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Stepping towards more accurate seismic interpretation

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Seismic analysis is all about extracting more information from seismic data. Besides the simple stratigraphic interpretation, the goal is to draw inferences about lithology, porosity, pore fluid content, by also bringing together any *a priori* information that may be available. Many times, such an interpretation gets complicated by the goals that are set for interpretation. For example, thin target reservoirs, that are below seismic tuning could be challenging, despite significant efforts expended during processing of the seismic data. In such situations, the utilization of seismic inversion could help. Consequently, advanced methods have been developed for spectral balancing and bandwidth extension of seismic data. Earlier, *thin-bed reflectivity inversion* was developed for bandwidth extension of seismic data, which was based on spectral inversion, and was found to help in various situations. A relatively new method for bandwidth extension using *sparse layer seismic reflectivity inversion* based on the application of basis pursuit decomposition is now being used in our industry. This method yields a reflectivity series, which can be filtered to a desirable bandwidth that exhibits optimum resolution and reasonably accurate synthetic ties to wells and can also be used to derive relative acoustic impedance. By extending the bandwidth of the input seismic data (5 – 70 Hz) to say 120 Hz high-end, more reflection cycles are seen which usually correlate well with the picked horizons on the input seismic data as well as the synthetic seismograms generated with the individual bandwidth wavelets. Not only the attribute computation carried out on bandwidth enhanced seismic data show higher resolution, but the higher resolution seismic data leads to an overall more detailed and accurate interpretation.

Our efforts at drawing comparisons of attribute computations such as P-impedance, broadband and multispectral coherence, long- and short-wavelength positive and negative curvature attributes, and spectral magnitude computations on input and bandwidth extended versions of seismic data for various case studies have demonstrated a higher level of detail, whether it is the lineaments corresponding to faults or the thin-layered lithointervals.

Another interesting technique that shows promise is the recently introduced phase decomposition analysis, which entails amplitude variation with time as a function of the seismic reflection phase. Assuming a zero-phase wavelet embedded in the seismic data, while flat spots or unresolved water contacts may be seen on the zero-phase component, in seismically thin layers, impedance changes will show up on phase components that are 90° out of phase with the wavelet. Thus, bright spots caused by thin hydrocarbon reservoirs are associated with low impedance and show up on the phase component that is −90° out of phase with the seismic wavelet. In all cases the interpretation of bright spots is found to be convenient, and easier, with the use of the −90° seismic phase component.

An important aspect that may be mentioned here is about using reprocessed vintage seismic data, which usually have narrow frequency bandwidths. One major advantage that reprocessing has over processing the original data is that the interpreters have significant insight into the subsurface geology. The interpreter will want the processor to fix bad well ties, minimize events that are now known to be interbed multiples, and sharpen chaotic features that the interpreter now knows to be complex geology rather than seismic noise. With this additional focus and care, reprocessing can illuminate both stratigraphic and structural features not visible before. The reprocessing cost and time is usually much less than the cost of acquisition of a fresh survey and its processing. Reprocessing with state-of-the-art processing techniques can result in a significant uplift to the data quality, resolution, preservation of amplitudes, and lead to enhanced interpretation.

Such state-of-the-art techniques and workflows when implemented on the available seismic data can yield more detailed interpretations. As long as we take care of the amplitude preservation during processing/reprocessing and their calibration with well data, the application of such techniques will result in meaningful interpretations.

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