Determining Facies from Wireline Logs using Discriminant Analysis

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Abstract

Reservoir simulation requires a matrix of cells to model the geotechnical properties of lithologic intervals (facies) in the subsurface. Typically, a control set of reservoir facies determined from well core are assigned or "pigeonholed" into one of a small superset of lithofacies, representing distinct reservoir engineering properties. These are then used to populate the matrix using some gridding procedure, usually geostatistical Kriging. Core being a physical sample of the reservoir, geologists can construct a realistic facies model from direct observation. However, in areas of poor core control, one may need to interpret facies from wireline logs alone. Some lithologies such as clean sand, coal or 100% clay intervals are easy to differentiate from wireline logs, but mixed and interbedded lithologies are more problematic. The statistical technique known as Discriminant Analysis offers a solution.

Discriminant analysis is a multivariate statistical technique allowing probabilistic discrimination of a data set into discrete populations in multidimensional space. It is rooted in the traditional cross-plot analysis used to discriminate clusters in two dimensions, but extended to n-dimensional space. It is also somewhat analogous to multiple regressions, but where the dependent variable is categorical rather than a continuous real number. Applied to wireline logs, each log represents a single linear dimension of multidimensional space, whereas a "facies" corresponds to a multidimensional cluster or ellipsoid in this space. Several examples from Athabasca Oil Sands reservoirs provide an overview of the technique.

Reference Cited

Gupta, R. and H.D. Johnson, 2002. High resolution facies architecture of heterolithic tidal deposits: An integrated outcrop and electrofacies analysis of a complex Reservoir. In M. Lovell and N. Parkinson (eds.), Geological applications of well logs: AAPG Methods in Exploration No. 13, pp. 161-184.