Integration of Geological and Geophysical Data, Current Practices and Future Directions

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Abstract

The integration of geological and geophysical data has long been used in the building of static reservoir models. Geophysical attributes are often used as proxies for geological facies and petrophysical properties. For example, velocity can be used in some instances as sand or shale indicator, or acoustic impedance is often used as an indicator of porosity. Common practice is to create the regression relationship between the well and geophysical attribute and use this relationship to convert from one variable to the other. An alternative approach is to perform a cokriging or cosimulation, a geostatistical integration requiring the use of a spatial model, or variogram. Although the two integration methods are not equivalent and can be shown to generate significantly different results, kriging and its derivatives are an extension of classical regression that incorporates knowledge of spatial relationships. The fact that they are not equivalent comes from the presence of the slope term, b, in the traditional regression equation – a term replaced by a covariance matrix in the geostatistical reformulation. The slope term imparts a spatial estimation bias resulting in systematic over-or-under estimation within specific geographic regions of the mapped area. These regions are not specified by the modeler, but instead are controlled purely by the mathematics.

In order to observe the difference between these two approaches, cross validation, a statistical technique, can be used to test each model hypothesis. Cross validation temporarily suppresses one data value at a time using the remaining data and designated interpolation procedure (regression or cokriging) to calculate an estimate in its place. The resulting estimates can then be compared with the actual values, and a set of statistical metrics can be calculated to test the integrity of the estimation method. In this paper, we will show an example of the methodology using acoustic impedance and well porosity from a Texas Oil Field. Cross validation results will be shown for each case, linear regression estimates and cokriging estimates, in order to demonstrate the unbiased behavior of kriging based methods.