

## **Latest Advances in Seismic Imaging of Subtle Geologic Features in Carbonates – Examples from the Permian Basin and Fort Worth Basin, Texas, USA.**

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### **Abstract**

Seismic exploration in carbonates often focuses on subtle features embedded in high velocity rocks. Porous reservoir intervals commonly fall below the classical 1/4 wavelength (20-50 m) limit to seismic resolution. In addition, permeability pathways may exist along microfaults and crack systems that have little vertical offset. Although we may not be able to resolve these subtle features on vertical seismic sections, we can often detect them on horizon amplitude extractions. Modern multi-trace seismic attributes such as coherence, coherent energy gradients, and a suite of vector dip attributes, including inline dip, crossline dip, reflector curvature, and reflector rotation greatly facilitate this process by avoiding the need to pre-interpret discrete horizons and by enhancing subseismic lateral variations in reflectivity. In this presentation, we will describe the mathematical and physical basis of these new attributes being developed at the University of Houston, and show how they are often coupled to each other through the underlying geology. Next, we will apply these attributes to the analysis of complex faulting, deposition, and karst from Paleozoic carbonate plays in Texas. We will show that while seismic coherence is a powerful tool for mapping faults and stratigraphic features, it often fails in providing any insight into reservoir heterogeneity when the reflections are consistently strong. Instead, we find that coherent energy gradients best image subtle channels, while dip/azimuth and curvature allow us to see subtle faulting and fracturing that is below conventional seismic resolution. Image log data may be one of the most powerful tools for the calibration of multi-trace seismic attributes. In addition to using image logs to calibrate attributes, we are interested in using image log and other wireline data to improve workflows for building field-scale seismic-based, sequence stratigraphic frameworks for carbonate reservoirs.

### **BIOGRAPHIES**

**Charlotte Sullivan** is a research geologist with the Allied Geophysical Laboratories (AGL) at the Department of Geosciences, University of Houston. Her technical expertise is in sedimentology and sequence stratigraphy, with special interest in the integration of image logs with seismic and other data. Dr. Sullivan has over 25 years experience in tech services, and exploration and development geology in Indonesia, Philippines, Qatar, Trinidad, Mexico, West Texas and New Mexico. She worked for Robertson Research, Phillips Petroleum, Pennzoil and Southwestern Energy before joining the AGL in 2000.

**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

five years, he joined Amoco at their Tulsa Research Center. Dr. Marfurt has spent the last 22 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 five patents, two in seismic coherence technology. He is the author of several dozen articles and coeditor of two books published by the SEG. Kurt joined the University of Houston in 1999 as a Professor in the Department of Geosciences and as Director of the Allied Geophysics Laboratories.

**Charles (Chuck) Blumentritt** is a Ph.D. student in geology at the University of Houston. Chuck spent 28 years as a geophysicist with Amoco, working at various times in acquisition, processing, technical projects and interpretation. He has worked both exploration and development projects in the Rocky Mountains, Tunisia, Egypt, UAE-Oman, Trinidad, Mexico, and Gulf of Mexico. His primary interest is in integrating 3-d seismic and well data to develop more accurate geologic interpretations.