Quantitative Seismic Analysis Using Noise Abatement in a Tight Sand Horizontal Play

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Onshore 3D seismic data typically contains unique noise issues which are not present offshore. The near surface is subject to a complex velocity structure which frequently causes misalignment of reflections from different shot-receiver pairs within the CMP gather. Fold of stack is also historically much lower for onshore 3D's than offshore surveys, although this is starting to change. Coherent noise in the form of source-generated and cultural noise is also a much bigger issue for land-based surveys than the offshore counterpart. Taken all together these issues can present serious challenges to the onshore 3D in terms of resolution needed to properly quantify rock properties via prestack attributes or inversion.

Traditional filters work on coherent noise by translating the time-offset domain data to other domains where the noise is isolated from the signal. These methods tend to work reasonably well offshore where the signal is densely sampled spatially. Because they tend to mix the energy of the signal across the offsets in the gather, often they are highly detrimental to 3D geologic resolution in the onshore environment with the lower fold and uneven spatial sampling. Filters for random noise which are applied post-stack tend to mix signal and noise together, hiding the noise instead of removing it. Obviously, these approaches are detrimental to the signal and resolution of the geology to some degree.

There is a new class of noise abatement tools which is emerging from various processing centers. These tools work on the gathers and the stack together without translating the data to another domain. Most classes of noise (source-related and random) are precisely identified and removed – without the distortion of the signal that occurs with other methods. The method we use has been shown to be extremely effective at improving the focus of the data when used both before and after migration. Most of the noise is removed mid-processing, improving the ability to resolve typical ambiguities between statics and velocity solutions. The resulting dataset going into migration does not have the noise component. Not migrating noise is always a good thing.

After migration, the PSTM gathers are typically conditioned again to further improve the signal. The resulting gathers subsequently are clean enough so that typically a partial stack has as much signal to noise as does the full stack with the benefit of improved frequency content. The seismic data at this stage needs spectral balancing which often improves the higher frequency components of the signal even further. With higher signal to noise and a broader frequency spectrum, prestack attributes and inversion processes are better able to resolve geologic detail than without this noise abatement technology.

This case study shows the application of this technology to an older 3D in the Texas Panhandle which is being used for horizontal well planning. The target is thin; tight Lower Morrow Sandstone which sits unconformably on the Mississippian Limestone section. The challenge for the drilling engineer is keeping the borehole in the target zone in the presence of faults and variable target thickness. The study

shows the difference between processing workflows that use this technology and traditional ones. While not quite sufficient to completely resolve the target, the final inversion allows the engineer to plan the well trajectory with some degree of confidence.