Lithology Prediction Based on the Full-Waveform Inversion Results

Runhai Feng[1], Stefan M. Luthi[1], Dries Gisolf[1], and Siddharth Sharma[1]

[1]Delft University of Technology, Delft, Netherlands

Abstract

A non-linear full-waveform inversion scheme (FWI-res) has been applied to a synthetic seismic dataset, which was obtained based on a high-resolution geological and petrophysical model (Book Cliffs, USA). Since the non-linear relationship between the data and the property values has been fully honoured by the inversion method, the retrieval of the rock properties and geological geometries is successful. Then the inversion results are used as an input for the prediction of lithology, in which the fuzzy logic method will be used. The property values from three well logs are firstly used to build the membership functions (MFC) of the 12 different lithologies in which the unnormalized double-Gaussian function is utilised in order to fit the possibility of the histogram. Because in the petrophyscial modeling the lithology has been divided into the marine and non-marine parts, the membership function (MFC) has been separated accordingly. In order to qualify the performance of the classifier, both of the confusion matrix as a visual inspection and the Matthews Correlation Coefficient (MCC) as a quantity measurement are proposed. The biggest advantage of the confusion matrix is that not only the percentage of correct classifications can be analysed, but that also for the nearly correct classification can be analysed, as well as the wrong classifications. Instead of using the accuracy which is defined as the ratio of the correctly classified samples over the total number of samples, the MCC is used here a numerical discrimination of the misclassification distributions. The result of the classification shows that the main reservoir lithologies, such as the coarse and medium-grained sandstones, are well predicted. Wrong predictions do happen, in which medium-grained sandstone is misclassified as claystone, which is the non-reservoir lithology. However, this error only accounts for a very small percentage and does not influence our overall assessment of the performance of the fuzzy logic method.