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

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Introduction

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.

Methods

Indirect identification of Silt-Clay layers was difficult because of the clay expansion effect in the PVC liners due to pressure loss when sampling, and of a variable depth measurement due to stretch/shrinkage of the cable length while logging.

Two approaches have been tested:

- The first approach was to enhance continuous GR and Resistivity logs signal by means of geostatistical methods (Factorial kriging and Gaussian Anamorphosis). The goal was to enrich the borehole log trend by HF components extracted from the core log, while preserving borehole log histogram. Due to the dissimilarity of Resistivity measurements, this method was not accurate enough for automatic silt/clay layer identification.
- The second method is using a moving window approach combined with correlation calculations:
  1. A common depth scale between borehole and core logs is built manually from different sources of data, accounting for clay expansion;
  2. Silt layers identified in the well from logs and FMI are then approximately localized along the cores;
  3. The borehole logs which do not perfectly fit the corresponding core log can be shifted and stretched in order to enhance the curves fit.
     The shift is determined from the linear correlation coefficient between a core log and its corresponding borehole log on a short moving segment. Several shifts upward and downward are tested. Comparing the correlation coefficients allows determining the optimal shift at a given location leading to enhanced silt layer limits.

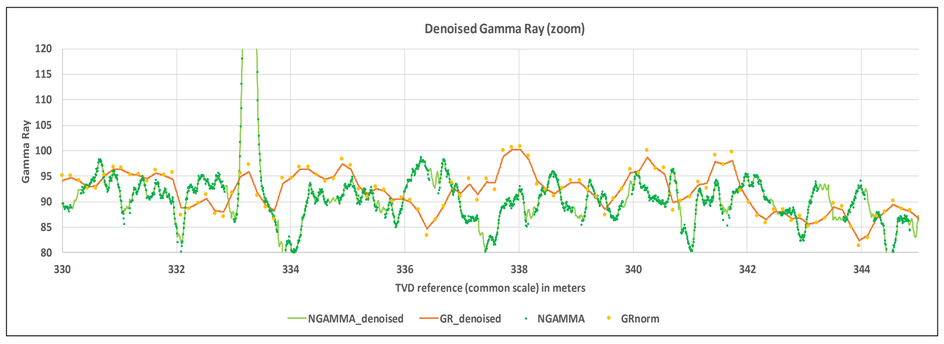
The proposed shifts come from statistical calculations and must be validated by a geologist.

This analysis is facilitated by using a continuous enhanced core log resulting from multivariate geostatistical calculations combining core and borehole logs and filtering noise.

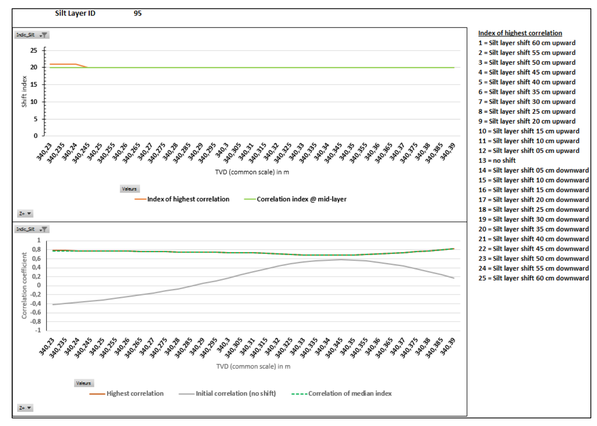
Results

The final second method led to the following results:

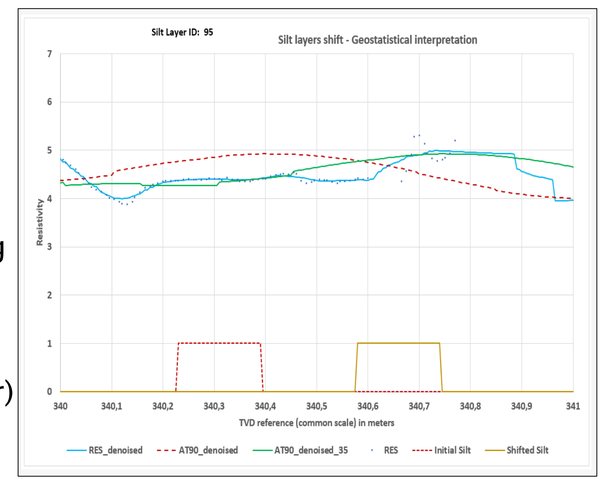
1. Creation of denoised logs used for calculating correlation between logs



2. Calculation of local correlation coefficients between logs, based on statistical plots analysis



- Shift for best correlation;
- Shift for best correlation at the middle of the silt layer;
- Initial local correlation coefficient without any shift
- Local correlation coefficient with the best shift
- Local correlation coefficient with the shift at the middle of the silt Layer



- Resistivity core measurements and the associated denoised continuous curve;
- Denoised Resistivity well log (AT90), before and after having applied the best shift at the center of silt layer ·
- initial and shifted silt layers (with the best shift at mid-layer)

The proposed shift improves correlation between cores and well logs, and leads to a shifted layer in front of a local peak of core resistivity, making it a good candidate for sampling.

Conclusion

The current work has allowed preparing synthetic documents (Excel sheets) in which the different data sources are merged in a consistent manner. These documents allow comparing well data and core related measurements with a reasonable level of accuracy.

From such documents, it is possible to define with a quite good precision the intervals of the preserved cores that can be sampled for detailed silt characteristics analysis.

References

Boom Clay: Identification of key cores on Mol-2D borehole for laboratory analysis. Study executed by Géovariances. NIROND-TR 2018-15 E V8 December 2019. 326p

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