University of Fribourg / Faculty of Science and Medicine / Department of Geosciences

Characterisation of lithological heterogeneity within the Opalinus Clay and at its upper lithostratigraphic boundary (N Switzerland)

Bruno Lauper

The production of long-lived radioactive waste is one of the major drawbacks of nuclear energy. Based on the current level of knowledge, there is an international consensus that deep geological disposal represents the long-term, safest method to dispose of such waste. In Switzerland, the selected host rock for nuclear waste storage consists of a very low permeable shale formation called Opalinus Clay. This 80 to 130 m thick succession of argillaceous and silty mudstones, present across northern Switzerland and Germany, was deposited during Early to Middle Jurassic times in a shallow-marine, epicontinental sea covering central Europe. Although considered as relatively homogeneous in comparison to other Mesozoic formations, some lithological heterogeneity exists and may influence the rock properties differently. It is therefore crucial to understand the overall lithological heterogeneity within the Opalinus Clay and its bounding units to allow the modelling and prediction of rock properties that may potentially be unfavourable to a deep geological storage.

Within this thesis, a vast array of different methods, including petrographic, mineralogical, geochemical and textural analyses, was applied to characterise the lithological heterogeneity within and at the top of the Opalinus Clay in northern Switzerland. Based on drill core material, the results showed that the studied successions can be described using a five-fold subfacies classification scheme, which also provides the means to harmonise petrographic descriptions within multidisciplinary research projects and enhance reproducibility of Opalinus Clay studies. The results further outline the convenience of combining rapid, non-destructive, core scanning techniques (e.g., X-ray fluorescence) to detect, classify and correlate horizons that constitute major (calcareous) heterogeneities within the Opalinus Clay, and to better understand their genesis and depositional setting.

In conclusion, this thesis highlights the relevance of combing different analytical techniques and various proxies to evaluate, describe, quantify, interpret and predict lithological heterogeneity within the Opalinus Clay and at its upper lithostratigraphic boundary. More generally, it presents methodologies that can be applied to the study of geological formations from the subsurface, and to maximise the amount of information derived from limited numbers of drill cores.

Jury:
Prof. Dr. Anneleen Foubert (thesis supervisor)
Dr. Gaudenz Deplazes (thesis co-supervisor)
Dr. David Jaeggi (thesis co-supervisor)
Prof. Dr. Jochen Erbacher (external expert)
PD Dr. Hendrik Vogel (external expert)
Dr. Stephan Wohlwend (external expert)
Prof. Dr. Olivier Graefe (president of the jury)