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**Charlotte Sullivan /Kurt Marfurt/ Chuck Blumentritt, Applied Geophysical Laboratories (AGL), University of Houston: Recent advances in geometric seismic attributes at the AGL, and application of this technology to the imaging of fractures, joints and small scale faults, and to the goal of separating seismic signatures related to paleokarst, hydrothermal processes and tectonic collapse features**

### **Geometric Attributes Applied to Fracture, Karst and Hydrothermal Overprints**

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#### **Abstract**

New geometric seismic attributes being developed at the AGL at the University of Houston provide a means of seismically unraveling the history of tectonic and paleokarst deformation, thereby allowing us to infer petrophysical properties such as diagenetic alteration, and the likelihood of open cracks. One of the best-accepted geologic models for determining deformation is the relation between reflector curvature and the presence of open and closed cracks. Depending on the tectonic regime, structural geologists link open cracks 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 are of great efficacy in conventional mapping of lineations, including faults, folds, and flexures. Estimates of reflector rotation are relatively insensitive to joints; rather they highlight cracks that have some component of scissor displacement, and provide a quality control measurement on fitting reflectors with a quadratic surface. Long spectral wavelength curvature estimates are of particular value in extracting subtle, broad features in the seismic data such as fault blocks, compaction over karst landscape, folds linking stepover faults, and pressure ridges. Estimates of reflector curvature and rotation can be applied either on slabs of data flattened about a picked horizon, or on the uninterpreted seismic cube, which avoids interpreter bias. We will illustrate the value of these spectral curvature estimates and compare them to other attributes through application to 3-D data sets from west Texas and the Ft. Worth Basin in Texas, and from the Appalachian and Michigan Basins, and Canada. We can show that even though we may not be able to resolve thin bed thicknesses much below tuning, amplitude-sensitive geometric attributes allow us to detect subtle lateral changes in thickness of beds less than 1/10 of a wavelength thick. In our examples from west Texas, we illustrate application to seismically predicting direction of open (mode 1) fractures through time, and application to resolving paleocave from tectonic collapse structures.

We use our Appalachian, Canadian and Michigan examples to show our progress toward separating seismic signatures of subaerial karst, tectonics, and hydrothermal processes

### **Biographies:**

**Kurt Marfurt** began his geophysical career as an Assistant Professor teaching mining geophysics at Columbia University's Henry Krumb School of Mines in New York. After 5 years he joined Amoco at their Tulsa Research Center. Marfurt has spent the last 23 years doing or leading research efforts in modeling, migration, signal analysis, basin analysis, seismic attribute analysis, reflection tomography, seismic inversion and multicomponent data analysis. Through Amoco he won 5 patents, 2 in seismic coherence technology. He is the author of several dozen articles, coeditor of two books published by the SEG, and has received both the best presentation award for work on modeling (1989) and best paper award for work on seismic coherence (1999) from the SEG. Marfurt joined the University of Houston in 1999 as a Professor in the Department of Geosciences and as Director of the Allied Geophysics Laboratories. He is currently a member of the GSH, SEG, EAGE, AAPG, and AGU, served two terms as an Assistant Editor, is currently serving his fifth term as an Associate Editor for Geophysics, and teaches a short course for the SEG on seismic attributes.

**Charlotte Sullivan** is a petroleum geologist and Research Assistant Professor at the University of Houston. She has 30 years of industry experience with a focus on carbonate reservoirs in the Philippines, Qatar, Trinidad, Mexico, West Texas, New Mexico, and the Eastern U.S. Charlotte worked for Robertson Research, Phillips Petroleum, Pennzoil and Southwestern Energy before joining the AGL in 2000, where she spends considerable energy on the calibration of seismic attributes. She is a member of AAPG, GSA, SEG, WTGS and HGS, and teaches core and outcrop-based industry short courses on Sedimentology and image logs.

C. H. "Chuck" Blumentritt graduated from St. Louis University with a B.S. in Geophysical Engineering in 1970, after which he joined Amoco for a career spanning nearly 29 years as a geophysicist. He began working in acquisition, processing, and technical projects which provided an excellent foundation for the bulk of his experience in seismic interpretation in various parts of Wyoming, Alaska, Africa, the Middle East, Trinidad, and the Gulf Coast. This work included all types of tectonic provinces: passive margin, compression, wrench, and salt -and included siliciclastic and carbonate depositional environments. Chuck is currently a researcher with the Allied Geophysical Laboratories at the University of Houston, where he is applying newly developed volume based seismic attributes to data from a variety of geologic settings, and is completing his PhD studies.