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Churning seismic attributes with principal component analysis

Satinder Chopra[+] and Kurt J. Marfurt[†]

[+]Arcis Seismic Solutions; [†]The University of Oklahoma

Seismic attributes are an invaluable aid in the interpretation of seismic data. Different attributes are derived for different purposes. For example there are discontinuity attributes for fault interpretation, impedance and AVO-derived attributes for lithology interpretation, spectral decomposition frequency volumes to quantify tuning effects and help identify hydrocarbons, and many others. Extracting all the potential information hidden in the seismic data using a single attribute almost never occurs. Therefore a combination of attributes or multiattribute analysis is carried out to gauge more information overall than what is possible with any one attribute.

When attempting multiattribute analysis usually attributes of a similar kind are used, i.e. coherence and curvature attributes for fault interpretation, or impedance, lambda-rho, mu-rho, or other similar kind of attributes for lithology or fluid interpretation. However, in doing so we may be limiting ourselves to a subset of the information, say structural vs. stratigraphic. There are several ways of combining multiple attributes, with visualization in RGB and HLS color space coupled with transparency being one of the more powerful means. Unfortunately, such color display is limited to three and with transparency four attributes. One of the methods commonly used for this purpose is principal component analysis, which essentially 'churns' the different attributes and yields one or two volumes that represent the maximum variation in the input attributes. Such analysis reduces redundancy but projects the interpreter into mathematical vs. physical space, such that the resulting images can be difficult to understand. We present the results of our investigation into the combination of attributes that should be used for such an analysis.