A toolbox for characterization of chalk

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The mineralogy and textures of fine-grained carbonates, and alterations within, are challenging to accurately analyse with conventional petrographic methods due to the small grain-size and the brittleness of the rock. Use of high-resolution techniques can elucidate detailed information on composition and crystal structure and have to large extent revolutionised mineralogical analyses of fine-grained carbonates such as chalk.

We have tested several methods for studies on chalk and have found the most suited applications for both sample preparation and analyses at multiple scales. Of particulate interest has been sample preparation for the highly porous and brittle chalk for high resolution electron microscopy. The best suited advance has been by preparing micrometer-sized lammellas by the use of focused-ion-beam milling. The analyses are carried out by the use of various types of electron microscopy including scanning and transmission electron microscopy combined with mapping by Mineral Liberation Analyzer. With a combination of these tools it is possible to catch mineralogical characteristics and mineral new-growth at the needed scales. To supplement these analyses, whole-rock and stable isotope analyses have been performed together with Raman spectroscopy, tip enhanced Raman spectroscopy, atomic force microscopy and X-ray diffraction.

By combining these methods we have created a “toolbox” which is able to study the mineralogy and alterations caused by rock – fluid interactions at sufficient resolution and accuracy on micron-scale and at smaller dimensions. The various methods yield results at different scales, and provide information on both elemental composition and phase identifications based on the crystal lattice parameters. As such, the combination of these analyses yield additional information compared to a single-method approach. Benefits are in the field of basic research as well as for applied sciences in e.g. the field of enhanced oil revcovery and reservoir chemistry.