The Elastic Look-Ahead Walkaway and Predictive Drilling Applications

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ABSTRACT

Introduction

Determination of the variation of velocity in the earth is critical to imaging but also to time-to-depth conversion and pore pressure prediction. Vertical Seismic Profiles (VSPs) have been used for predictive purposes for many years. The common approach is to correlate the corridor stack with surface data to place the well within the seismic volume and thereby determine its location relative to interpreted drilling targets or hazards. Inversion of the corridor stack to acoustic impedance can provide improved vertical resolution and predictive capabilities (e.g. Payne (1994)), but as with all trace inversions the low frequency or long wavelength component must come from an external source as it is not present in the bandlimited trace amplitudes. Additionally, since velocity determination is the ultimate goal an assumption about density is required to convert acoustic impedance values to velocities. Prior to drilling a well and acquiring check shot or VSP t(z) measurements this information generally comes from the moveout of reflections in surface seismic recordings – velocities are estimated using either stacking coherency or reflection tomography. But these velocity estimates may still be too inaccurate to reduce drilling risks to the desired level. Typical problems associated with surface seismic –derived velocities are: bias due to anisotropy, ambiguities due to multiple contamination or illumination issues and limited resolution or bandwidth (limited that is compared to what is achievable with borehole seismic). What is needed is a borehole seismic survey that contains reflection moveout – enter the multi-offset VSP or walkaway.

Walkaways have been used extensively for imaging, anisotropy estimation and AVO calibration but have seen limited use for predictive drilling applications. This is undoubtedly due to the larger volume of data (relative to zero offset VSP data) and more complex processing. Being able to turn around a walkaway data set in a time frame relevant for drilling decisions requires efficient acquisition, data transfer, processing and analysis. The latest borehole seismic technology provides quality 3C data with reliable, efficient acquisition, and rapid data transfer from rig to computing center is now possible (possibly with some data compression), but what of automated processing and analysis ? This is the focus of this paper: to review our approaches to look-ahead walkaway data analysis, to show supporting synthetic and real data examples and to discuss present imitations and the way forward to expand the range of applicability of this very promising technology.