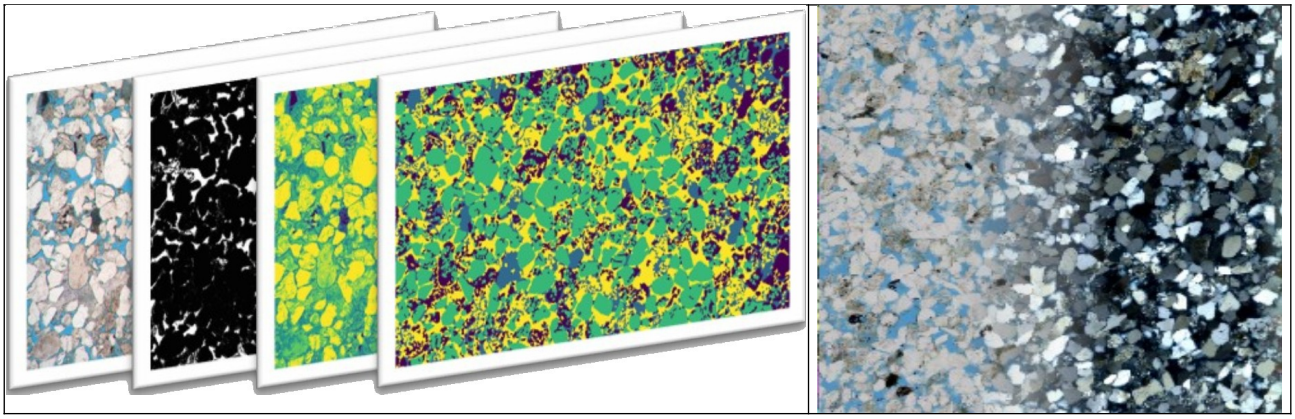
Classification and Feature Description of Mineral Objects in Spectral Thin-Section Images



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 **grain labeling** and the **vectorized feature description** of the mineral- and clay segments.

The basis for the classification and feature description is (a) a segmentation of grains, coatings and filament, and (b) a spectral image stack, with each image describing the material reflectance of a spectral band of light. Classifying (i.e. labeling) shall differentiate the segments based on their size (for grains) and reflectance similarity. In a simple view, the classes are clusters in nD spectral space. Challenges to consider are (a) the incoherent segment boundaries between the spectra, (b) the absence of individual objects in some spectra, and (c) the quantized reflectance expression. Having classified the individual image objects, the project answer *how to describe mineral-/clay objects in a property model, based on spectral reflectance.* The target feature descriptor is used by geologists to derive the rock property model. The descriptors may directly include spectral features, it may be derived from statistic- or probabilistic functions, or can be a product of a neural learning process.

The project goals are given as follows:

- Design and develop a robust classification scheme using geometric grain features and the objects' reflectance patterns, accounting for quantization artifacts and spectral variation
- Survey and evaluate different object-based feature descriptors from the literature on imaging, mineralogy and computational geosciences
- Design a feature (i.e. property) descriptor for characterizing the individual object classes
- Design and develop a feature extraction- and comparison algorithm, based on the survey