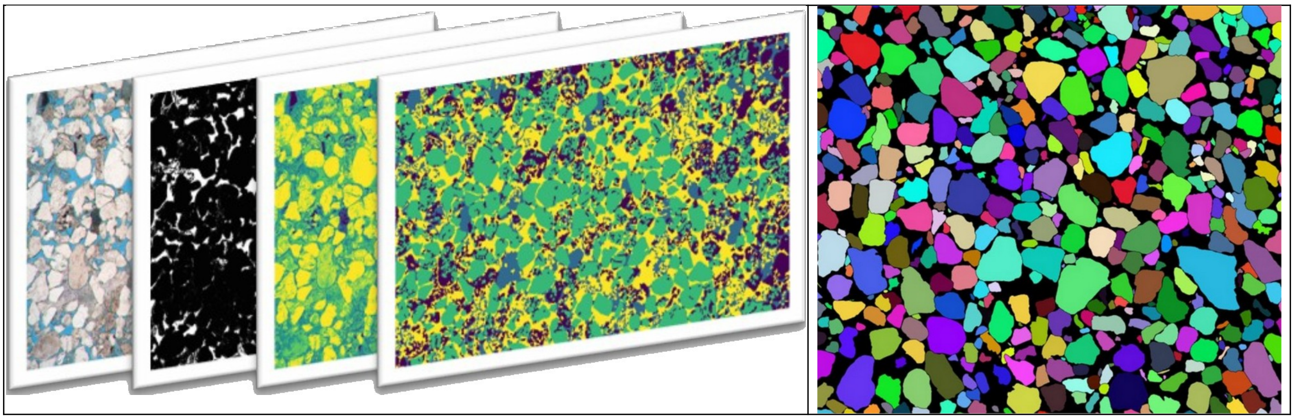
User-guided, semi-supervised thin-section segmentation



The ongoing gas depletion from the Groningen gas field led to pressure loss within the sandstones, which resulted in reservoir compaction, an associated surface subsidence and an increasing seismicity. In order to quantify the subsidence rate, and estimate local seismic event probabilities, a detailed rock property model of Groningen's reservoir is needed. For inferring the rock properties, multi-spectral scans of core-sample rock thin sections are available to the *Geo-Energy group* at UG's *Energy and Sustainability* research institute. The thin sections include tiny mineral grains (like sand grains) and filament material (akin to hard cement) between the grains. Some grains are separate from the filament via a surrounding thin-film coating. The type, shape and size of the grain, the presence-/absence of a coating film, and the filament area contribute to the target rock properties.

Computationally, transforming the thin-section photograph to quantified rock properties entangles (a) a sub-pixel accurate segmentation of grains, coating and filaments, (b) the grain labeling of different type- and size categories, (c) the sub-pixel accurate registration of the spectral image stack (and a re-alignment of the segment boundaries), and (d) the vectorized description of non-stationary, image-derived statistical properties for mineral objects. Here, we focus on the **object segmentation task**.

With the advent of advanced machine-learning, the ideal process would use a deep neural segmentation network. Yet, early experiments concluded that the specific thin-sections yield unsatisfactory results with pre-trained ML models. Thus, the emerging research question is *how to rapidly obtain large sets of training data – specifically the segmentation references – required for training a specialized deep learning model*. An exclusively manual segmentation is inadequate, requiring >8 hours for segmenting a single thin-section image. Thus, the envisaged project outcome is a segmentation procedure combining traditional parametric segmentation algorithms with user-parametrized correction methods. Hereby, the parametrization process should be *recordable* (i.e. order- and parametrization of the individual procedures), so the combined process can then be automatically replicated for later, larger image sets.

The project can be split into the follow sub-goals:

- Develop a pixel-accurate, automated fore- and background segmentation for thin-sections
- Survey, select and implement parametrized, unsupervised object segmentation techniques to separate individual grains and their coating (with sub-pixel contour accuracy)
- Design and develop a parametrized, local segmentation-/object-contour correction method that facilitates interactive, controllable modifications of segment boundaries
- Design and develop a procedure to record, log, store and reproduce the parametrized sequence of processing and correction steps
- Develop a GUI to control the segmentation process