Non-destructive identification of silt-clay layers on borehole core logs in PVC liners

J.-M. Chautru & H. Binet (GEOVARIANCES), A. Berckmans & L. Wouters ONDRAF/NIRAS, Prof. Em. N. Vandenberghe

Abstract

The Boom Clay is investigated as potential host formation for geological disposal of high-level and/or long-lived radioactive waste in Belgium.

The main objective of the study was to link borehole geophysical measurements to PVC cased core loggings, so to transfer the microstratigraphy determined in the well loggings onto the cores and track down the position of the silt-clay layering that is so typical for the Boom Clay Formation.

The study was hampered by the clay expansion effect in the PVC liners due to pressure loss when sampling, subsequent loss of material during the coring and a variable depth measurement due to stretch/shrinkage of the cable length while logging

The first approach was to enhance continuous logs signal by means of geostatistical methods. For logs representing the same variable (GR, Resistivity…), the variograms calculated from boreholes measurements (every 15cm) and from core measurements (every 2 cm) are expected to be similar. Subsequently Factorial Kriging was used to extract the trend and high frequency component from the logs. To preserve the log histogram and the relative weight of trend and high frequency component, a Gaussian transformation of each extracted curve was done. The last operation leads to a new curve which has the resolution of the high-frequency component of the core log with the histogram of the same component in the borehole log. This final curve is added to the trend of the borehole log, building a final log with the same histogram and the same ratio between trend and high-frequency component as in the initial log at a higher resolution.

After applying this methodology, it became clear that the available data characteristics did not allow the definition of a geostatistics based procedure for automatic silt/clay layer identification. The dissimilarity between the Resistivity curves in the well and along the cores was a critical issue.

This led to a second method using a moving window approach combined with correlation calculations which yielded more reliable results.

This second approach to silt/clay layers detection along the cores is a two-step process:

First, the silt layers identified in the well from logs and FMI could be approximately localized along the cores by using the common depth scale;

Second, some borehole logs which do not perfectly fit the corresponding core log can be shifted and stretched in order to enhance the curves fit. The silt layer limits are affected by such shifting and stretching operations and their location along the cores will change.

Next a moving window approach is used. The linear correlation coefficient between a core log and its corresponding borehole log on a short segment, for various shifts upward and downward is calculated. The comparison of the correlation coefficients will allow determining the optimal shift at a given location. It must be kept in mind that the defined shift will be optimal with regards to statistical criteria, not to geological criteria. Therefore, the shifts proposed must be validated by a geologist. This analysis can be facilitated by replacing an original core log, which is discontinuous, by a continuous enhanced core log resulting from multivariate geostatistical calculations combining core and borehole logs and filtering noise.