

Resolving The Discrepancies Between Vertical Seismic Profiles And Petrophysical Logs, At Least A Few Of Them

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ABSTRACT

Seismic data have been a very powerful tool used in the exploration of reservoirs throughout the world and no less so in the western Canadian basin. Seismic 2D data criss-cross our countryside and now 3D data is commonplace throughout the exploration/production process. Wireline petrophysical logs have also been the definitive source of information for the understanding of the drilled reservoir. The merging or tying of these two sometimes contradictory datasets can be fraught with pitfalls, miss-conceptions and errors. This paper will investigate two more subtle seismic distortions and contaminations, (attenuation Q and higher order multiples) that hinder this tying process and detract from the valuable information within these data.

Methods

VSP data were collected in several wells, and processed to understand and reduce the differences between the wireline logs and the surface seismic. Figure 1. shows the detailed results of a VSP and the surface seismic.

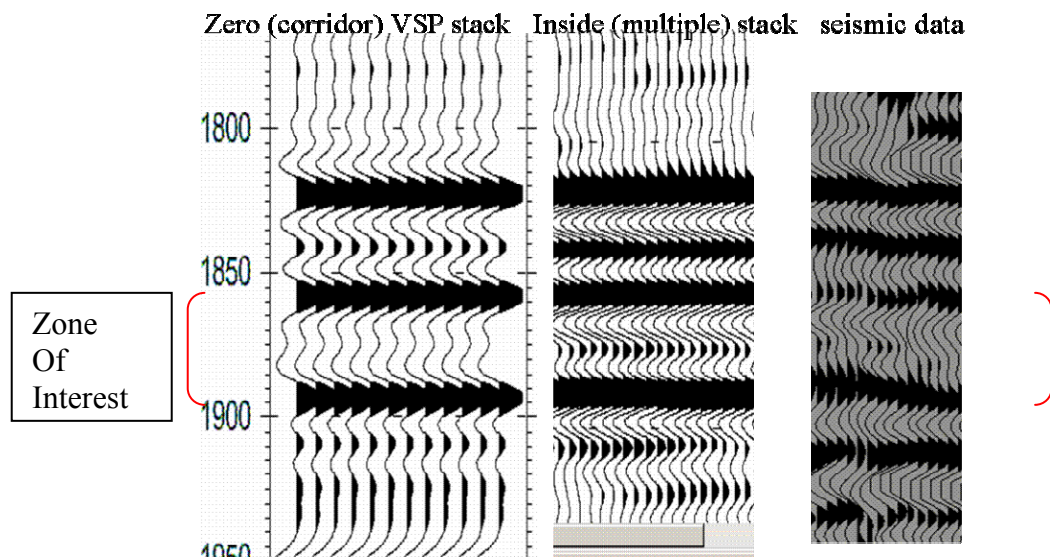


Figure 1.

In comparing the sections in *fig. 1*, we see that the zero offset VSP does not tie the surface seismic with a great amount of confidence. There appears to be strong variations in amplitude in the zone of interest as well as an apparent phase difference. This dataset was processed with great care to preserve and control the phase and amplitude. The final phase matching to know geologic tops of predictable acoustic properties was carried out throughout the section but still there is a problem. With greater investigation the inside stack appears to tie better from an amplitude perspective, the phase also appears to be distorted but to a much lesser extent. Or is it? Well ties show that the phase will have to be rotated between 45 and 90 degrees for the greatest correlation. This is in direct contradiction with the pre-drill shallow zone phase matching and exhibits a strong time varying effect. The easiest explanation for this is attenuation or 'Q'.

The concept of attenuation 'Q' has been around for years and numerous papers have been written on the time varying phase effects of shales and anisotropic rock on seismic waves and apparent phase at reflectors. Rio et al. demonstrated the effects of lamination of varying thickness to wavelength proportions on the phase and amplitude of the propagated wave, and Tonn, compared different methods and their overall correction of the seismic data. Figure 2. shows a modeled theoretical effect using a constant high Q (non-attenuative) and a variable Q, on the amplitude and more importantly the phase of the data. There is little effect at reflection 1 where the amplitude and the phase are virtually equal and the phase is unaffected. At reflection 2 after propagating through the laminated anisotropic section the amplitude and the phase are distorted quite drastically.

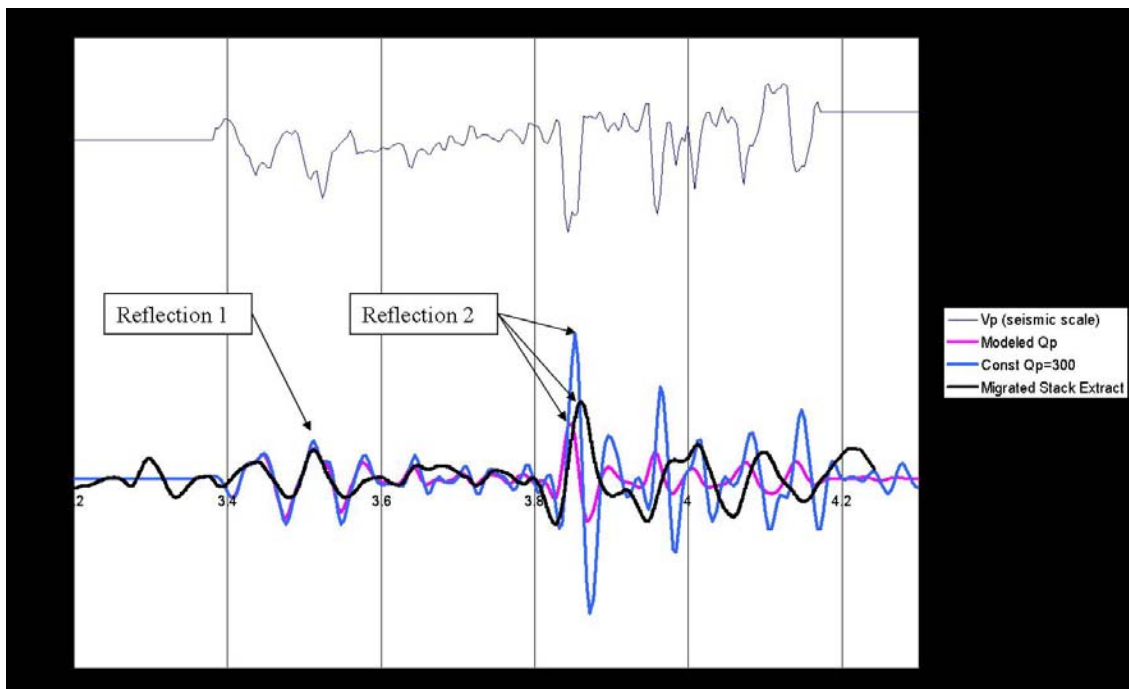


Figure 2.

To compound this effect with additional contamination by higher order, short period multiples, with little residual moveout, could, and have lead to erroneous interpretations. The phase shifted multiple ridden zone can take on the appearance of perspective reservoir with porosity and desired fluid fill.

Conclusions

Seismic data can be degraded and contaminated to lead to in-correct interpretations. Detailed analysis, investigation of potential seismic contamination as well as full integration of a robust and sound geologic model can mitigate some of these effects. The correction for these distortions and “noise” is quite straight forward and can be carried out in most processing centres, but must be understood and quantified through VSP data and models. De-multiple is critical to the preservation of the geologic information within our seismic data and must be applied in a logical and informed manner to remove the multiple without affecting the primary amplitude or phase. Attenuation can be determined from wireline logs and VSP data, or from other methods derived directly from the seismic data, and again, must be applied with care and quality control.

This paper has demonstrated the effects of potential distortive processes on surface seismic in the western Canadian basin. The understanding of them, proper correction for them and interpretation with them in mind can help to mitigate risk, but the caveat must be stated, the mis-use or abuse of these corrections, or the generic application of these results can and will be disastrous.

References

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