3-D volumetric multispectral estimates of reflector shape

Kurt J. Marfurt and Saleh Al-Dossary Allied Geophysical Laboratories, University of Houston

ABSTRACT

While seismic attributes such as acoustic impedance and spectral decomposition are directly related to porosity and reservoir thickness, geometric attributes are only indirectly related to reservoir properties. By use of geologic models and paleo and modern geologic analogues, geometric attributes provide a means of unraveling the history of tectonic deformation and depositional environment, thereby allowing us to *infer* Petrophysical properties such as sand/shale ratios, diagenetic alteration, and the likelihood of fractures. One of the most well accepted geologic models is the relation between reflector curvature and the presence of open and closed fractures. Such fractures, as well as other small discontinuities, are relatively small and below the imaging range of conventional seismic data. Depending on the tectonic regime, structural geologists link open fractures to either Gaussian curvature or to curvature in the dip or strike directions. Reflector curvature is fractal in nature, with different tectonic and lithologic effects being illuminated at the 50 m and 1000 m scales.

Until now, such curvature estimates have been limited to the analysis of picked horizons. We have developed what we feel to be the first volumetric spectral estimates of reflector curvature. We find that the most positive and most negative (also called principal) curvatures to be the most valuable in conventional mapping of lineations, including faults, folds, and flexures. Such lineations are mathematically independent of, and interpretationally complementary to, the well-established coherence geometric attribute. We find the long spectral wavelength curvature estimates to be of particular value in extracting subtle, broad features in the seismic data such as block faults, karsts,

and compartmentalization. While single trace attributes can be calibrated by vertical well control, we feel that the calibration of the fracture prediction capability of geometric attributes will be best addressed through either horizontal image logs, production history, pressure-transient tests, and/or tracer tests. We will illustrate the value of these spectral curvature estimates and compare them to other attributes through application to a land data set from the Fort Worth Basin with a long history of production, and to a deep water marine data set from the Gulf of Mexico that has little well control.