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Enhanced Duplex Wave Migration Post-processing Methodology for Identifying Fracture Zones

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ABSTRACT

Fractures play a significant role in most carbonate and unconventional reservoirs' (tight gas and shale gas) production. Conventional seismic attributes such as curvature, discontinuity and amplitude analysis can provide information on large-scale fractures and faults. These methods are based on many assumptions and therefore, may not be accurate for identifying small-scale fractures. The duplex wave migration (DWM) technology is an accurate technique involving direct measurement from prestack seismic data. The duplex wave undergoes two reflections, first from the sub-horizontal layer and then from a sub-vertical layer (or in an opposite order) and then reaches the surface where it is recorded. The energy associated with the duplex wave is much lower compared to the conventional single- bounce reflection energy and usually it is contaminated with noise. We developed an improved DWM stack post- processing methodology using amplitudes and voxel connectivity strength that resulted in significant enhancements for defining the subsurface fractures and geobodies. The specific steps for our improved DWM stack post-processing methodology will be presented in this presentation.

We have imaged approximately 200 km^2 of wide-azimuth land seismic data located in Saudi Arabia using this methodology. The DWM tool showed higher lateral resolution of the lineaments compared to that in conventional PSDM. The post-processed DWM volumes provided us with a new attribute that correlated closely with the discontinuities and fracture zones observed in both cores and logs. The geobodies extracted from the DWM voxel connectivity volumes provided crucial 3D insights into the fracture patterns and their true geologic connectivity. In addition, the geobodies extracted from the VCF volume help to visualize the fracturing zones which could be interpreted as "best" areas (i.e., opportunities) for development drilling. We anticipate that future exploration drilling in this area will highlight the success of our production-well-correlated VCF technique for measuring fracture density, to better predict production pathways for hydrocarbon extraction.