Significance of Seismic Phase in Interpretation of Stratigraphy and Sedimentology

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ABSTRACT

Waveform and measured seismic amplitude are a function of not only reservoir thickness but also the characteristics of seismic wavelet phase. Most petroleum reservoirs fall into the category of seismically thin beds. A rotation of seismic wavelet phase in thin-bedded section changes the microgeometry of, and relationships among, seismic events, potentially leading to different interpretations of seismic stratigraphy, lithofacies, and geomorphology. As a result, phase conditioning of seismic data can be critical for reservoir-scale stratigraphic analysis and prediction. Standard seismic processing produces 0°-phase seismic data as the final products delivered to interpreters. Interpretive advantages of 0°-phase data include wavelet symmetry, center lobe coincidence with reflection interface, and higher resolution. However, those advantages are realized only if the seismic reflection comes from a single reflection interface. In most common seismically thin reservoirs where composite seismic responses mix reflections from the top and the base of the bed, 90°-phase data (equivalent to the quadrature attribute if data are exactly zero-phased) are a better choice. Models and real data examples from West Texas carbonate sequences and Gulf Coast clastic successions show that 90°-phased data provide (1) better ties between well logs (SP/GR) and seismic, (2) better seismic-lithologic mapping, (3) better seismic-geomorphologic interpretation, (4) higher S/N ratio, and (5) less geologic interference and higher stratigraphic resolution. A 90°-phasing of 3-D data also provides a unique opportunity to study reservoir-scale depositional architecture (vertical grain-size trends and progradational/accretional style) directly using seismic information.