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Adequate QC steps and their impact on reservoir characterization analysis

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The differentiation between lithology and fluid content in a reservoir is one of the objectives of reservoir characterization that is carried out using seismic data. Seismic impedance inversions, deterministic or geostatistical, help us achieve this objective. Obviously, seismic data conditioning and inversion analysis are two main components of an inversion process. A proper QC workflow needs to be followed during individual steps. The purpose of data conditioning is to enhance the signal-to-noise ratio by following conventional processes such as band-pass filtering, super gathering, random/multiple noise attenuation and trim statics. Following are the questions that need to be answered after data conditioning

- Is the variation of amplitudes with seismic offsets and azimuths preserved?
- Is there any distortion of the far offset amplitudes due to anisotropy?

While data conditioning is usually performed in offset domain, seismic impedance inversions are executed in the angle domain. Therefore, angles must be estimated, which is usually done by following the relationship given by Walden (1991) as follows:

$$Sin\theta = \frac{V_{int}x}{V_{NMO}^2 t} = \left(\frac{V_{int}}{V_{Smooth}}\right)\frac{x}{\sqrt{x^2 + (V_{Smooth}t_0)^2}},$$

where V_{int} is the interval velocity obtained from V_{Smooth}, V_{Smooth} is the spatially varying velocity derived by smoothing the stacking velocities over a cable length (Mukhopadhaya and Mallick, 2011). As per this equation, incidence angles depend on the interval velocity. Errors in the interval velocity yield approximately proportional errors in estimated angles. Hence, velocity plays an important role in offset-to angle domain conversion. Two types of velocities, namely seismic and well velocity are available for such a domain conversion. From the QC standpoint, it is desirable to make sure that the velocity model used in the domain conversion process honors well -log data, geological interpretation, in addition to spatial variation of seismic velocity. It might be worthwhile to mention here that the angle estimation also depends

on wherefrom they are measured, whether zero time on seismic data or the floating datum. The proper way of angle estimation is to follow the floating datum.

Thereafter, during the inversion analysis step, following are the things that need to be considered before running seismic impedance inversion on the full volume:

- Wavelet extraction analysis: time/spatial variation.
- Reliable low frequency model.
- Comparison of near-angle stack with final PSTM stack data.
- Analysis of the different lithological trends in the zone of interest.

In the current study, we have tried to characterize the Bone Spring, Wolfcamp and Barnett shale intervals, in terms of local sweet spots by addressing different QC steps described above.

References

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