Advanced Noise Reduction in Acoustic Logging Waveforms for Logging-While-Drilling or Unconventional Applications

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Summary

Currently in the acoustic logging industry, the only filtering that is implemented regularly is frequency filtering. In any applications prone to noise – such as unconventionals, where there may be bad holes, or with the use of logging-while-drilling tools – frequency filtering is not sufficient by itself. Many times noise is not isolated in time or frequency. The development of advanced noise reduction techniques allows for the use of a better quality waveform for subsequent processing to provide an accurate slowness or other products.

Introduction

Formation characterization and data is an integral part of drilling and completions, particularly in unconventional applications. That said we are continuously trying to minimize the amount spent on collecting data while maximizing the information extracted from that data. Sometimes that means that we choose fewer wells to collect data from and sometimes that means making use of tools, such as logging-while-drilling tools, to cut down rig time. To help maximize the information extracted from cased wells, unconventional wells generally, or from logging-while-drilling tools and to help operators make full use of the tools available to them, this research focuses on advanced noise reduction techniques for sonic log data.

Theory and/or Method

We have adapted a more traditional predictive deconvolution routine for uses in acoustic logging applications. We were unable to use previously written predictive deconvolution routines for many reasons, of which one was that traditional geophysics uses reflective time-series, but in acoustic logging we are using refracted waveforms.

In order to adapt the deconvolution routines, we needed to characterize the noise that we sought to remove. Therefore, we performed our development in two main stages. The first stage revolved around defining the noise. The second stage revolved around how to remove the noise without adversely affecting the character of the formation signal.

Examples

The main test data sets were acquired using logging-while-drilling tools. These data sets often exhibit a strong preceding or anteceding destructive noise signal that masks the formation signal. The development of the routine went through three main iterations. The crux of what needed the most development was that the noise signal is not isolated in time or in frequency.

The routines were then tested on: 1) a cased well, successfully improving the slowness when compared to the field slowness computation and 2) on a data set collected by a logging-while-drilling tool, improving on both the slowness computation from the field and a previously computed slowness that employed only time and frequency domain filtering.

Conclusions

The development has focused on the use of data from cased wells and the data from logging-while-drilling tools. Although, as initially thought, a more standard predictive deconvolution routine could not be used, the routines have been adequately modified to take into account refracted waves and the reverberating nature of the noise in acoustic logging.

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