Subfacies heterogeneity within the Opalinus Clay: a multidisciplinary approach (Mont Terri rock laboratory, Switzerland)

Géraldine Nicole Zimmerli

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In 1994, the Nagra (National Cooperative for the Disposal of Radioactive Waste) selected the Opalinus Clay (late Toarcian to early Aalenian) as the preferred host rock for deep geological disposal of high-, intermediate- and low-level radioactive waste in Switzerland. The Mont Terri rock laboratory (northwestern Switzerland) is an important international test site for research on argillaceous formations since 1996. The Opalinus Clay is an argillaceous to silty mudstone formation, which consists mainly of clay minerals, carbonates and quartz, as well as minor feldspar, pyrite, siderite, mica and organic carbon. It has been deposited in an epicontinental sea covering central Europe during Lower to Middle Jurassic times.

This master thesis tested and improved the subfacies classification model of Lauper et al. (2018). This classification scheme is a user-friendly subfacies model for the whole Opalinus Clay in Switzerland, in order to harmonise Opalinus Clay descriptions for researchers from different fields. Accurate petrographic descriptions are a crucial prerequisite to many studies (e.g. rock properties). The five subfacies are the smallest lithologically coherent and macroscopically identifiable units.

For testing and improving the subfacies classification model, detailed petrographic and mineralogical investigations (macro- and microfacies analyses, X-ray diffraction), textural analysis (computed tomography), organic matter quantification (Rock-Eval pyrolysis) and stable carbon and oxygen isotope analyses were performed using several drill cores from the Mont Terri rock laboratory. The macro- and microfacies, X-ray diffraction, Rock-Eval pyrolysis and stable carbon and oxygen isotope analyses support the subfacies classification model, where an evolution from clay-rich (SF1) over quartz-rich (SF3) towards carbonate-rich (SF5) is evident. The additional CT analyses allow a 3D view of the lenses and the matrix. Moreover, the REV analyses enable to determine the representative elementary volume of each subfacies (> 3.5 cm).

Finally, a depositional and palaeoenvironmental interpretation model was constructed. The Opalinus Clay indicates a shallowing-upward sequence (regression) in a storm-wave-dominated epicontinental sea (with possible river and tidal influences). The lithology variability is primary attributed to local differences in depositional, environmental and diagenetic conditions. From SF1 towards SF5, one can observe an evolution from distal to proximal deposits, an increase in bottom energy, sedimentation rate, oxygen level and shallowing.

Prof. Dr. Anneleen Foubert