Seismic Waveform Classification: *Techniques and Examples*

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Seismic waveform shape and character can define facies and reservoir parameters with far greater detail than traditional time and amplitude mapping. Modern techniques using waveform classification make it possible to define and map subtle changes in seismic response and to match them to subsurface information. Waveform classification can also be combined with multi-attribute analysis by concurrently evaluating trends in numerous seismic measurements such as instantaneous attributes, semblance, acoustic impedance and AVO.

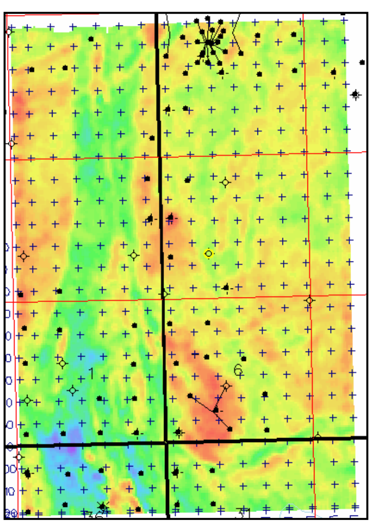
There are two primary types of classification methods: *Unconstrained* (Unguided or Unsupervised) and *Constrained* (Guided or Supervised). An unconstrained classification gives the interpreter insight by showing how a waveform is changing within the survey. Aside from defining an analysis interval, unconstrained classification does not use any a priori information to determine how a seismic trace is classified, and the results are entirely data driven. Constrained classification uses the known information at specific well locations to classify the seismic data.

The benefit to constrained classification is that it becomes possible to impart geologic meaning to the cluster analysis. Whereas in unconstrained classification a result is based on how the individual traces in a 3D survey are grouped by their respective similarity (or difference), in constrained classification, a result is based on how well a target trace compares to the model trace. If an interpreter has a good understanding of a seismic signature generated by a specific geologic facies, that waveform can be correlated to the other traces in the 3D. A Waveform Correlation Map can then be derived showing where the target traces have the highest correlation to the known waveform

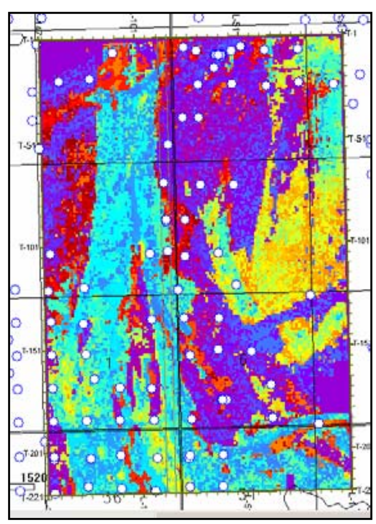
Multiple attribute volumes can be also be derived from a single 3D survey. The most common of these are instantaneous amplitude, phase and frequency, but they may also include acoustic impedance and AVO. Subtle differences within the seismic data are often enhanced or defined by these attributes. A problem arises, however, when an attempt is made to correlate a trend from one volume to another.

"Measurements" such as maximum amplitude, ratio of peak to trough, amplitude slope, etc. are taken over the same interval of *each* of the attribute volumes. *Principal Component Analysis* is then used to reduce the information redundancy within the various attribute volumes. It provides a unique solution that is statistically meaningful by ranking those measured attributes that correlate to others. Usually, three or four attributes make up the correlated data set.

This paper will focus on some of the various techniques of performing seismic waveform classification including Constrained/Unconstrained classification and Principal Component Analysis (PCA). A Slave Point carbonate play and Lower Cretaceous clastic channel play in Western Canada will be used for illustration purposes.



Post Stack Amplitude



Classification Result