GSA Combined NE and SE Sections March 2004

Application of Volumetric Seismic Attributes to Fractured Reservoirs: A Potentially Important Technology for the Appalachian Basin

Fractured reservoirs, including unconventional reservoirs, represent the greatest potential growth area for gas reserves onshore North America. New geometric seismic attributes being developed at the Allied Geophysical Laboratories at the University of Houston are particularly sensitive to curvature, small-scale faults, karst, and field scale fracture systems. These new attributes are derived from conventional, P-wave 3-D seismic surveys and represent a cost-effective technology for small independents.

Seismic exploration in Paleozoic Basins focuses on subtle features embedded in high velocity rocks. These features commonly fall below the classical 1/4 wavelength (20-50 m) limit to seismic resolution. Microfaults, joints, and fractures so important to gas production may have little to no vertical offset. Although we may not be able to resolve such subtle features on the vertical section, 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 interpret discrete horizons and by enhancing subseismic lateral variations in reflectivity. Although reflector curvature calculated from discrete interpreted horizons is well correlated to fracture intensity, we believe we are the first to be able to generate curvature images for 3-D data volumes. In this presentation, we define the mathematical and physical basis of these attributes, 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 karsting from Paleozoic plays in Texas, and suggest applications for fractured reservoirs in the Appalachian Basin. 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 seismic resolution.