AAPG Annual Convention
Salt Lake City, Utah
May 11-14, 2003

Stephan Bergbauer[1], Tapan Mukerji[1], Peter H. Hennings[2] (1) Stanford University, Stanford, CA (2) Phillips Petroleum Company, Bartlesville, OK

Improving Curvature Analyses of Deformed Horizons Using Scale-Dependent Filtering Techniques

When developing fractured reservoirs, knowledge of location, style, density, and orientation of fractures is essential. In quantitative structural geology, a horizon's curvature is often used to infer the density and location of fractures. It is assumed that areas of elevated calculated curvatures underwent elevated deformation. Usually, curvatures are calculated from spatial data after sampling the continuous horizon at discrete points. This sampled geometry of the horizon includes surface undulations of all scales, which are then also included in the calculated curvatures. Including surface undulations of all scales in the curvature analysis leads to noisy and questionable results. We argue that the source data must be filtered prior to curvature analysis to separate different spatial scales of surface undulations, such as broad structures, faults, and sedimentary features. Only those surface undulations that scale with the problem under consideration should then be used in a curvature analysis. For the scale-dependent decomposition of spatial data we test the suitability of four numerical techniques (Fourier analysis, wavelet transform filtering, singular value decomposition, factorial kriging) on a seismically mapped horizon in the North Sea.

For surfaces sampled over a regular grid (e.g. seismic data), spectral analysis extracts meaningful curvatures on the scale of broad horizon features, such as structural domes and basins. A combination of Gaussian and mean curvature, which we call shape-curvature, provides a means for evaluating how well the smoothed surface represents the original surface. The spectral method is also suitable for extracting meaningful curvatures of smaller scale structures.