Seismic Attribute as an Aid to Production from Fractures

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Summary

Characterization of fractures is essentially the understanding of fracture patterns, so that appropriate ways can be devised for effectively draining out fractured reservoirs. The presence of naturally occurring fracture networks can lead to unpredictable heterogeneity within many reservoirs. Alternatively, fractures provide high permeability pathways that can be exploited to extract reserves stored in otherwise low permeability matrix rock. So, in essence, characterization of fractures is an important goal that should not be underestimated.

Of the various seismic attributes available, curvature and coherence attributes are found to useful for delineating faults and predicting fracture orientation and distribution. There are different curvature measures that can be used, each having its own characteristic property. Curvature computation is not only restricted to horizon-based surfaces, but has been extended to volume computation as well. The orientations of faults and fracture lineaments interpreted on curvature displays can be combined in the form of rose diagrams, which in turn can be compared with similar diagrams obtained by FMI well logs to gain confidence in calibration.

Coherence measurements in three dimensions represent the trace-to-trace similarity and therefore produce interpretable changes. Similar traces are mapped with high coherence coefficients and discontinuities have low coefficients. Regions of seismic traces cut by faults for example, result in sharp discontinuities in trace-to-trace coherence, producing delineation of low coherence along fault planes. Since three-dimensionality is an essential ingredient of coherence computation, faults or fractures in any orientation are revealed equally well. Stratigraphic features generate similar discontinuities resulting in sharp detection of reef and channel boundaries and deltaic sediments. An attractive characteristic of coherence volumes is that it gives an unbiased view of the features in the seismic volume – no interpretation is required for viewing them.

In a vertically fractured zone, AVO response will vary with azimuth; the largest variation will be between the AVO responses parallel and perpendicular to the dominant fracturing direction. Amplitude Versus Offset (AVO) analysis of azimuthally restricted seismic data is used to determine the orientation and density of fractures.

Various visualization techniques - such as opacity or thin-slab - can be quite valuable when mapping fracture distribution, connectivity and orientation at well locations and detecting fractures between wells within a reservoir.

Apart from these, the common interpretation workflows being used in the industry will be mentioned. Examples will be presented for the application of seismic measurements and well control, which are sensitive to fractures. This will be followed by a discussion of the recent progress in efforts for improving fracture delineation. Finally, the challenges facing us in terms of production from fractures will be mentioned.