Petrophysical Parameter Prediction Utilizing Limited Core Training Data

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Abstract. Estimates of routine and special core petrophysical parameters from logs in uncored wells rely on establishing correlations between core and log data in a nearby cored well, or by using generic database correlations for the particular reservoir type of interest. The purpose of the present study is to determine how much core training data is necessary in order to make meaningful predictions. We will demonstrate that even very limited core plug training data can produce good predictions, provided that the core plug data is representative of the reservoir(s) of interest. By using a methodology that combines machine learning with the concepts of representative genetic units and global hydraulic elements, we will show that careful selection of minimal representative core plug training data can provide predictions that are almost as good as those obtained by utilizing much larger core plug training datasets. We will demonstrate this from predictions of permeability using key well logs and different amounts of core plug training data. Specifically we compare the performance of predictors trained on data from 4 scenarios using progressively smaller numbers of core plugs as follows: (1) the entire core plug dataset in the training well, (2) core plug data from specific reservoirs in the training well, (3) core plug data from short representative genetic units (RGUs) in the training well, and (4) minimal representative core plug data selected via global hydraulic element (GHE) analysis within individual RGUs in the training well.

Remarkably, the predicted permeability values throughout the well based on scenario (4) using minimal core plug data (from just a few representative plugs – each from a different GHE) were almost as good as those from scenario (1) using the entire core plug dataset (several hundred plugs), in terms of the r2 correlation coefficient between the predicted and actual permeabilities. The r2 values from all of the scenarios were relatively high. The methodology can be applied to predicting other petrophysical parameters from minimal, representative core data, as will be discussed.

The benefits of the methodology are that it provides a rapid, cost effective way of predicting petrophysical parameters, which would potentially be useful in the exploration, appraisal, development and decommissioning phases of a field. The same approach can be used to provide rapid, cost effective predictions of petrophysical parameters from historical core, thus allowing further insights into wells drilled some time ago.