and phase differences were corrected by designing and applying matching filters to match the Mid and Far stack to the Near stack.
3. Time Alignment - misalignments were corrected.
4. Offset Balancing - Knowledge gained from AVO analysis of the well data was used to balance the offset amplitudes. Fig(2) shows well synthetics used for background amplitude calculation.

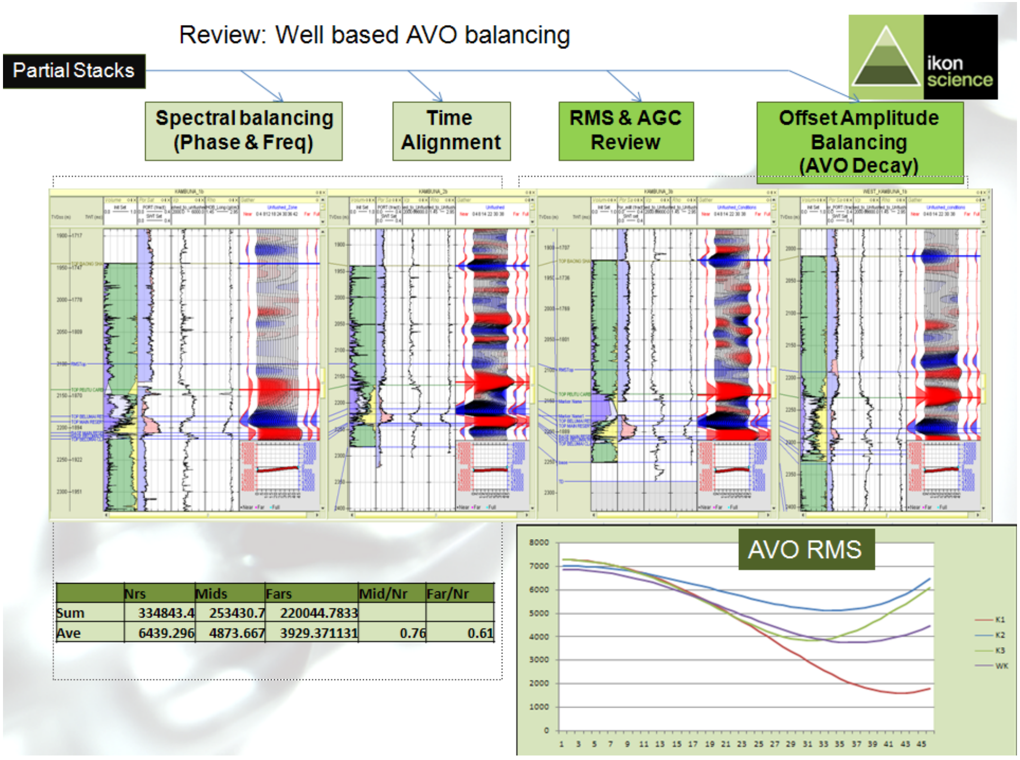


Figure 2 RokDoc - Well synthetic background amplitude analysis.

A small subset was extracted from the partial stacks for testing of different Seismic Data Conditioning algorithms. Optimum results rely on the ability to compare the various parameter settings and modify them accordingly. The seismic data conditioning workflow tries to correct for phase, frequency, amplitude and time differences. Once the exact procedure was outlined and tested, the workflow was applied and reviewed throughout the entire volume.

Conclusions

- The seismic post conditioning was successful in making the partial stacks more comparable. Each step progressively improved the final results of creating an improved Intercept and Gradient reflectivity. (fig(3))

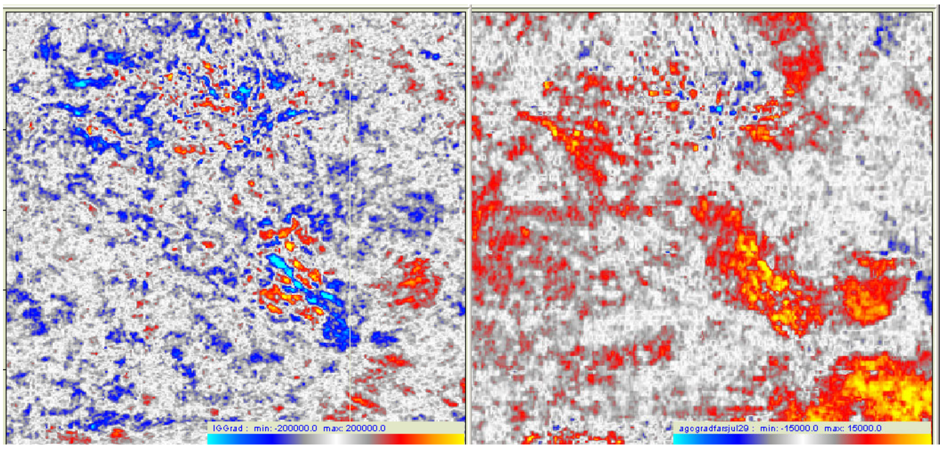
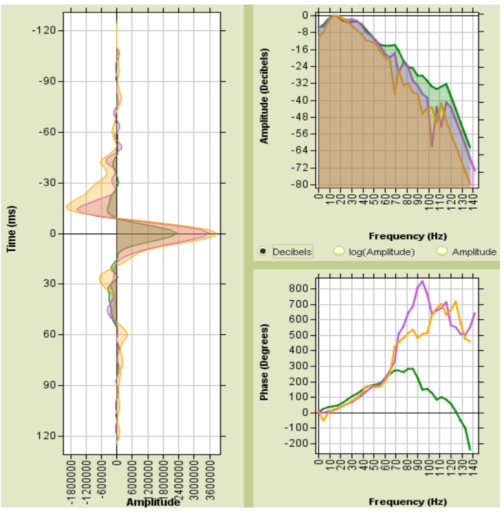
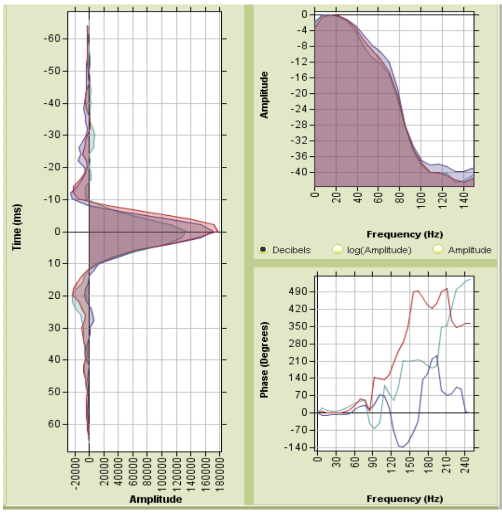


Figure 3 Amplitude extraction at the top reservoir from the Gradient reflectivity before (a) and after (b) seismic data conditioning. After seismic conditioning the gradient now matches the theoretical response as observed at the wells.

- A phase rotation of about 30 degrees was required for both the Mid and Far stacks to match the Zero phased Near stack.
- The Mid stack did not require heavy time alignment. At the reservoir level the time shifts were of the order of 3ms. Nevertheless for quantitative generation of Intercept and Gradient reflectivities, 3ms is enough to add noise to the end products.
- The Far stack required on average more time alignment than the Mid stack. At the reservoir level the time shifts were of the order of 10ms. The alignment significantly improved the end products of Intercept and Gradient.
- More comparable wavelets between seismic cubes highlight the improvements of the Seismic Data conditioning (Figure 4)
- The final stacks honour the knowledge gained from well data analysis. The wells and the seismic now share the same dynamic range of AVO characteristics as those seen at the wells.
- A significant factor in improving the data was the conditioning of the amplitudes to honour the AVO characteristics seen at the wells.



a)



b)

Figure 4 Exctracted wavelets from the Raw P-wave stacks (a) and the post conditioned P-wave stacks (b).

References

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