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Phase correlation and Dynamic Time Warping to tie wells to seismic information.

Evert Durán and Milagrosa Aldana
Universidad Simón Bolívar, Ciencias de la Tierra, Caracas, Venezuela, Bolivarian Republic Of (evertduran@usb.ve)

Well tying to a seismic volume has been historically based on the correlation of post-stack seismic amplitudes to impedance contrasts filtered by a wavelet (the convolutional model of the seismic trace). Pre-stack data contains a more pristine representation of the geology and also more phase information because it is not affected by the stacking process. Each stacked trace can be seen as a geological representation of a subsurface point filtered by a slightly different wavelet. If two traces correspond to the same point, it is the reflectivity series or the transitions that the seismic energy encounters what establishes the equality between them, despite the wavelets used.

The phase spectrum of a signal stores information on how the energy is distributed within it. The reflectivity series controls the distribution of the energy which is filtered by the wavelet and, hence, the phase becomes a key factor for identifying geological changes. In this work, a comparison is made between a simple phase correlation, a Dynamic Time Warping (DTW) algorithm and the same DTW algorithm applied in the phase domain in order to assess the best method to tie well information to seismic data. In a DTW, two sequences are warped non-linearly trying to measure their similarity regardless of possible non-linear variations present in the studied domain. The methods are applied to post and pre-stack seismic data. So far, phase correlation seems to be a good way to match seismic traces around wells in a post-stack dataset. Nevertheless, correlation with pre-stack data allows us to recognize the common geological information recorded in every seismic trace.